

CL 201 THERMODYNAMICS

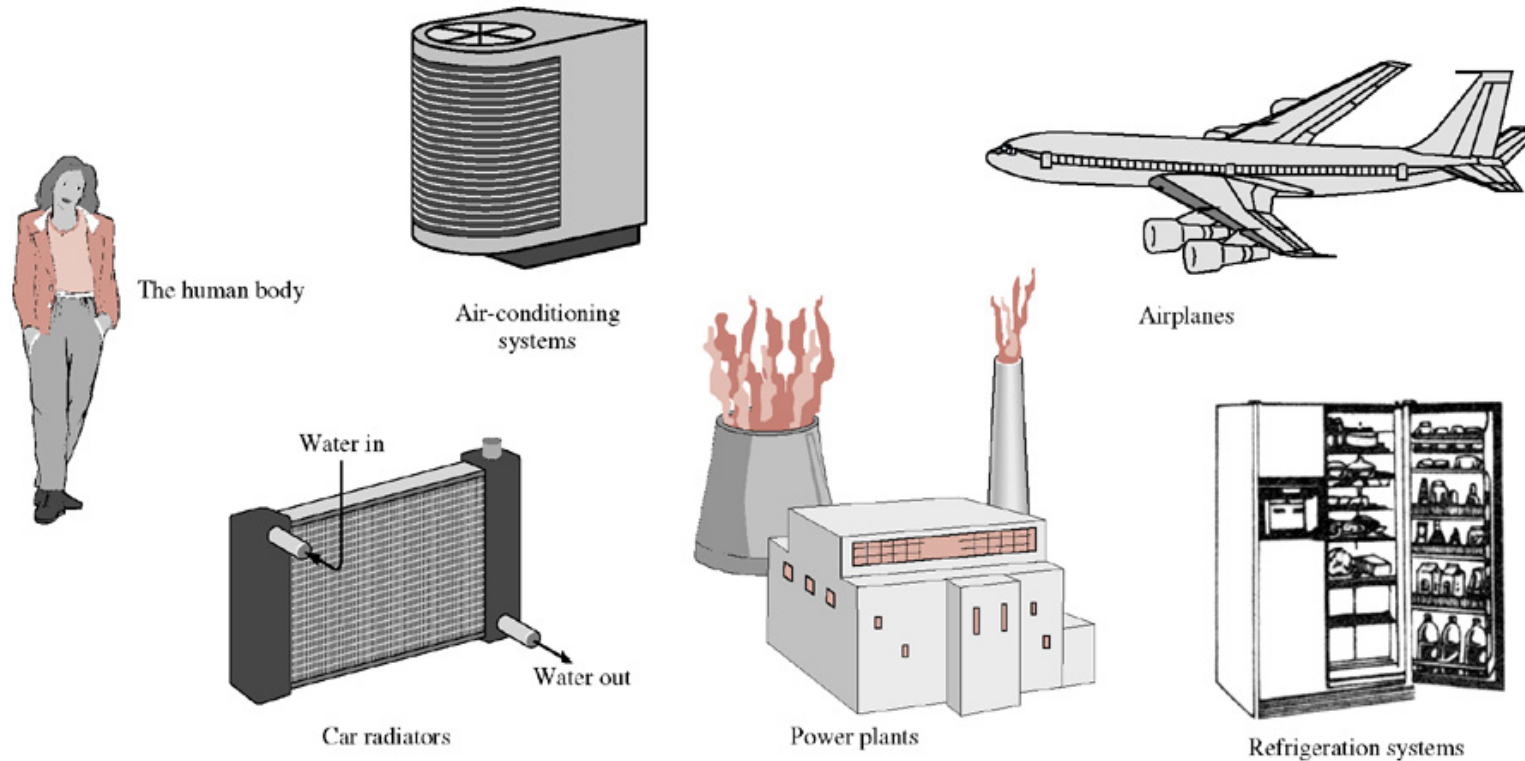
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What is Thermodynamics?

The name ***thermodynamics*** is derived from the Greek words ***therme*** (heat) and ***dynamis*** (power).

Thermodynamics can be defined as science of *energy*.

Application Areas of Thermodynamics



DEFINITIONS AND FUNDAMENTAL CONCEPTS

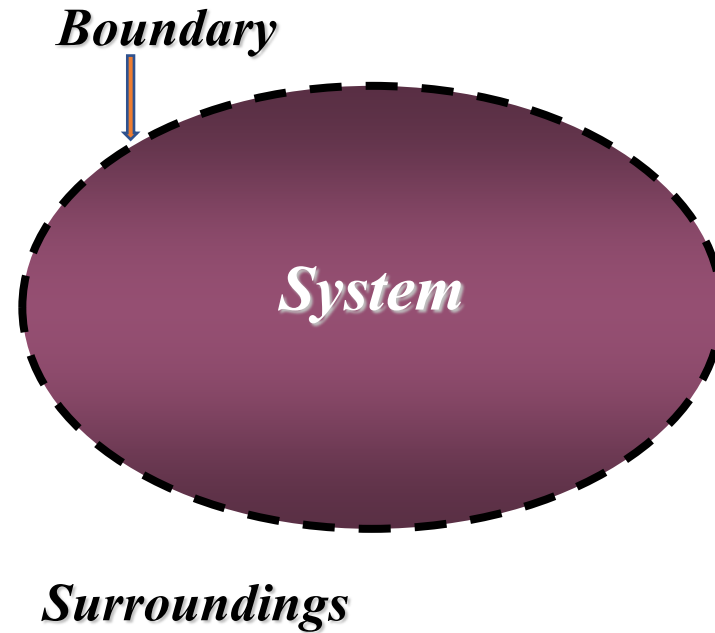
Systems and Processes

System

A substance or group of substances in which we have special interest is called a *system*.

Example

- Reaction vessel,
- distillation column,
- heat engine.



Surroundings

The part of the universe outside the system and separated from the system by boundaries is called *surroundings*.

Boundary

The boundaries may be either **physical** or **imaginary**; **rigid** or **movable**.

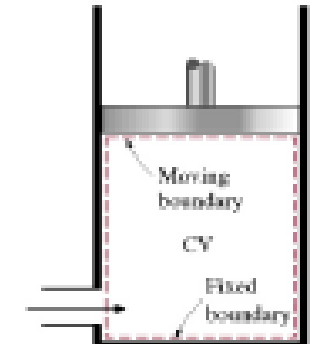
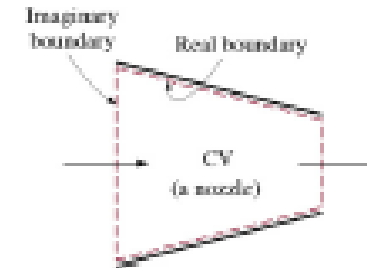
The surroundings are usually restricted to

- ✓ The immediate vicinity of the system
- ✓ Portion of the universe that are affected by changes occurring in the system.

Process

The changes taking place within the system is referred to as a *process*.

Example : 1) Combustion of hydrocarbon fuel and oxygen
2) Steam condensing in a shell-and-tube heat exchanger



Homogeneous and Heterogeneous Systems

Homogeneous system

Here the properties are the same throughout or vary smoothly without showing any surface boundary. Also known a *phase*.

Examples: Any pure liquid like benzene in a beaker
A column of dust-free air above the earth's surface

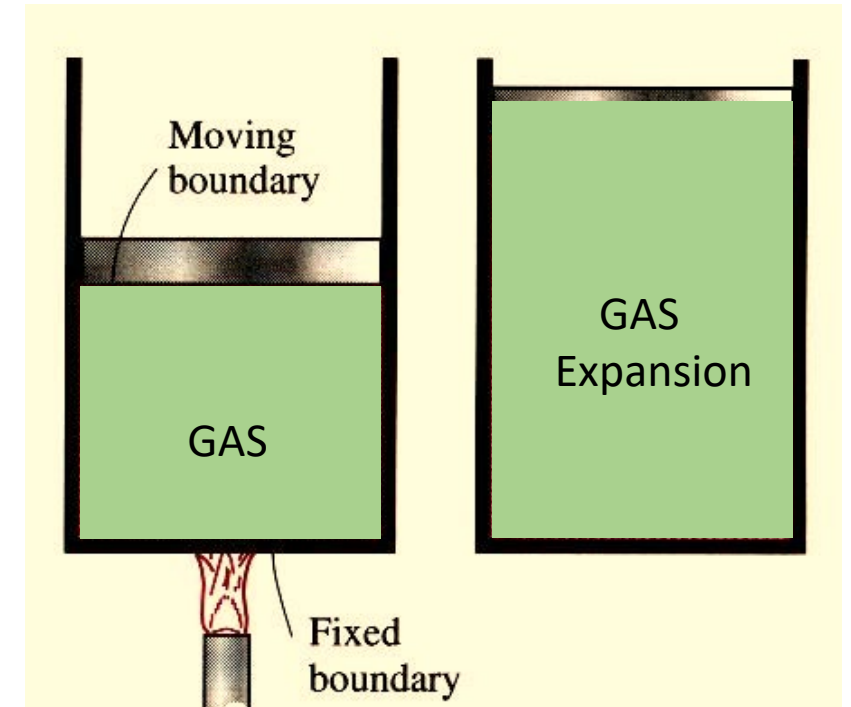
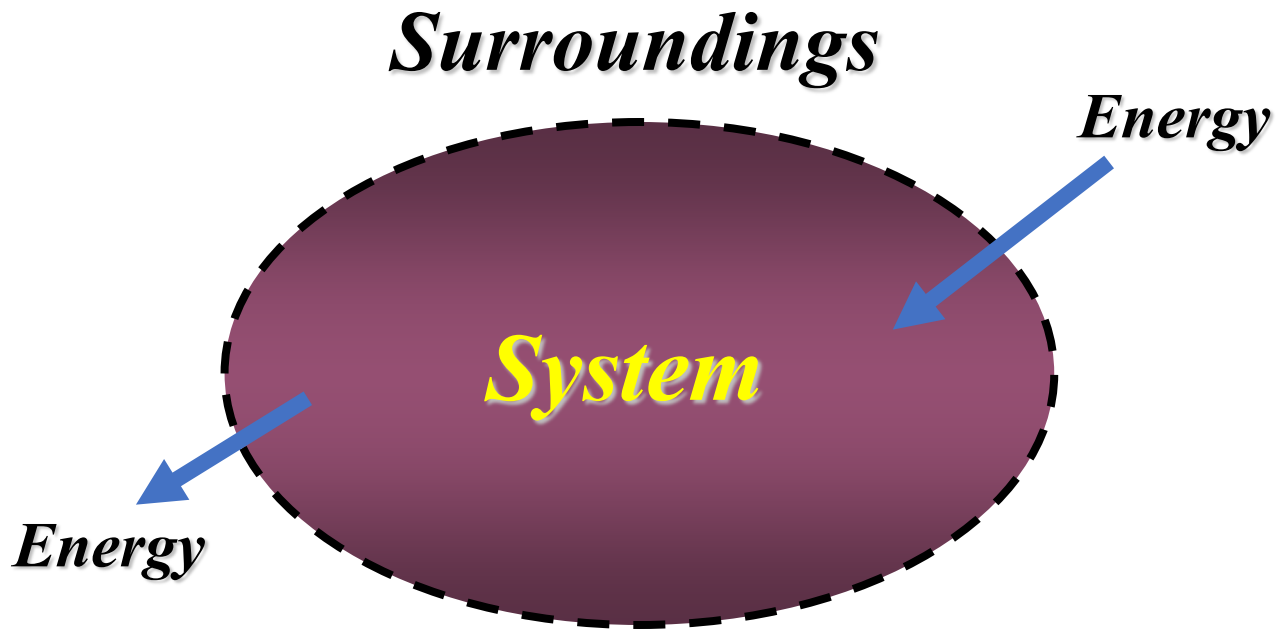
Heterogeneous system

This is a system which consists of two or more distinct homogeneous regions or phases. There is a sudden change in properties at the phase boundaries. Heterogeneous system made up of two immiscible liquid phases

Examples: A liquid mixture of kerosene and water
Water and water vapour taken in a closed container
Alloys (Mixture of different solids any number of different phases)

Closed and Open Systems

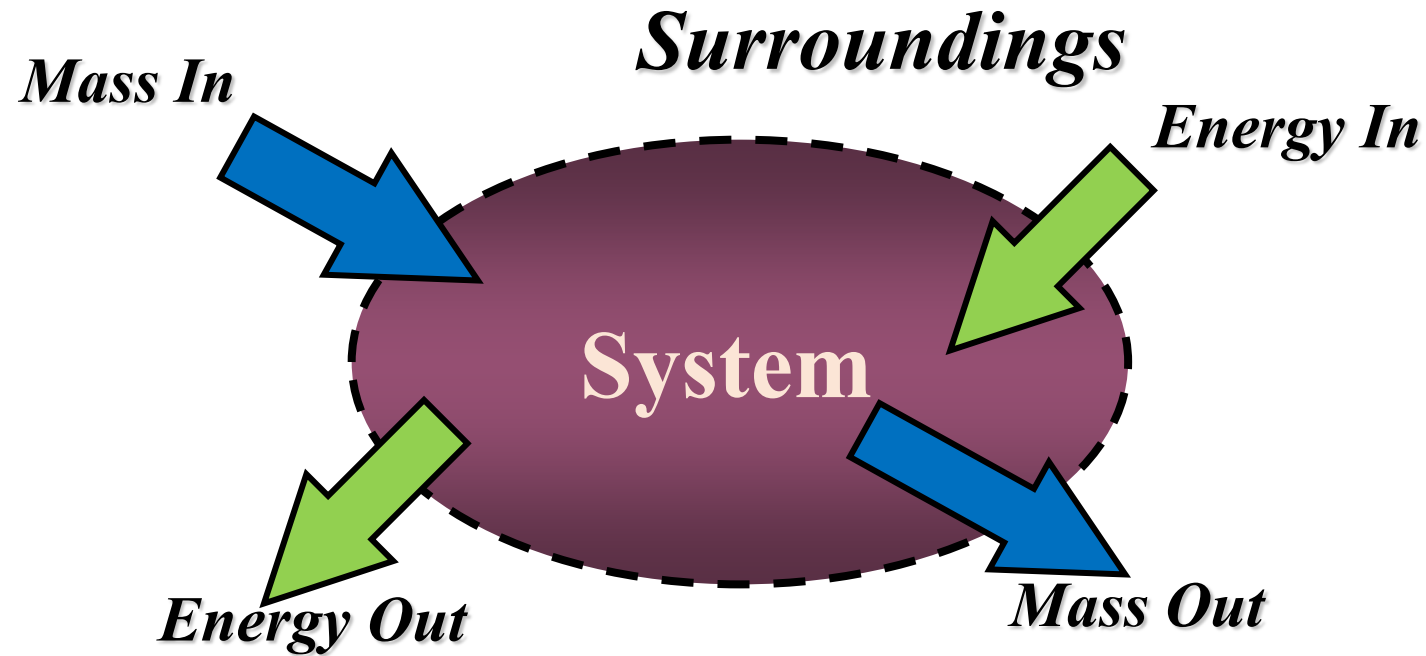
Closed System (Control Mass)



Closed system

Systems that can exchange energy &/ work with the surrounding but no mass enters or leaves across the boundaries are known as *closed systems*. Such a system is said to be a *control mass*.

Open System (Control Volume)



Open system

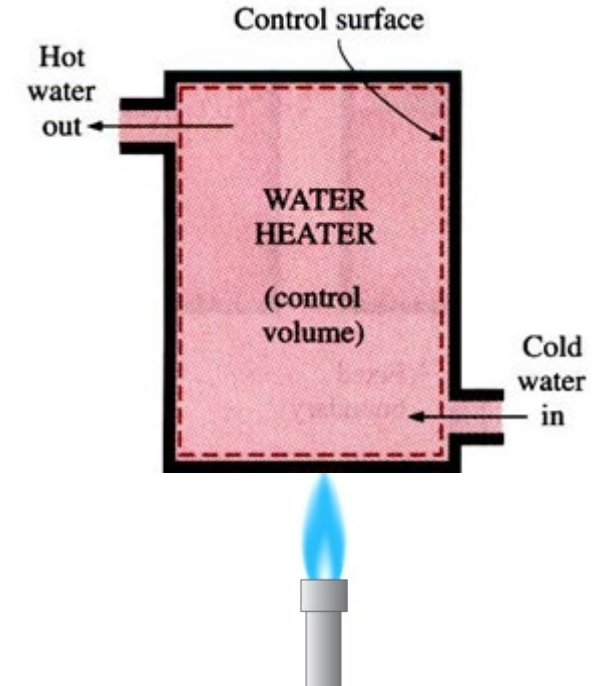
Here both mass and energy can be exchanged with the environment. Such a system is said to be a *control volume*.

Example: Multiphase system - each phase is open since material is free to move each phase, although the system as a whole may be closed in terms of flow of matter.

Question

Batch reactor - ?

Tubular flow reactor - ?



Isolated System



*Surroundings
Are changing*

The system is totally unaffected by the changes in its environment. Neither energy nor mass can cross the boundaries of an isolated system.

- ☐ System closed by heat insulation layer - *thermally isolated* (may have mass flow)
- ☐ System enclosed by impervious walls to the flow of heat - *mechanically isolated* (may have heat/energy flow)
- ☐ System enclosed by rigid walls - *completely isolated* (neither material nor energy can be added/removed).

A perfectly isolated system is an ideal concept. The system and surroundings considered together constitute an isolated system. Thus, the universe can be treated as an isolated system.

STATE AND PROPERTIES

- ❖ There are certain specific properties (such as pressure, volume, and temperature) are necessary to define the conditions of a given system. These set of conditions are called the *state* of the system.
- ❖ The properties used to define the state are called the *state functions* / *properties* of the system.
- ❖ The minimum number of variables required to represent the state uniquely depend on
 - the number of *phases* constituting the system
 - the number of distinct *chemical species* present in the system (Phase rule).

Homogeneous System Consisting of A Single Substance

The properties generally used to represent the state – pressure(P), the volume(V), and the temperature(T).

If two properties, P & T are known, all other physical properties, e.g. density, viscosity, refractive index are thereby definitely fixed.

Thus, thermodynamic properties serve to define the state of a system completely.

EXTENSIVE PROPERTIES AND INTENSIVE PROPERTIES

Extensive Properties

If the properties are depending on the quantity (or extent) of matter specified in the system, they are called *extensive properties*.

Examples: Mass, volume, Heat capacity etc.

- ❖ The total value of any extensive property is calculated by the summation of the values of the said property of individual components present in all phases.

Intensive Properties

An *intensive property* is independent of the size of the system.

Examples: Pressure, temperature, specific volume, density, etc.

When Intensive Properties become Extensive Properties

Intensive properties becomes the extensive properties when divided by unit amount of the substance concerned (mass).

Examples : specific volume $v = V/m$, specific total energy $e = E/m$, density $= V/m$, Specific heat.

- ❖ Intensive properties are independent of the amount of the substance

State and Path Functions

State functions

The *state functions* are the **properties** that are **fixed for a particular state** of the system and **do not** in any way **depend upon** the **past history** or the **path** by which the state was arrived at.

- When a system is considered in two different states, the difference(Δ) in property(say M) between the two states depends solely upon those states themselves regardless of the process by which the change is brought about.
- Therefore, ΔM , for state 1 to state 2, is always the same and do not in any way depend upon the past history or the path by which the state was arrived at.
- For a cyclic process, the initial and final states are the same and the change in the property $\Delta M = 0$.

Path functions

The path(from the initial to the final state) dependent properties like **heat** and **work** vary with different types of paths.

For example,

- ❖ In a combustion chamber, burning of some mass of hydrocarbon fuel in air at constant volume results in heat energy generation by the system, but no work being done.
- ❖ In an internal combustion engine, a large part of the energy of the hydrocarbon-air system is converted to mechanical work and only the remainder into heat to engine. It means that the heat and work involved in a given change of state are not to be determined solely by the initial and final states; they also depend on the manner in which the change is carried out.
- ❖ Heat and work are therefore not thermodynamic properties of the system.
- ❖ **Both heat and work are called *path functions*.**

Steady State vs Equilibrium State

Steady State

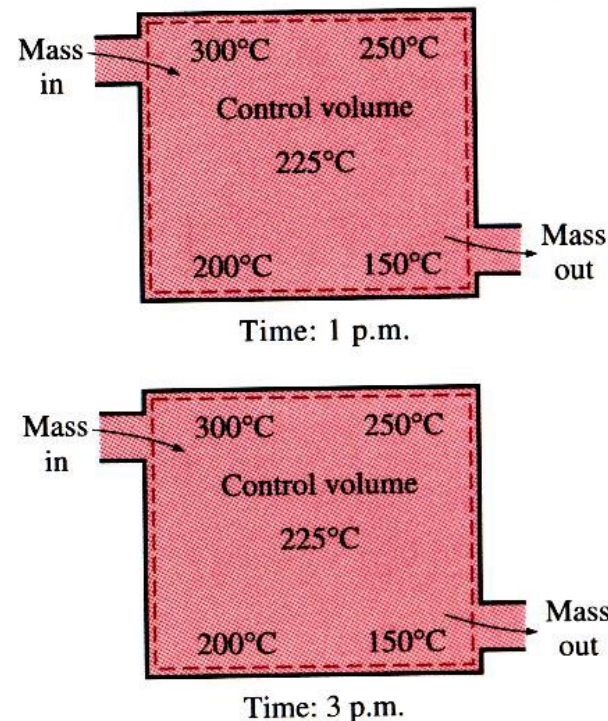
A system that interacts with the surroundings, is said to be in *steady-state condition* when the properties at a specific location in the system is not function of time, i.e. properties remain unaltered with progress of time.

Example: Walls of a furnace (inside surface exposed to hot combustion gases and the outside surface to the atmospheric air)

Under *steady-state condition*,

- the temperature at any given point remains constant and does not vary with time
- the temperatures at different points in the wall would be different.

✓ Under steady state, a system exchanges mass, heat, or work with the surroundings.



Steady State vs Equilibrium State

Equilibrium State

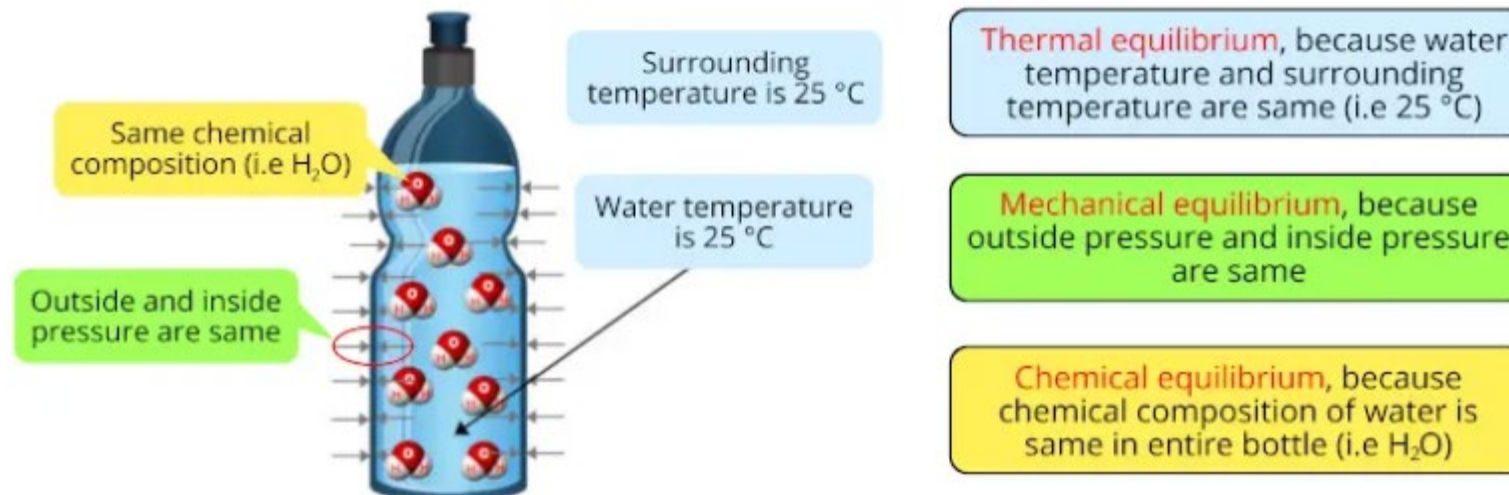
A system is said to be in a state of equilibrium if the properties are uniform throughout and they do not vary with time.

- Thermal equilibrium - the temperature (T) is uniform throughout (No heat exchange)
- Mechanical equilibrium - the pressure (P) is uniform throughout
 - ✓ Under uniform temperature and pressure, chemical reaction (mass transfer) may occur between the various components present in the system.
- Thermodynamic equilibrium –
 - ✓ no mass transfer between the phases
 - ✓ no diffusion of mass within the phase
 - ✓ no chemical reaction between the constituents

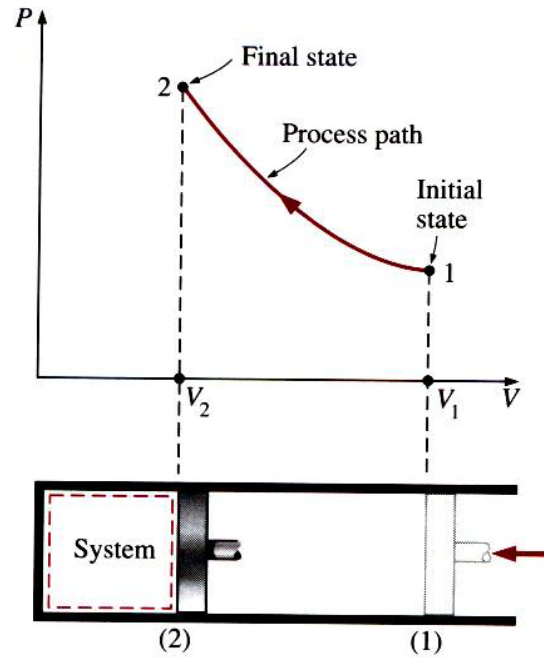
In absence of heat and work exchange

A state of equilibrium implies a state at rest all forces are in exact balance

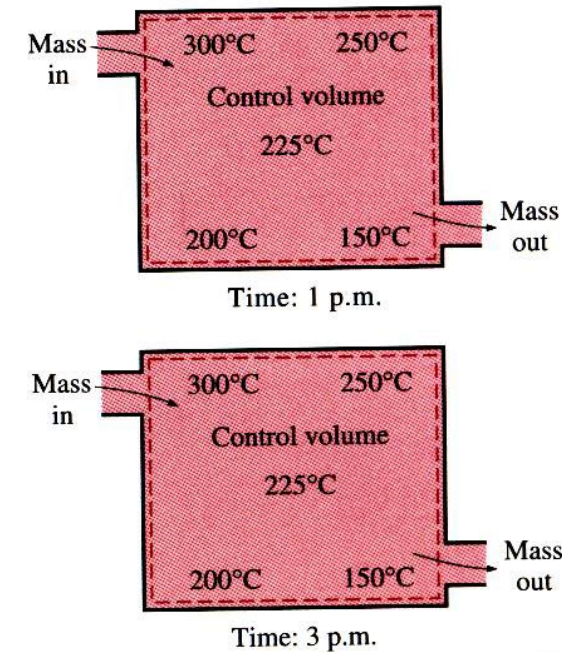
"Two systems are said to be in thermodynamic equilibrium when they are in thermal, mechanical and chemical equilibrium with each other"



CYCLES AND PROCESSES



- **Process:** change of a system from one equilibrium state to another
- **Path:** series of states occurring during a process
- **Quasi-equilibrium process:** process is slow enough for system to be near equilibrium at intermediate states



- **Steady:** no change with time
- **Uniform:** no change with location
- **Steady-flow process:** flow through a control volume such that properties are steady at any point but non-uniform across the control volume

PHASE RULE

The concept of equilibrium is important in thermodynamics, because, properties have any real meaning only in the equilibrium state.

Degrees of Freedom

The number of independent variables necessary to define the state of equilibrium uniquely is known as the *number of degrees of freedom*.

There is a definite relationship between the number of degrees of freedom (F), the number of distinct chemical species constituting the system and the number of phases (P) present at equilibrium. This is given by the Gibbs phase rule,

$$F = C - P + 2$$

The number of degrees of freedom determines all the intensive thermodynamic properties of the system.

Questions

Find the number of degrees of freedom for

- 1) Water and water vapour in thermodynamic equilibrium
- 2) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) = 2\text{NH}_3(\text{l})$

TEMPERATURE and ZEROTH LAW OF THERMODYNAMICS

- ✓ Temperature is a property of a system which determines the degree of hotness.
- ✓ Thermodynamic temperature scale is under evolution. What we have now is an empirical scale.
- ✓ When two systems are at the same temperature they are in thermal equilibrium
- ✓ *Zeroth Law of Thermodynamics : If body A is in thermal equilibrium with B and B is in thermal equilibrium with C, then C is also in thermal equilibrium with A.*

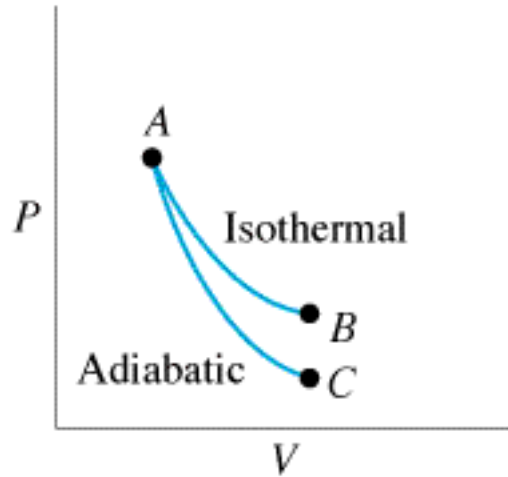
HEAT TRANSFER

- Heat - the form of energy that is transferred between a system and its surroundings provided there is any temperature difference between them.
- Direction: Heat energy transfer is always from the higher temperature body to the lower temperature one.
- When the system and surroundings are in thermal equilibrium, they are at equal temperatures and no further energy transfer takes place.
- Heat energy, in transition, is only recognized when it crosses the system boundary.

Energy Transfer by Work

- Work - Energy transfer associated with a force acting through a distance. e.g., rising piston, rotating shaft, and electric wire crossing a system boundary.
- Energy may cross a system boundary as heat (driven by temperature differential) or work. If its not heat, it is work.

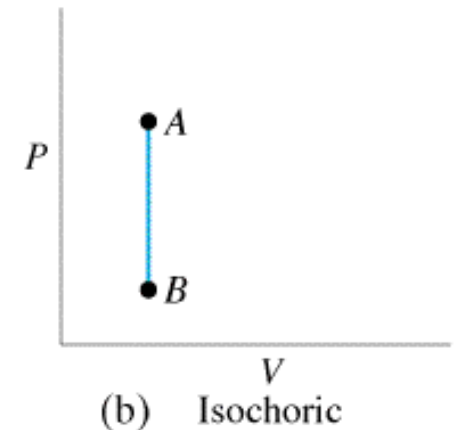
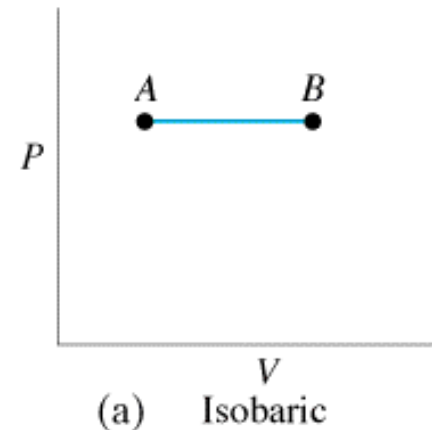
Different Thermodynamic Processes



An *isothermal process* is one where the temperature of the system does not change ($\Delta T=0$).

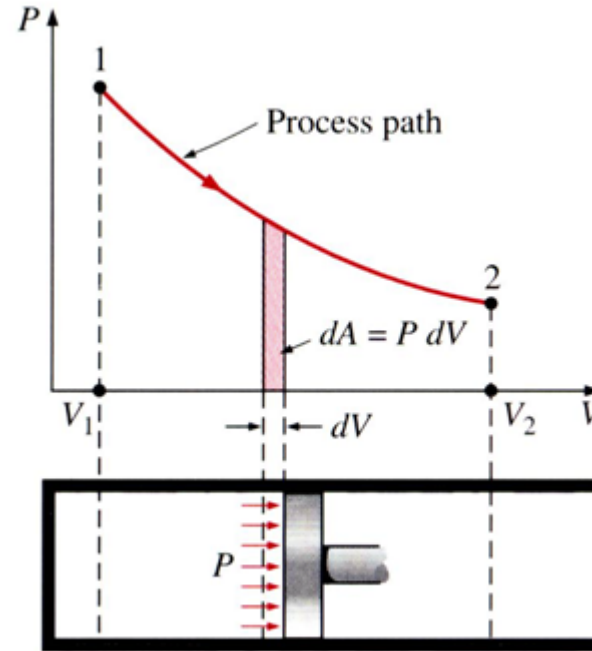
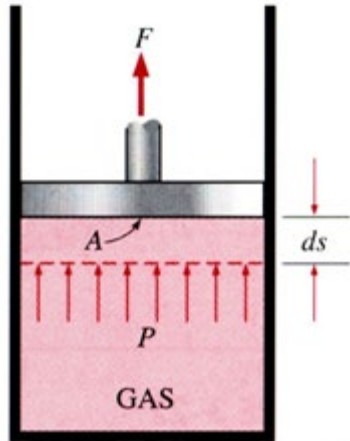
An *adiabatic* process is one where net heat flow $\Delta Q=0$. That is, no heat flows into or out of the system.

An *isobaric* process holds the pressure constant ($\Delta P=0$), while an *isochoric* process holds the volume constant ($\Delta V=0$).



Work Done by a System

Let us consider the expansion or compression work in a cylinder, where a gas is confined and let the pressure of the gas be P and volume V . If the surface area of the piston exposed to the gas is A . Energy is expended in the form of work (W) when a force(F) acts through a distance(ds).



Question

What is the amount of Work done(W)?

You have to find $W = \int P dV$

Work

Energy is expended in the form of work(W) when a force(F) acts through a distance(ds). Thus,

$$dW = F ds \quad (1)$$

Let us consider the expansion or compression work in a cylinder, where a gas is confined and let the pressure of the gas be P and volume V . If the surface area of the piston exposed to the gas is A , the force acting on the piston is

$$F = PA \quad (2)$$

The displacement of the piston in the direction of the force ds is related to the change in volume dV of the gas as

$$ds = dV / A \quad (3)$$

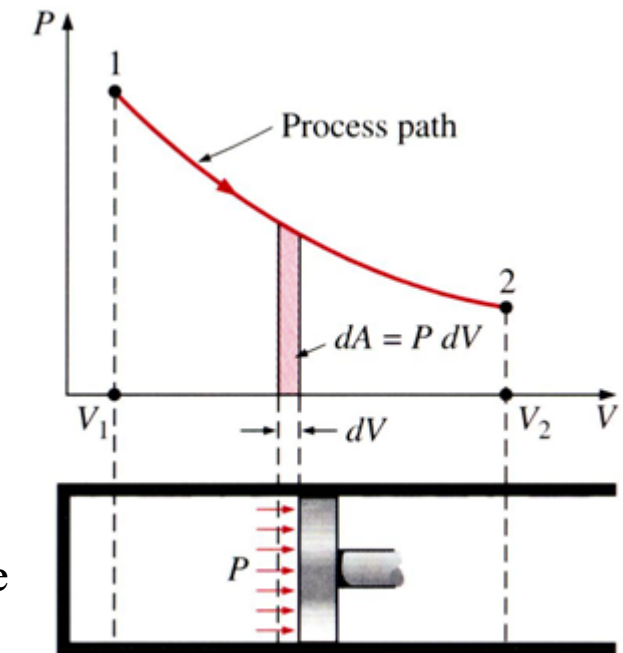
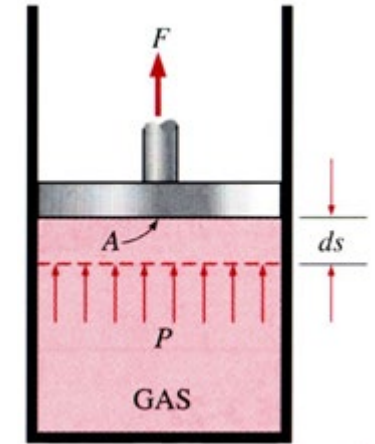
Substituting Eqs. (2) and (3) in Eq. (1), we get

$$dW = P dV \quad (4)$$

If the volume of the gas changes from the initial value V_1 to the final value V_2 , Eq. (4) may be readily integrated to get the work done on the face of the piston:

$$W = \int_{V_1}^{V_2} P dV \quad (5)$$

The pressure–volume history of the gas undergoing the change in state is illustrated on the P - V diagram of Fig. 1.1. The integral of the Eq. (5) is given by the area under the curve between the limits V_1 and V_2 . The area, and hence the work done in the compression or expansion of the gas depend on the shape of the PV curve, thus establishing that the work done in a process is a path function.



REVERSIBLE AND IRREVERSIBLE PROCESSES

Processes occur when there exists a driving force for a change of state between the parts of the system or between the system and the surroundings.

- ❑ If the driving force is finite, the process is *irreversible*
- ❑ if driving force is infinitesimal small in magnitude, the process is *reversible*

REVERSIBLE PROCESSES

In contrast, the direction of a reversible process can be changed by an infinitesimal change in the forces acting on the system. A system undergoing a reversible process can be brought back to its original state, leaving no change in the surroundings.

Example:

Water and water vapour in equilibrium contained in a cylinder provided with a frictionless piston. The external force on the piston is kept equal to the force due to the vapour pressure of water at the given temperature. By increasing the force acting on the piston by an infinitesimally small amount, the vapour will condense; and decreasing it slightly will make water to vaporise. The process is very close to a reversible process as the work required to condense a certain amount of water vapour would be equal to that required to vaporise the same quantity of water.

FOR REVERSIBLE EXPANSION OF THE GAS

The same process can be carried out reversibly if the weight on the piston is replaced by infinitely large number of fine particles together weighing W . Refer Fig. 1.6.

- If the particles were removed one at a time, the pressure of the gas would never be out of balance with the downward forces.
- When the entire weight is removed from the piston, the potential energy of the surroundings is increased, as is evident from the height of the pile obtained on the side.
- The system does maximum useful work on the surroundings.
- The weights can be replaced one by one on the piston and the piston can be made to retrace its path without using any extra energy from the surroundings.
- This is a reversible process, as the process can be reversed at any instant by an infinitesimally small increase in the downward forces and the original state of the system is restored without any change in the surroundings.

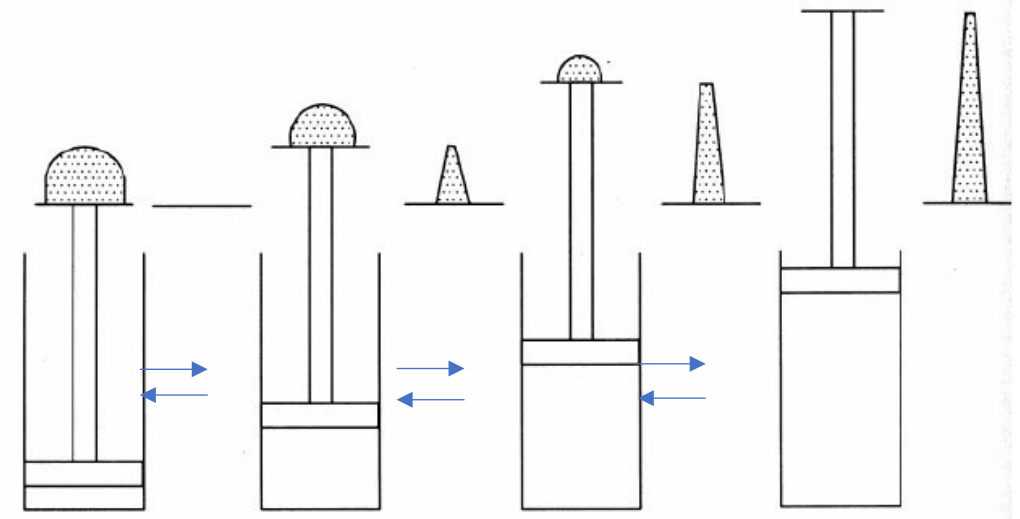


Fig. 1.6 Simulation of reversible expansion of a gas.

THE CHARACTERISTICS OF A REVERSIBLE PROCESS

- ✓ In a reversible process, the driving and opposing forces are in exact balance, and an infinitesimal change in the external conditions would cause a reversal in the direction of the process.
- ✓ For reversible process to occur, friction, turbulence, and other dissipative effects should be absent.
- ✓ It takes an infinite time for its completion.
- ✓ A reversible process occurring in a work-producing machine delivers the maximum amount of work and that occurring in a work-requiring machine requires the minimum amount of work.
- ✓ A reversible process is an idealised and imaginary concept and may be used for the comparison of the performance of actual systems and for indicating the efficiency of processes.

IRREVERSIBLE PROCESSES

- All spontaneous processes in nature are irreversible
- Cannot be reversed without the use of external energy
- Heat or work interactions by the surroundings are needed to be brought back to its initial state.

Example of irreversible Processes

- ✓ The free expansion of a gas
- ✓ Diffusion of a solute from a concentrated solution to a dilute solution
- ✓ Transfer of heat from a hot body to a cold body
- ✓ Rusting of iron in the presence of atmospheric oxygen
- ✓ Mixing of two pure gases

If all naturally occurring processes are irreversible, then why should we introduce the concept of reversible processes?

A gas at high pressure is confined in a piston–cylinder arrangement. The piston is held in position by placing a suitable weight W over it. The pressure of the gas is balanced by the atmospheric pressure and the weight of the piston that includes the weight placed on it. Assume that the piston and cylinder neither absorb nor transmit heat and that the piston moves within the cylinder without friction. Now, suppose that the mass W is removed by sliding it into a compartment on the side. Due to the force imbalance, the piston rises up as indicated in Fig. 1.5.

The work done by the gas on expansion against the atmosphere is not available for restoring the gas to its initial state. If the gas returns to its original state, work would be done on the system, in which case, the surroundings undergoes some change. Therefore, the process is clearly an irreversible one.

On the other hand, if the weight is raised to a higher level due to the expansion of the gas, the potential energy of the surroundings would increase and by utilising the increment in the potential energy, the state of the system can be restored.

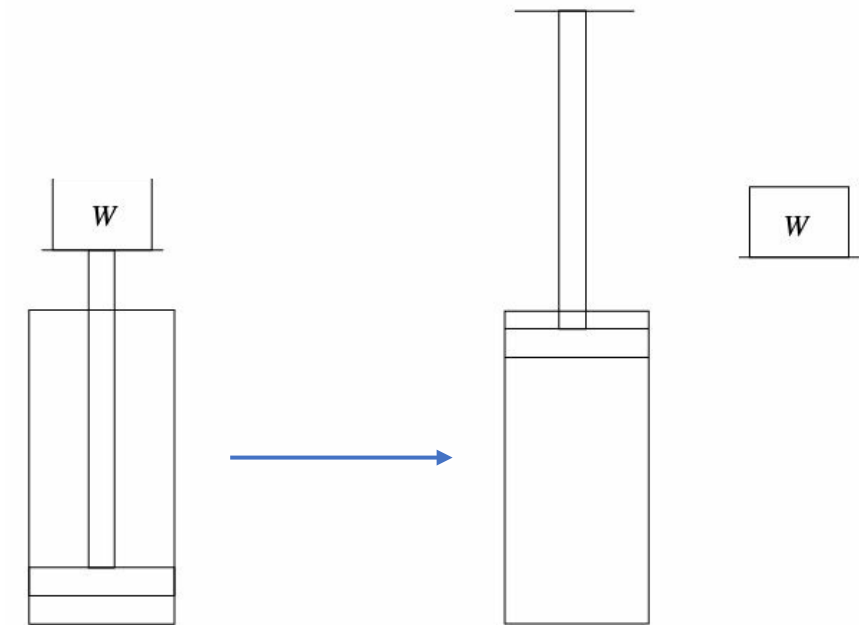


Fig. 1.5 Irreversible expansion of a gas.

FOR IRREVERSIBLE EXPANSION OF THE GAS

$$W \neq \int P dV$$

- ❖ The work of expansion done by the gas against the atmosphere is measured as $W = \int F dz$
- ❖ When the force acting downwards and the gas pressure are in exact balance,
 - $F = PA$, The work done by the gas against the atmosphere is $\int F dz = \int P A dz = \int P dV$
- ❖ Once the weight W is removed from the piston, the forces are out of balance; that is, the force exerted by the gas and the downward force are not equal. Therefore, $W \neq \int P dV$
- ❖ Only for a reversible process, the forces are always in exact balance and the work done by the system is evaluated from the properties of the system.
- ❖ Thus $W = \int P dV$ is applicable only for a reversible process.

The calculation of work appearing in the surroundings using the properties of the system is possible only if the process is reversible.

HEAT RESERVOIR, HEAT ENGINE AND HEAT PUMP

Heat Reservoir

A thermal reservoir is a sufficiently high temperature reservoir (HTR) system under equilibrium. It supplies finite amount of heat to a low temperature reservoir (LTR) without any change in its temperature.

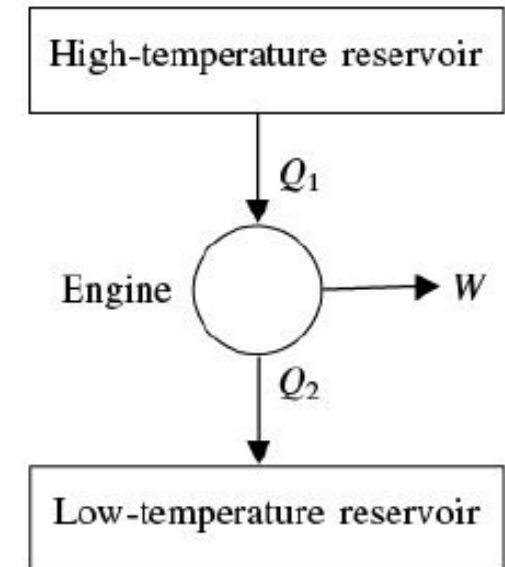
Heat Engine

A heat engine is a thermodynamic system (HTR) that are operating in a cycle; here heat is supplied to Engine from which some part is converted into work and the remaining part of heat energy is released to heat sink (LTR).

The figure shows an engine that receives heat Q_1 , delivers work W and rejects heat Q_2 to the sink.

The *thermal efficiency* (η) of the engine is defined as the ratio of work output (W) to the heat input (Q_1).

$$\eta = (W / Q_1)$$



Heat Pump

A *heat pump* is a thermodynamic system operating in a cycle; by means of external energy in the form of work it removes heat from a low temperature body (LTR) and transfers it to a high temperature body (HTR).

Figure shows a heat pump which receives heat Q_2 from the LTR and supplies heat Q_1 to the HTR utilising external work W .

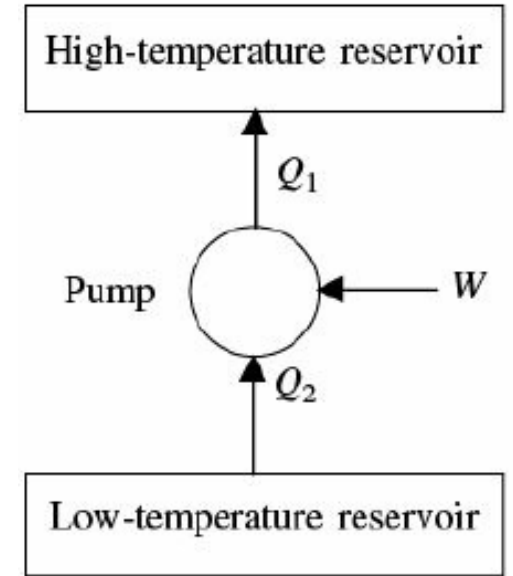
The coefficient of performance (COP) of heat pump is defined depending upon the primary purpose for which it is used.

In refrigerator, the primary purpose is the removal of heat from LTR (Q_2) by the work-input (W) to high temperature atmosphere (HTR). Here,

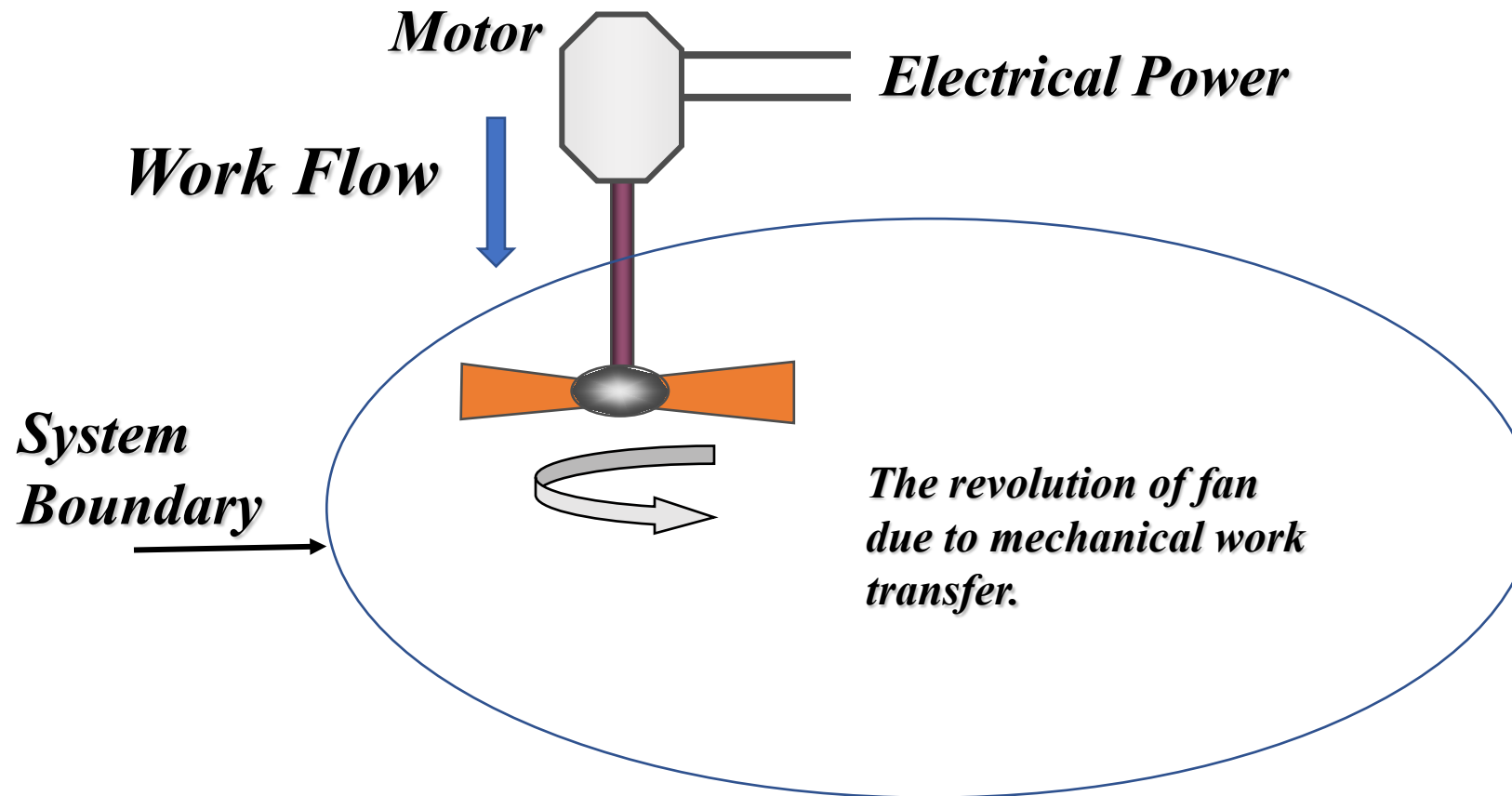
$$\text{COP} = Q_2 / W$$

When heat output to HTR is the primary purpose, then

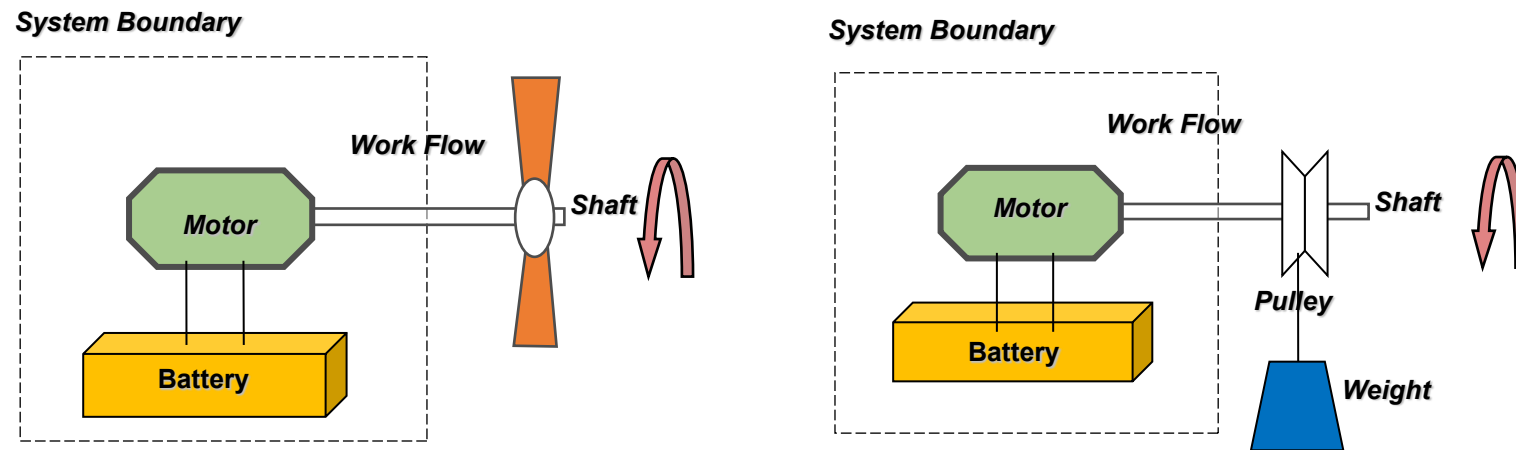
$$\text{COP} = Q_1 / W$$



Mechanical work flow

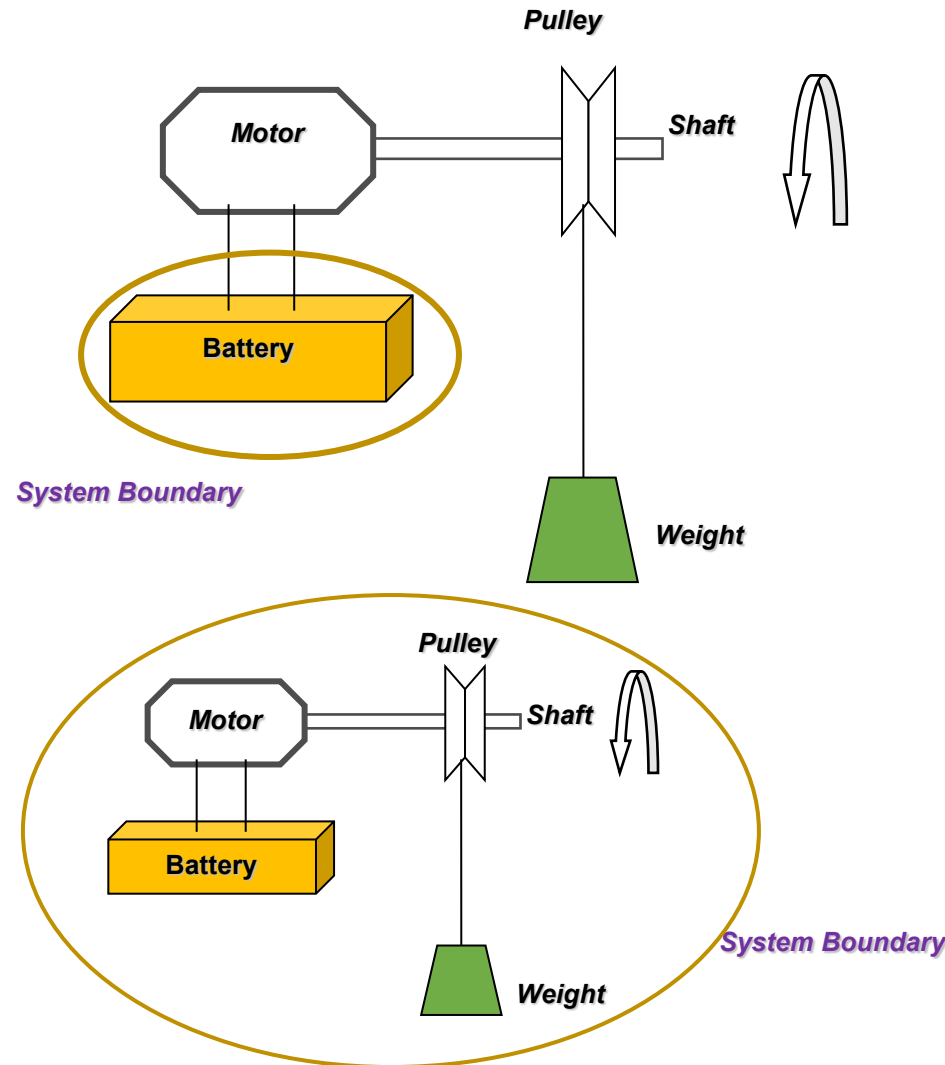


Is work being done?



YES. As work crosses the system boundary. *Work is being done by the system.*

Is work being done?



YES. As flow of electrical energy across the system boundary constitute a work. The sole effect could be raising a weight if the motor is 100% efficient.

No. Work does not cross the system boundary

Sign Convention

Heat transferred to a system and work done by a system are positive. Heat transferred from a system and work done on a system are negative.

Q (+)	System gains heat
Q (-)	System loses heat
W (+)	Work generated in the system and transferred to surroundings i.e. Work done on by the system
W (-)	Work received in the system from surroundings i.e. Work done by on the system

Mechanical Forms of Work

Find the work done for reversible process

- 1) Constant Volume Process (Isochoric)
- 2) Constant Pressure Process (Isobaric)
- 3) Isothermal Compression of Ideal Gas
- 4) Polytropic Process ($PV^n = \text{constant}$)

1) Constant Volume Process (Isochoric)

$$W_b = \int_1^2 P dV = 0$$

2) Constant Pressure Process (Isobaric)

$$\begin{aligned} W_b &= \int_1^2 P dV \\ &= P_1(V_2 - V_1) \end{aligned}$$

3) Isothermal Compression of Ideal Gas

$$PV = mRT_0 = C \quad P = C/V$$

$$\begin{aligned} W_b &= \int_1^2 P dV = \int_1^2 C/V dV = C \ln V_2 / V_1 \\ &= P_1 V_1 \ln V_2 / V_1 \end{aligned}$$

4) Polytropic Process ($PV^n = \text{constant}$)

$$PV^n = C \quad P = CV^{-n}$$

$$W_b = \int_1^2 P dV = \int_1^2 CV^{-n} dV$$

$$= C \frac{V_2^{-n+1} - V_1^{-n+1}}{-n+1} = \frac{P_2 V_2 - P_1 V_1}{1-n}$$

The First Law of Thermodynamics & It's Applications

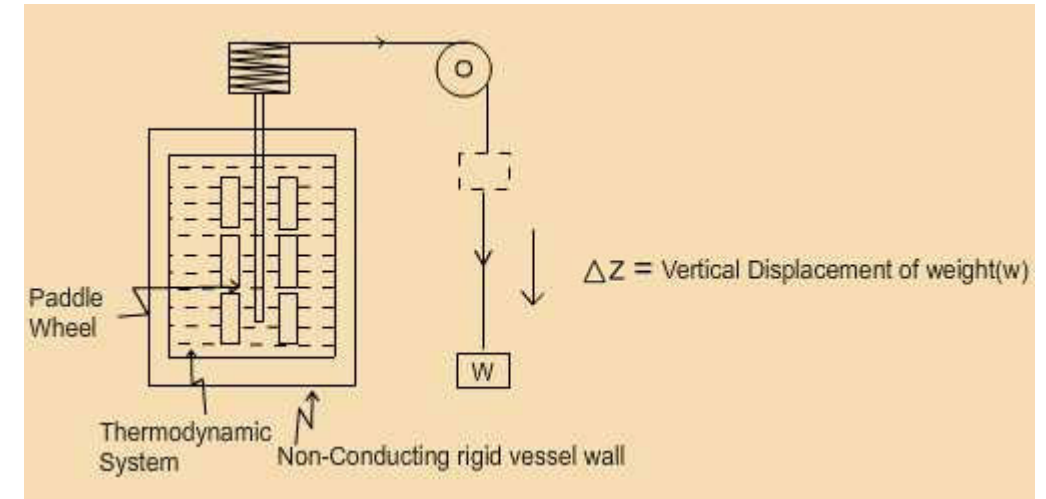
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Concept of Internal Energy

- **Work** and **Heat** - the two most common modes of energy exchanged by a thermodynamic system and its surroundings
- British scientist James P. Joule during 1840s by a series of carefully executed experiments about the interconvertibility between these two forms of energy.



- ❑ The system consisted of insulated, rigid vessel and stirred by means of rotating shaft provided with vanes
- ❑ Fixed quantities of different fluids (water, oil, and mercury) were placed.
- ❑ The amounts of work done on the fluid by the stirrer were measured in terms of potential energy that needed to raise /lower a weight, and
- ❑ The temperature change of the fluids was recorded.
- ❑ **Observation by Joule:**
 - Each fluid a fixed amount of work per unit mass was required for every degree of temperature rise caused by the rotating paddle wheel.
 - the temperature of the fluid could be restored to its initial value by the transfer of heat by bringing it in contact with a cooler object.

Question:

Work and heat are distinctly different forms of energy - how are they interconvertible?

Both Heat and Work are distinct in *transit* across the system boundary, there must some common form of energy within a thermodynamic system. That common form is called internal energy(ΔU).

Internal Energy (U) is the inter-convertibility form of energy that exists between work and heat in common within a thermodynamic system.

Source of Internal Energy (U)

- Material is composed of atoms and molecules (microscopic level). So, input energy may be utilized for translational, vibrational and rotational energies of the atoms and molecules.
- In addition, on a sub-molecular scale, each atom is composed of electrons and nuclei of atoms with bonding among themselves. So, input energy may also be utilized in increasing the bond energy.
- With these considerations, when a system may receive energy in the form of work done on it, part of the energy received may be utilized to heat another body or surroundings and the rest be restored to its state prior to receipt of work. This is possible as in the interim between these two processes all energy may be stored in the form of internal energy.

The First Law of Thermodynamics

Energy can neither be destroyed nor created, when it disappears in one form it must re-appear at the same time in other forms. The total quantity of Energy in Universe is constant.

There is no *formal* proof of the first law, but at the same time there is no evidence that violates the principle.

For any thermodynamic process, the changes occurring both within a system as well as its surroundings need to be considered as in thermodynamic terms, both system and surroundings together forms the “universe”. Therefore, the first law of Thermodynamics may be represented by the following mathematical form:

$$\Delta E_{\text{Universe}} = 0$$

$$\Delta E_{\text{System}} + \Delta E_{\text{Surroundings}} = 0$$

(Where Δ represents *finite change* occurring during the thermodynamic process)

Application of the First Law to Closed Systems

- In closed systems, no mass transfer across its boundary.
- Work and heat may cross (enter / leave) a system boundary and may be stored as internal energy.
- In addition, system may also possess potential and kinetic energies. Using the notations U , E_k , E_p for specific internal, kinetic and potential energies, respectively, we can write:

$$\Delta[U^{total} + E_k^{total} + E_p^{total}]_{\text{system}} = \text{Total energy input to system in all forms}$$

- If the energy transfer across the system boundary takes place only the form of work and heat:

$$\Delta[U^{total} + E_k^{total} + E_p^{total}]_{\text{system}} = Q_{input}^{total} + W_{input}^{total}$$

- The above relation may be written per unit mass / mole of closed system, i.e.,:

$$\Delta U + \Delta E_k + \Delta E_p = \Delta Q + W$$

- The above equation may also be written in a differential form:

$$dU + dE_k + dE_p = \delta Q + \delta W$$

(symbol δ to indicate infinitesimal work and heat transfer, as opposed to d used state variables)

- If there is no change in potential and kinetic energies for the system or it is negligible – as is usually true for most thermodynamic systems of practical interest – the above equation reduces to:

$$dU = \delta Q + \delta W$$

One of the great strengths of the mathematical statement of the first law as above is that it equates a state variable (U) with two path variables (Q , W).

the term δW represents any form of work transfer to or from the system. In many situations of practical interest the thermodynamic work for closed systems is typically the PdV work

$$dU = \delta Q - \int_{V_1}^{V_2} PdV$$

In keeping with the definition of work above, we adopt the following convention:

- ✓ if work is done on system, $W > 0$
- ✓ if work is done by system, $W < 0$
- ✓ for heat addition to system, $Q > 0$
- ✓ for heat removal from system, $Q < 0$

The process of change in a thermodynamic system may occur under various types of constraints, which are enlisted below:

- ❖ Constant pressure (*isobaric*)
- ❖ Constant volume (*isochoric*)
- ❖ Constant temperature (*isothermal*)
- ❖ Without heat transfer (*adiabatic*)

For Constant Pressure (*isobaric*) Process

For a constant pressure process,

$$\begin{aligned}\delta Q &= dU + PdV \\ &= dU + d(PV) \\ &= d(U + PV) \\ &= dH\end{aligned}$$

where $H = U + PV$

The term H is termed *enthalpy*. It follows that like U , H is also a *state variable*. On integrating the differential form of the equation above one obtains for the process:

$$\int_1^2 \delta Q = \int_1^2 dH$$

Upon integration,

$$Q = \Delta H$$

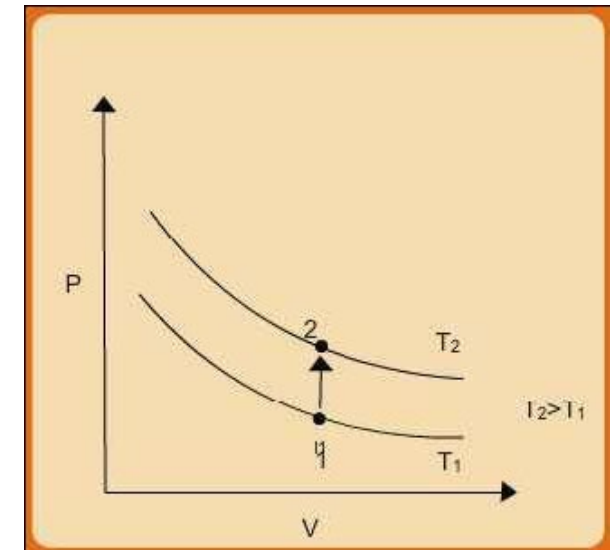
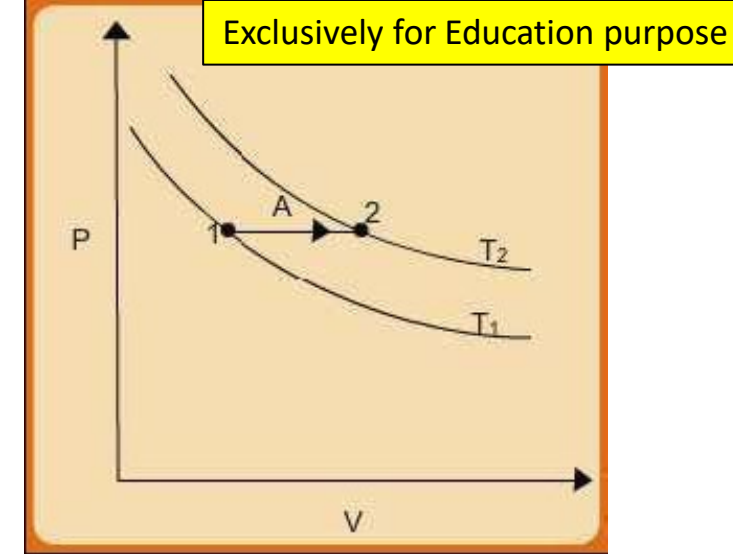
For Constant Volume (*Isochoric*) Process

For a constant volume process,

$$\begin{aligned}\delta Q &= dU + PdV \\ &= dU + 0 \\ &= dU\end{aligned}$$

Upon integration,

$$Q = \Delta U$$



HEAT CAPACITY (C)

Heat capacity, C is mathematically defined as:

$$C \equiv \frac{\delta Q}{dT}$$

It follows that using constant pressure and constant volume separately, two types of heat capacity may be defined:

➤ Constant pressure heat capacity (C_p) such that:

$$C_p = \frac{\delta Q}{dT} = \left(\frac{\partial H}{\partial T} \right)_p$$

➤ Constant volume heat capacity (C_v) such that:

$$C_v = \frac{\delta Q}{dT} = \left(\frac{\partial U}{\partial T} \right)_v$$

Thus, we can rewrite the thermodynamic eqns. as follows:

$$Q = \Delta H = \int_{T_1}^{T_2} C_p dT \quad (\text{At const P.})$$

$$Q = \Delta U = \int_{T_1}^{T_2} C_v dT \quad (\text{At const V.})$$

- ❖ Addition of heat to a system,
 - the translation, vibrational and rotational (as well as subatomic level) energies of the molecules are increased
 - the specific heats would be dependent on temperature.
- ❖ On compression (pressure applied) of gas,
 - intermolecular interactions begin to contribute to internal energy (i.e. to enthalpy)
 - specific heats are pressure dependent
- ❖ For **ideal gases**, the specific heats are independent of pressure as there are no intermolecular interactions;
 - ❖ Specific heats for ideal gases are only temperature dependent.

$$C_{Real\ Gas} = f(T, P)$$

$$C_{Ideal\ gas} = f(T)$$

Values of specific heats at constant pressure of ideal gases (*ig*) (from experimental measurements) are typically expressed in the form of polynomials such as:

$$\frac{C_P^{ig}}{R} = A + BT + CT^2 + \frac{D}{T^2}$$

Where, A, B, C and D are characteristic constants for a substance, and R is the universal gas constant.

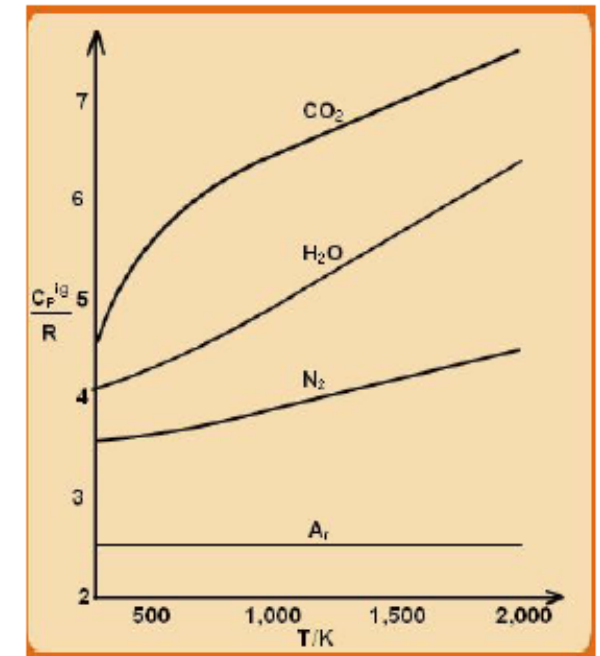


Fig. 3.4 Variation of C_P^{ig}/R vs. Temperature (Source: J. M Smith, H.C. Van Ness, M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6th ed., McGraw-Hill, 2001)

Applications to Ideal Gases for isothermal and adiabatic conditions – in closed systems

For such a case the relationship between U and H may be rewritten using the Equation of State(EOS):

$$H = U + PV$$

$$= U + RT$$

$$H - U = RT$$

Now both H and U are only temperature dependent for ideal gases we write:

$$\frac{dH}{dT} - \frac{dU}{dT} = R$$

$$\Rightarrow \boxed{C_p - C_v = R}$$

For solids & liquids, the molar volume V is relatively small, so $H \approx U$; and $C_p \approx C_v$

For an isothermal process for an ideal gas.

$$dT = 0 \text{ and } dU = 0,$$

$$\delta Q = -\delta W \quad (\text{as } dU = 0)$$

Upon integration, $Q = -W$

Now,
$$W = - \int_{V_1}^{V_2} P dV = - \int_{V_1}^{V_2} \frac{RT}{V} dV = RT \ln \frac{V_1}{V_2} = RT \ln \frac{P_2}{P_1}$$

$$\boxed{Q = -W = RT \ln \frac{V_2}{V_1} = RT \ln \frac{P_1}{P_2}}$$

For Adiabatic Process

$$dQ = 0$$

So, $dU = -\delta W$

$$\Rightarrow C_v dT = -PdV = -\frac{RT}{V} dV$$

$$\Rightarrow \frac{dT}{T} = -\frac{R}{C_v} \frac{dV}{V}$$

$$\begin{aligned} \Rightarrow \frac{dT}{T} &= -\frac{C_p - C_v}{C_v} \frac{dV}{V} \\ &= -\left(\frac{C_p}{C_v} - 1\right) \frac{dV}{V} \\ &= -(\gamma - 1) \frac{dV}{V}, \text{ where the ratio of heat capacities is defined as: } \gamma = C_p/C_v \end{aligned}$$

Upon integration,

$$\begin{aligned} \ln\left(\frac{T_2}{T_1}\right) &= (\gamma - 1) \ln\left(\frac{V_1}{V_2}\right) \\ \Rightarrow \frac{T_2}{T_1} &= \left(\frac{V_1}{V_2}\right)^{\gamma - 1} = \left(\frac{P_2}{P_1}\right)^{(\gamma - 1)/\gamma} \end{aligned}$$

and $P_1 V_1^\gamma = P_2 V_2^\gamma = PV^\gamma = \text{const.}$

Further: $dW = dU = C_v dT$

Or $W = dU = C_v dT$

Since, $W = -\int P dV$

$$W = \frac{P_2 V_2 - P_1 V_1}{\gamma - 1}$$

$$W = \frac{P_1 V_1}{\gamma - 1} \left[\left(\frac{P_2}{P_1} \right)^{(\gamma-1)/\gamma} - 1 \right] = \frac{RT_1}{\gamma - 1} \left[\left(\frac{P_2}{P_1} \right)^{(\gamma-1)/\gamma} - 1 \right]$$

All the above relations can be clubbed together in the form of a single P - V - T relation, which is termed a *polytropic* equation. In generalized equations, we can write as follows:

$$PV^\delta = \text{constant}$$

$$TV^{\delta-1} = \text{constant}$$

$$TP^{(1-\delta)/\delta} = \text{constant}$$

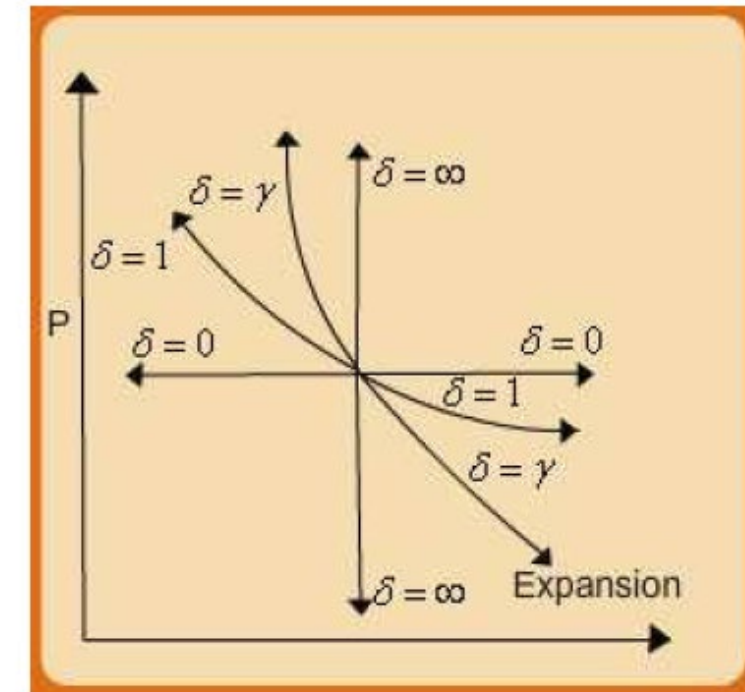


Fig. 3.5 Schematic of Polytropic Processes

Different values of δ reproduce the isothermal, isochoric, isobaric and adiabatic processes. So, such the generalized expressions can also be applied for work and heat transfer:

$$W = \frac{RT_1}{\delta - 1} \left[\left(\frac{P_2}{P_1} \right)^{(\delta-1)/\delta} - 1 \right]$$

$$Q = \frac{(\delta - \gamma)RT_1}{(\delta - 1)(\gamma - 1)} \left[\left(\frac{P_2}{P_1} \right)^{(\delta-1)/\delta} - 1 \right]$$

Applicable for isothermal,
isochoric, isobaric and
adiabatic processes

Assignment #1_25/08/2020

Application of the First Law to Open Systems

For most thermodynamic systems, specifically in continuous process plants as well as in equipments; there are essentially open systems. Therefore, both mass transfer and energy transfer are there across their boundaries (through inlet and outlet). Examples: pumps, compressors, reactors, distillation columns, heat exchangers etc.

Mass Balance for Open Systems:

For generality consider an open system with which has multiple inlets (1, 2) and outlets (3, 4). The volume enclosed by the physical boundary is the *control volume* (CV). The general mass balance equation for such a system may be written as:

$$\text{The mass flow rate} = \frac{dm}{dt} = \dot{m}$$

$$\dot{m} = \rho u A$$

Where, ρ = fluid density; u = fluid velocity; and A aperture cross-sectional area

Mass balance equation:

$$\begin{aligned} \frac{dm_{cv}}{dt} &= \sum_{\text{inlet}} \dot{m} - \sum_{\text{outlet}} \dot{m} \\ &= \dot{m}_1 + \dot{m}_2 - \dot{m}_3 - \dot{m}_4 \\ &= -\Delta(\dot{m})_{fs} \end{aligned}$$

Where the symbol Δ = (outlet - inlet); and the subscript fs stands for "flow streams".

$$\text{Therefore, } \frac{dm_{cv}}{dt} + \Delta(\rho u A)_{fs} = 0$$

Under steady flow conditions, no accumulation of mass inside the control volume, i.e.

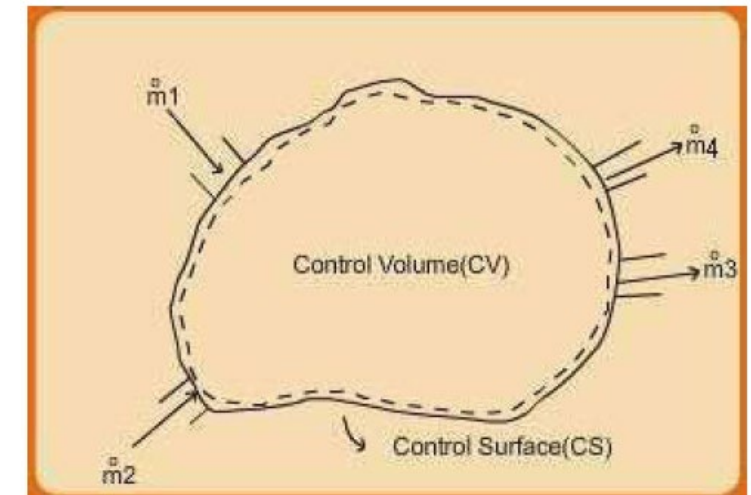


Fig. 3.6 Schematic of an open system

Under steady flow conditions, no accumulation of mass inside the control volume, i.e. $\frac{dm_{cv}}{dt} = 0$

The mass balance equation reduces to: $\Delta(\rho u A)_{fs} = 0$

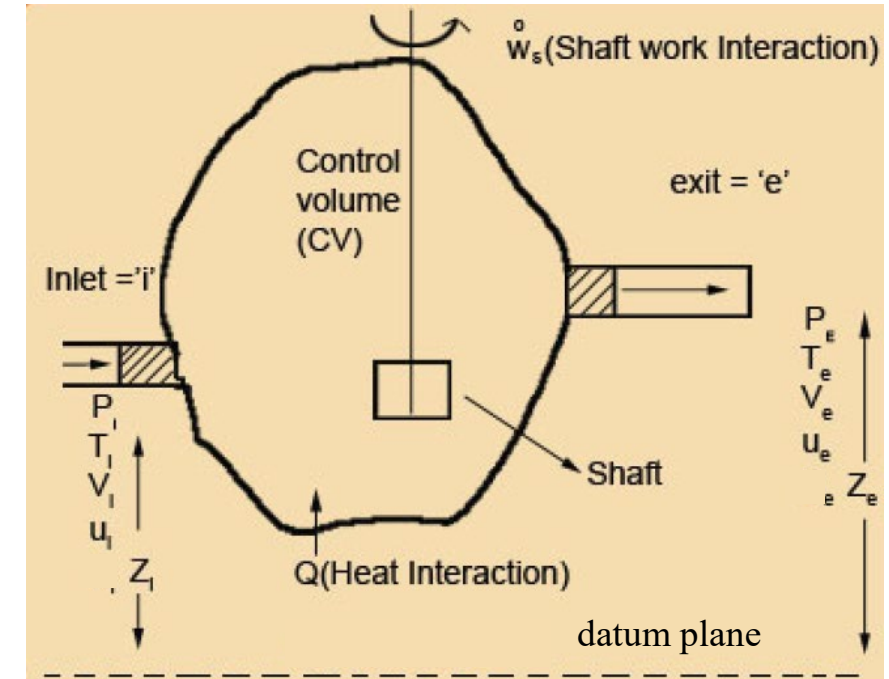
$$\rho_1 u_1 A_1 = \rho_2 u_2 A_2$$

$$u_1 A_1 / V_1 = u_2 A_2 / V_2$$

Where $V = \text{specific volume (v/m)} = 1 / \rho$

Energy Balance for Open Systems

- ❖ The schematic of an open system showing flow and energy interactions .
- ❖ For simplicity there is one inlet and one exit ports to the control volume.
- ❖ The thermodynamic states at the inlet (*i*) and exit (*e*) are: P , V , T , u (average fluid velocity across the cross section of the port), and Z (the height of the port above a datum plane).
- ❖ A fluid element of an unit mole or mass enters the CV carrying internal energy, kinetic and potential energies at the inlet conditions (P_i , T_i , with molar volume as V_i) and leaves values of these energies at the exit state conditions (P_e , T_e , with molar volume as V_e).
- ❖ The total specific energy of the fluid at the two ports corresponds to the sum of specific internal, potential and kinetic energies, given by:
 - Total specific energy of the fluid = $U + u^2/2 + gZ$
 - Rate of heat exchanges with the surroundings = $\dot{Q}$,
 - Total rate of work (in one or more forms) = $\dot{W}_{total}$



In the schematic, a specific work form, *shaft work*, that is delivered *to* or *by* the system by means of rotatory motion of a paddle wheel which is implicated in many typical process plant units.

A unit mass (or mole) of fluid entering the CV. Total energy balance equation for the control volume:

$$\frac{d(mU)_{cv}}{dt} = \left[\left(U + \frac{1}{2}(u^2) + zg \right) \dot{m} \right]_i - \left[\left(U + \frac{1}{2}(u^2) + zg \right) \dot{m} \right]_e + \dot{Q} + \dot{W}_{total}$$

$$\frac{d(mU)_{cv}}{dt} + \Delta \left[\left(U + \frac{1}{2}(u^2) + zg \right) \dot{m} \right]_{fs} = \dot{Q} + \dot{W}_{total}$$

The fluid element obviously needs to be “pushed” by another fluid element that follows it, so that the element enters the CV. Similar is the case for exit end.

If a fluid element of specific volume V is pushed into the CV at a pressure P , then work energy terms at inlet and exit end will be $-P_i V_i$ and $-P_e V_e$ respectively.

$$\dot{W}_{total} = \dot{W} - [PV \dot{m}]_i + [PV \dot{m}]_e$$

$$\frac{d(mU)_{cv}}{dt} + \Delta \left[\left(U + \frac{1}{2}(u^2) + zg \right) \dot{m} \right]_{fs} = \dot{Q} + \dot{W} - [PV \dot{m}]_i + [PV \dot{m}]_e$$

Where, $\dot{W}$ = sum of *all other* forms of work (shaft work, P-V work resulting from expansion or contraction of the CV, electrical work etc.) associated with the process occurring within the CV.

As the last two work terms on the right side of the eqn. are associated with the flow streams we may rewrite the equation as follows:

$$\frac{d(mU)_{cv}}{dt} + \Delta \left[\left(U + \frac{1}{2}(u^2) + zg \right) \dot{m} \right]_{fs} = \dot{Q} + \dot{W} - \Delta [PV \dot{m}]_{fs}$$

On rearranging:

$$\frac{d(mU)_{cv}}{dt} + \Delta \left[\left\{ (U + PV) + \frac{u^2}{2} + zg \right\} \dot{m} \right]_{fs} = \dot{Q} + \dot{W}$$

$$\frac{d(mU)_{cv}}{dt} + \Delta \left[\left\{ H + \frac{u^2}{2} + zg \right\} \dot{m} \right]_{fs} = \dot{Q} + \dot{W}$$

- Overall potential of kinetic energy of CV → fixed in space, so no overall change in potential of kinetic energy terms.
- Kinetic and potential energy changes between the inlet and exit streams → not significant for many cases in a chemical plant
- Under Steady State condition, $\frac{d(mU)_{cv}}{dt} = 0$

Therefore, the above equation is simplified to

$$\Delta \left[H \dot{m} \right]_{fs} = \dot{Q} + \dot{W}_s$$

Again under steady state $\dot{m}$ is constant:

$$\Delta H = Q + W$$

Examples of process plant units : *pumps, compressors, turbines, fans, blowers*, etc. In all cases a rotatory part is used to exchange work between the system and surrounding.

Assignment #2_26/08/2020

Second Law of Thermodynamics

By

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Introduction

- ❖ The First Law says about the conservation on the total energy contained within a system and its surroundings. If part of energy is disappeared in one form from the system during any thermodynamic process of change, it must reappear in another form either within the system or in the surroundings.
- ❖ **Question:** Is the above process feasible?
- ❖ **Drawback of first law :** provides no constraint on the possible direction a process may take place.
- ❖ Phenomenon in real world, For example,
 - ✓ Heat always flows from a high temperature body to lower temperature body.
 - ✓ Momentum flow is always from high pressure to low pressure region
 - ✓ Molecules always migrate from higher to lower chemical potential region.
- ❖ Experimentally, no more than 40-50% of the total heat available can be converted to work or other form of energy.
 - ✓ Heat is a lower form of energy which may be feasible to “degrade” work to heat, but it is impossible to “upgrade” heat completely into work.
- ❖ Heat - a more *primitive* form of energy, easily available from matter by combustion and subsequently converted to work.
- ❖ Work can not be obtained *directly* from the energy available in the form of enthalpy.
- ❖ **Question:** What determines the efficiency of conversion of heat to work?
 - ✓ Second Law of Thermodynamics may help answer this question.

The second law resulted from experiential observations from *heat engines*

Heat Engines & it's Working Principle

Heat engine - a machine that produces work from heat through a cyclic process. (Example: steam power plant; the working fluid (steam) periodically goes through a series of steps in a cyclic manner as follows:

Step 1: Liquid water at ambient temperature is pumped into a boiler operating at high pressure

Step 2: Heat produced by burning a fossil fuel convert water to steam in the boiler at high-temperature and pressure

Step 3: The energy present in the steam is then transferred as shaft work to a turbine where both steam temperature and pressure are reduced.

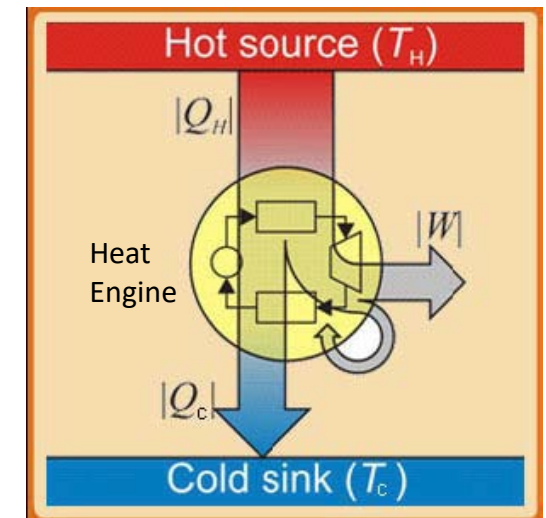
Step 4: Steam exiting from the turbine is converted to water by cooling it and transferring the heat released to the surroundings. The water is then returned to step 1.

Working Principle:

Heat engines absorb heat at a higher temperature body (*source*) and release a part of it to a low temperature body (*sink*); the difference between the two quantities constitutes the net work delivered during the cycle.

Example a heat engine :

Steam / gas power plant, automotive engines, etc.



FACTS

- The heat engines are operated in between two bodies which are at *constant* differential temperature levels. These bodies are called *heat reservoirs*.
- Theoretically *heat reservoirs* are bodies with infinite *thermal mass* (i.e. $mC_p \rightarrow \infty$,) i.e. they do not change it's temperature due to either release or absorption of heat.

The above facts led to a set of statements that are *equivalent to* the second law of Thermodynamics

Kelvin-Planck Statement:

It is impossible to devise a cyclically operating device, the sole effect of which is to absorb energy in the form of heat from a single thermal reservoir and to deliver an equivalent amount of work.

Clausius Statement:

It is impossible to devise a cyclically operating device, the sole effect of which is to transfer energy in the form of heat from a low temperature body to a high temperature body.

Efficiency of Heat Engine

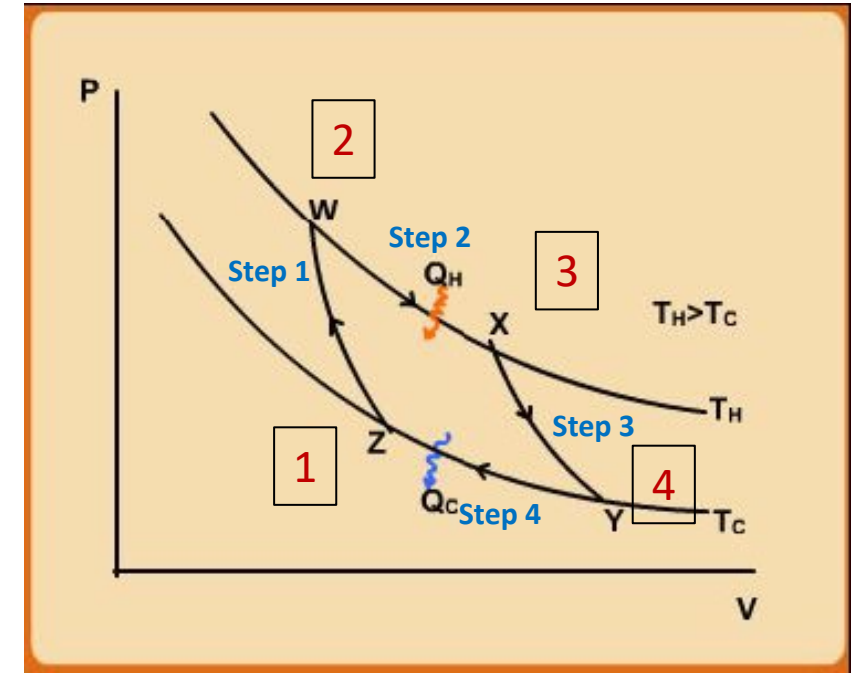
In theory we may say that a heat engine absorbs a quantity of heat $|Q_H|$ from a high temperature reservoir at T_H and rejects $|Q_C|$ amount of heat to a colder reservoir at T_C . It follows that the net work (W) delivered by the engine is given by:

$$W = |Q_H| - |Q_C|$$

Hence the efficiency of the engine is: $\eta = \frac{W}{|Q_H|} = \frac{|Q_H| - |Q_C|}{|Q_H|} = 1 - \frac{|Q_C|}{|Q_H|}$

Carnot Cycle

- ❖ The *Carnot engine* proposed in 1824 by the French engineer Nicholas Leonard Sadi Carnot (1796-1832),
- ❖ Provides a fundamental reference concept of the second law.
- ❖ The Carnot cycle as shown in figure is a series of reversible steps executed as follows:



Step 1 (Adiabatic Process, Z to W): A system at the temperature of a cold reservoir T_C undergoes a reversible adiabatic compression which raises its temperature to that of a hot reservoir at T_H .

Step 2 (Isothermal Process, W to X): In the hot reservoir, the system absorbs $|Q_H|$ amount of heat through an isothermal process during which its temperature remains at T_H .

Step 3 (Adiabatic Process, X to Y): The system next undergoes a reversible adiabatic process in a direction reverse of step 1 during which its temperature drops back to T_C .

Step 4 (Isothermal Process, Y to Z): A reversible isothermal process of expansion at T_C transfers $|Q_C|$ amount of heat to the cold reservoir and the system state returns to that at the commencement of step 1.

Features of Carnot Cycle

- ❖ The Carnot engine operates between two heat reservoirs
- ❖ All heat exchanges within the heat reservoirs occur under isothermal conditions; at the temperatures corresponding to the reservoirs
- ❖ All the heat transfer occurs under *infinitesimal* temperature gradients across the system boundary
- ❖ These processes are reversible in nature
- ❖ The isothermal and adiabatic processes are also carried out under mechanically reversible (quasi-static) conditions the cycle operates in a fully reversible manner.
- ❖ Any other heat engine that operates on a different cycle (between two heat reservoirs) must necessarily transfer heat across finite temperature differences and therefore cannot be thermally reversible.

The heat interactions during the isothermal process may be shown to be:

$$|Q_H| = RT_H \ln \frac{V_x}{V_w}$$

and $|Q_C| = RT_C \ln \frac{V_y}{V_z}$

For the adiabatic paths X to Y and Z to W , we can write

$$\ln \frac{V_x}{V_w} = \ln \frac{V_y}{V_z}$$

Therefore,

$$\begin{aligned} |Q_H| / |Q_C| &= (RT_H \ln \frac{V_x}{V_w}) / (RT_C \ln \frac{V_y}{V_z}) \\ &= T_H / T_C \end{aligned}$$

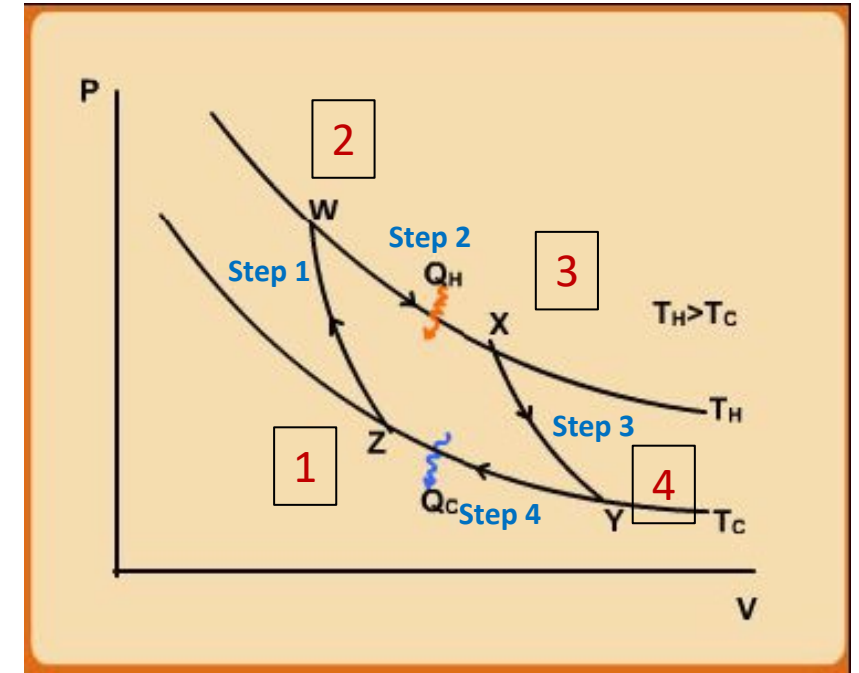
or $|Q_H| / T_H = |Q_C| / T_C$

As heat Q_H enters the system, so it is *positive*, while Q_C leaves the system, which makes it negative in value. Thus, removing the modulus, the above equation may be written as:

$$Q_H / T_H = - Q_C / T_C$$

or $(Q_H / T_H) + (Q_C / T_C) = 0$

or $\sum Q/T = 0$



Efficiency of Carnot Engine

$$\eta = 1 - \frac{|Q_C|}{|Q_H|} = 1 - (T_C / T_H)$$

- ✓ For 100% Carnot efficiency, $\eta = 1$
- ✓ It is possible when, $T_C \rightarrow 0$ or $T_H \rightarrow \infty$
- ✓ Obviously neither situation are practicable, which suggests that the efficiency must always be less than unity.
- In practice, the naturally occurring bodies that approximate a cold reservoir are: atmospheres, rivers, oceans, etc, for which a representative temperature T_C is $\sim 300^0\text{K}$.
- The hot reservoirs, e.g. typical furnaces for which $T_H \sim 600^0\text{K}$.
- Thus the Carnot efficiency is ~ 0.5 .
- In practice, real processes heat engine efficiencies never exceed 40%. due to mechanical irreversibilities associated with the processes.

Concept of Entropy

There exists a quantity Q/T which add up to zero for the complete cycle. Exploring this idea to any general *reversible* cycle run by any working fluid in the heat engine.

- ❖ The complete cycle may be divided into a number of Carnot cycles (shown by dotted cycles) in series.
- ❖ Each such Carnot cycle would be situated between two heat reservoirs.
- ❖ Each cycle becomes infinitesimal in nature and so the number of such cycles is infinity. Adding of all such cycles, the original finite cycle is reproduced.
- ❖ For each infinitesimal cycle the heat absorbed and released in a *reversible* manner by the system fluid may be written as $|\delta Q_H|$ and $|\delta Q_C|$ respectively.

We can write,

$$\frac{\delta Q_H}{T_H} + \frac{\delta Q_C}{T_C} = 0 \quad \longrightarrow \quad \delta Q_{rev} / T = 0$$

Sum up the effects of series of all the infinitesimal cycles,

$$\oint \frac{\delta Q_{rev}}{T} = 0$$

There is existence of a *state* variable, whose sum over a cycle is zero. This state variable is termed as “Entropy” (S) such that:

$$dS = \delta Q_{rev} / T$$

$$\oint dS = 0$$

$$\delta Q_{rev} = TdS$$

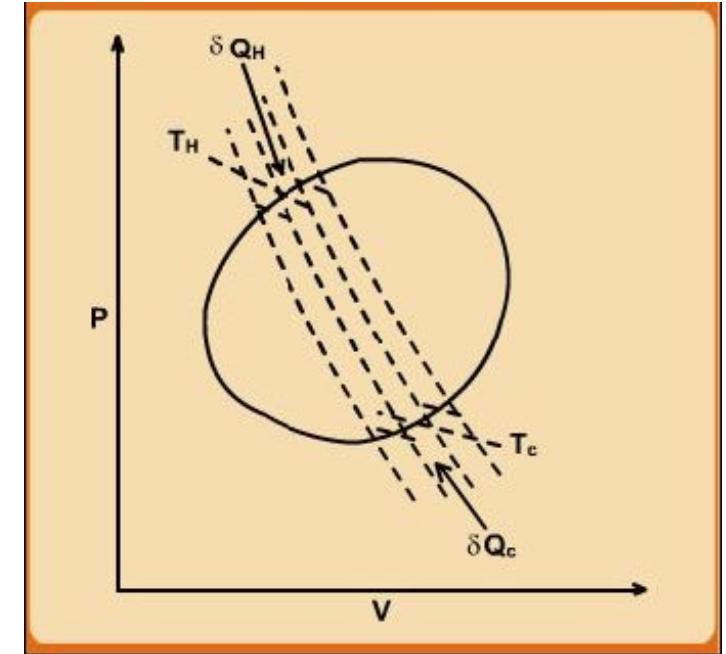
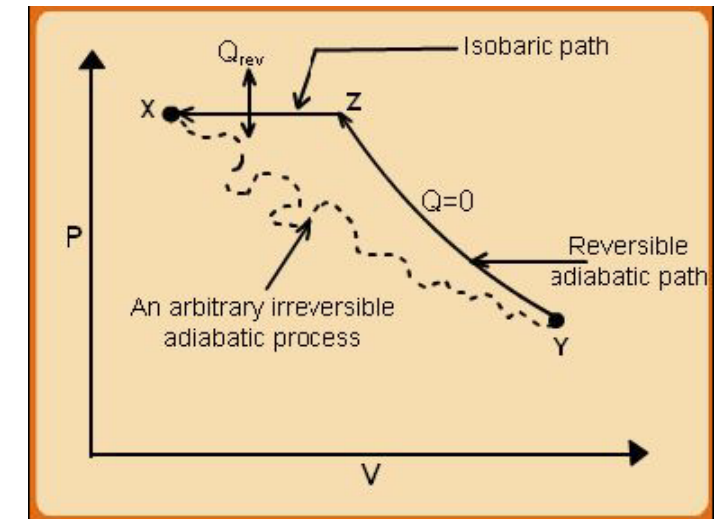


Fig. Illustration of an arbitrary cycle decomposed into a series of small Carnot cycles

For a perfectly reversible *adiabatic* process, equation, $dS = (\delta Q_{rev} / T)$ leads to the following result: $dS=0$ Thus, such a process is alternately termed as *isentropic*.

Entropy for Irreversible Process

- ❖ Finite changes of entropy for irreversible processes cannot be calculated by a simple integration of eqn., $\delta Q_{rev} = TdS$.
- ❖ Entropy is a state property like internal energy or enthalpy, so for irreversible process occurring between two states, the change in entropy would be given by equation, $dS = \delta Q_{rev} / T$.
- ❖ Since entropy is calculable directly by this equation, so one necessarily needs to construct a reversible process by which the system may transit between the same two states.
- ❖ The entropy change is identical if the initial and final states are the same for each type of process.
- ❖ This is equally true for any irreversible process where heat transfer is due to finite temperature gradients across the system and the surroundings.
- ❖ The same consideration holds even for mechanically irreversibly processes.



With the introduction of the definition of entropy the Carnot engine cycle may be redrawn on a temperature-entropy diagram as shown in fig.

Entropy Calculations for Ideal Gases

For a closed system, the first law provides: If the process of change occurs under reversible conditions, then the above equation becomes:

$$dU = dQ + dW$$

$$d(H - PV) = TdS - PdV$$

$$dH - PdV - VdP = TdS - PdV$$

For ideal gas, $dH = C_P^{ig} dT$

$$C_P^{ig} dT = TdS + VdP$$

$$= TdS + RTdP/P$$

$$dS = \frac{C_P^{ig} dT}{T} - R dP/P$$

Integrating,

$$\Delta S \Big|_{P_0}^P = \int_{T_0}^T C_P^{ig} \frac{dT}{T} - R \ln \frac{P}{P_0}$$

For constant C_P^{ig} , $T/T_0 = (P/P_0)^{R/C_P^{ig}} = (P/P_0)^{(\gamma-1)/\gamma}$

The same relation as obtained by the First Law analysis

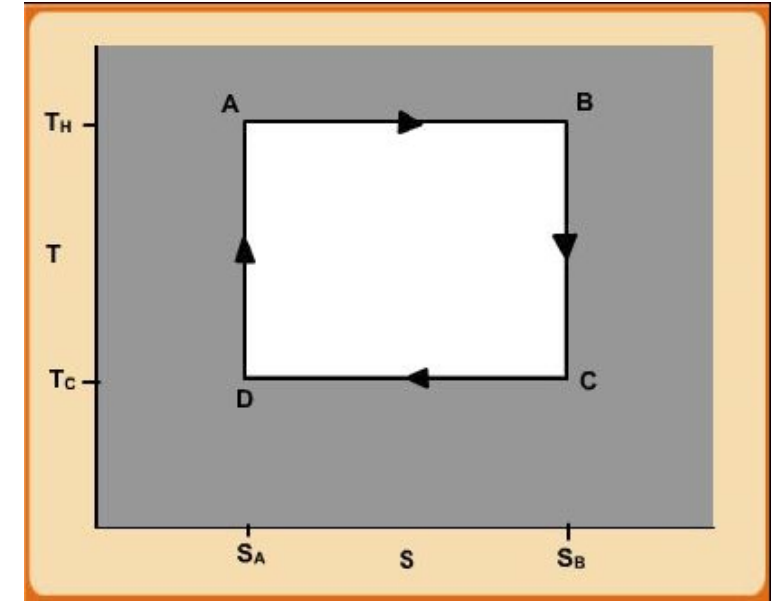


Fig. Representation of Carnot cycle on T-S diagram

Mathematical Statement of the Second Law

- ❑ Consider a mechanically irreversible adiabatic process between two equilibrium states X and Y reproduced as a broken line between points - **leads to an entropy change**
- ❑ The fluid is returned from Y to the original state X by means two sequential processes:
 - (i) a mechanically reversible adiabatic process from Y to Z - **no heat transfer; no entropy change**
 - (ii) a reversible isobaric compression Z to X – **if heat transfer involved is Q_{rev} , then $Q_{rev} = Tds$**

Thus, integrating this expression for the return path:

$$\Delta S^t = \int_Y^X dS^t = S_X^t - S_Y^t = \int_Y^X \frac{dQ_{rev}}{T}$$

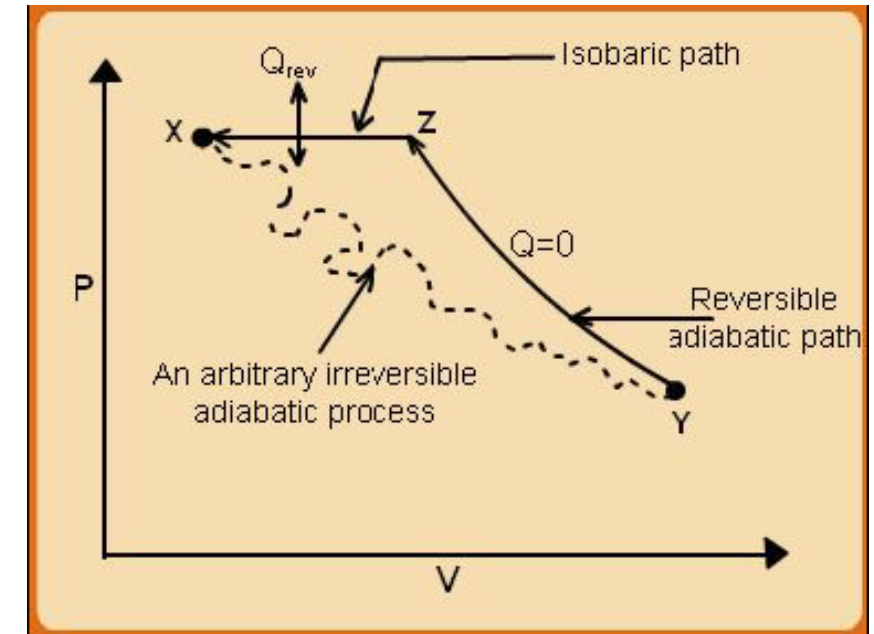
- ❑ For the entire cycle (X to Y to Z to X): $\Delta U^t = 0$ [U is state function]
- ❑ Thus, net total work during the cycle : $W^t = -Q_{rev}$
- ❑ Since a net work is to be done *on* the system over the cycle: $W^t > 0$
hence $Q_{rev} < 0$
- ❑ Therefore,

$$S_X^t - S_Y^t = \int_Y^X \frac{dQ_{rev}}{T} < 0$$

- ❑ The entropy change ΔS for the original irreversible step X to Y, we have:

$$\Delta S^t = S_Y^t - S_X^t > 0.$$

- ❑ Therefore, the original irreversible step is accompanied by a *positive* change of entropy.
- ❑ If the original process occurred through *irreversible heat transfer* process, an increase of entropy would result likewise.



Interpretation

- ❖ During the return reversible process,
 - since the heat transfer (during the isobaric path) occurs under reversible conditions it must occur under infinitesimal small temperature gradient between the system and surrounding.
 - Thus for the system and the surrounding, the net entropy change (Q_{rev}/T) is equal and opposite in sign.
 - ✓ Total entropy change of the universe (system + surrounding) = 0.
- ❖ During the initial irreversible path X to Y,
 - ✓ for the system - entropy increases
 - ✓ for the surrounding - no change in entropy
 - ✓ for the universe - positive change in entropy.

Since the above conclusion is not premised on any specific internal nature of the system, the above result may be generalized:

All Irreversible Processes Are Accompanied By A Positive Change Of Entropy Of The Universe.

$$\Delta S^t \geq 0$$

What change in a system is thermodynamically feasible?

The second law provides answer : A process can only proceed in a direction that results in a positive change in the total entropy of the universe, the limiting value of zero being attained only by a fully reversible process.

The corollary to this is: *No Process Is Possible For Which The Total Entropy Of The Universe Decreases.*

Assignment#3

Entropy Balance for Open Systems

- ❑ *Internally reversible process* - all the processes occurring within the system are mechanically reversible, that is they are not subject to dissipative forces.
- ❑ *External reversible process* - signifies that all heat transfer between the system and surrounding occur under infinitesimal gradients and are therefore thermally reversible.
- ❑ In principle reversible heat transfer is possible if
 - ✓ The surroundings have heat reservoirs with temperatures equal to those of the control surface
 - ✓ Reversible Carnot engines operate between the control-surface temperatures and the heat-reservoir temperatures.
- ❑ Unlike energy, entropy is *not* a conserved quantity for real world processes in which both mechanical and thermal irreversibilities are inevitable. Hence for such processes are attended by a positive *Entropy Generation Rate*, $\dot{S}_G$.

This conclusion may be expressed in mathematical terms as follows:

(Net rate of entropy change through flow stream)+(Rate of entropy change in Control Volume)+(Net rate of entropy change of surroundings) = Total rate of entropy generation

$$\Delta(\dot{S}m)_{fs} + \frac{d(mS)_{CV}}{dt} + \frac{dS_{surr}^t}{dt} = \dot{S}_G \geq 0$$

For *totally* reversible open system, the left side reduces to zero with respect to both the system and the surroundings. Or else there is a net entropy generation.

Let there be heat transfer at the rate $\dot{Q}_j$ at a particular part of the control surface of the open system where the surrounding temperature is given by $T_{\sigma,j}$

$$\frac{dS_{surr}^t}{dt} = -\sum_j \frac{\dot{Q}_j}{T_{\sigma,j}}$$

Here, j runs over all the heat reservoirs associated with the system. The negative sign is used for the entropy term for the surroundings as heat transfer terms by convention are associated with the system.

$$\Delta(S\dot{m})_{fs} + \frac{d(mS)_{cv}}{dt} - \sum_j \frac{\dot{Q}_j}{T_{\sigma,j}} = \dot{S}_G \geq 0$$

For steady flows through the control volume eqn. reduces to:

$$\Delta(S\dot{m})_{fs} - \sum_j \frac{\dot{Q}_j}{T_{\sigma,j}} = \dot{S}_G \geq 0$$

For the simplest case of one inlet, one exit, and one surrounding temperature:

$$\dot{m}(\Delta S)_{fs} - \frac{\dot{Q}}{T_{\sigma}} = \dot{S}_G \geq 0$$

Ideal and Lost Work for Flow Systems (open system, irreversible, under steady state)

- ❖ Mechanical irreversible processes result in *loss of work* due to dissipative conversion to heat.
- ❖ If work is to be delivered *by* an open system, the *maximum* work obtains when the processes are mechanically reversible, we call that *ideal work*.
- ❖ Conversely, when work is done *on* the system, the ideal work provides the *minimum* work needed to change the fluid state between the inlet and the exit due to an extra work needed to provide beyond the ideal work against mechanical dissipative forces.
- ❖ The ideal work obtains when the processes associated with the open system are both internally and externally reversible. For such a case

$$\dot{m}(\Delta S)_{fs} - \frac{\dot{Q}}{T_\sigma} = \dot{S}_G = 0$$

$$\dot{Q} = T_\sigma \dot{m}(\Delta S)_{fs}$$

From 1st Law applied to the ideal case:

$$\Delta \left[\left(H + \frac{1}{2}(u^2 / g_c) + z(g / g_c) \right) \dot{m} \right]_{fs} = \dot{Q} + \dot{W}_{ideal}$$

Simplifying (assuming negligible kinetic and potential energy changes)

$$\dot{W}_{ideal} = \Delta \left[H \dot{m} \right]_{fs} - T_\sigma \Delta(S \dot{m})_{fs}$$

$$\dot{W}_{ideal} = \dot{m}[\Delta H - T_\sigma \Delta S_{fs}]$$

In real processes however, actual work involved will depend on the extent of associated irreversibilities; hence we define *lost work* as follows:

$$\dot{W}_{lost} = \dot{W}_{actual} - \dot{W}_{ideal}$$

the simplest case where kinetic and potential energy changes are negligible:

$$\Delta \left[H \dot{m} \right]_{fs} = \dot{Q}_{actual} + \dot{W}_{actual}$$

Again for real process:

$$\dot{m}(\Delta S)_{fs} - \frac{\dot{Q}_{actual}}{T_{\sigma}} = \dot{S}_G$$

or,

$$\dot{Q}_{actual} = T_{\sigma} \dot{m}(\Delta S)_{fs} - T_{\sigma} \dot{S}_G$$

Therefore,

$$\dot{W}_{lost} = T_{\sigma} \Delta(S \dot{m})_{fs} - \dot{Q}_{actual}$$

$$\dot{W}_{lost} = T_{\sigma} \dot{S}_G$$

The above Eqn. suggests that greater the entropy generation rate due to process irreversibility, greater is the lost work. Since irreversibilities cannot be calculated theoretically, it is indirectly expressed by a process efficiency factor, η

For work done by system,

$$\eta = \dot{W}_{actual} / \dot{W}_{ideal}$$

For work done on a system,

$$\eta = \dot{W}_{ideal} / \dot{W}_{actual}$$

Lecture-18

If a thermal efficiency of 100% is not possible for heat engines, what then determines the upper limit? one would certainly expect the thermal efficiency of a heat engine to depend on the degree of reversibility of its operation. Indeed, a heat engine operating in a completely reversible manner is very special, and is called a Carnot engine.

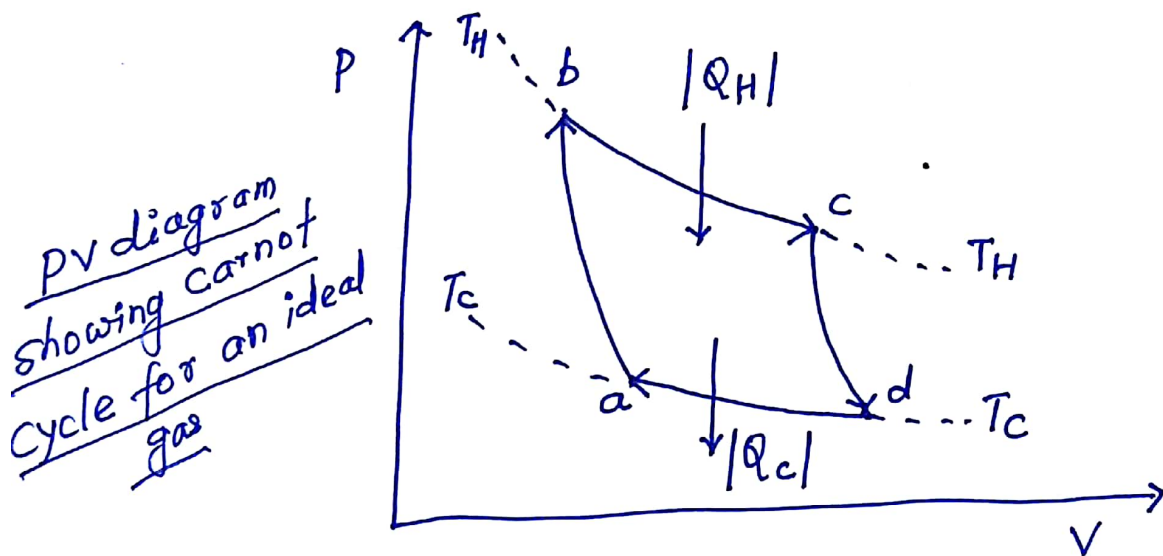
The characteristics of such an ideal engine were first described by N.L.S. Carnot in 1824. The four steps that make up a Carnot cycle are performed in the following order:

- Step 1: A system at an initial temperature of a cold reservoir at T_c undergoes a reversible adiabatic process that causes its temperature to rise to that of a hot reservoir at T_h .
- Step 2: The system maintains contact with the hot reservoir at T_h , and undergoes a reversible isothermal process during which heat $|Q_H|$ is absorbed from the hot reservoir.
- Step 3: The system undergoes a reversible adiabatic process in the opposite direction of step 1 that brings its temperature back to that of the cold reservoir at T_c .

Step 4: The system maintains contact with the reservoir at T_c , and undergoes a reversible isothermal process in the opposite direction of step 2 that returns it to its initial state with rejection of heat $|Q_c|$ to the cold reservoir.

* This set of processes can in principle be performed on any kind of system.

The cycle traversed by an ideal gas serving as the working fluid in a Carnot engine is shown by a PV diagram



It consists of four reversible processes corresponding to steps 1 through 4 of the general Carnot cycle described in the preceding section:

- $a \rightarrow b$ Adiabatic compression until the temperature rises from T_C to T_H .
- $b \rightarrow c$ Isothermal expansion to arbitrary point 'c' with absorption of heat $|Q_H|$.
- $c \rightarrow d$ Adiabatic expansion until the temperature decreases to T_C .
- $d \rightarrow a$ Isothermal compression to the initial state with rejection of heat $|Q_C|$.

For the isothermal step $b \rightarrow c$:

$$Q_H + W = \Delta U$$

$$\downarrow$$

$$Q_H + W = 0 \Rightarrow Q_H = -W$$

$$W = - \int_{V_b}^{V_c} P dV = - R T_H \int_{V_b}^{V_c} \frac{dV}{V} = - R T_H \ln \frac{V_c}{V_b}$$

$$\therefore \boxed{Q_H = R T_H \ln \frac{V_c}{V_b}} \longrightarrow (1)$$

For the isothermal step $d \rightarrow a$:

$$W = - \int_{V_d}^{V_a} P dV = - R T_C \ln \frac{V_a}{V_d}$$

$$Q_C + W = \Delta U = 0 \Rightarrow Q_C = -W = R T_C \ln \frac{V_a}{V_d}$$

$$\boxed{Q_C = R T_C \ln \frac{V_a}{V_d}} \longrightarrow (2)$$

$$\text{now, } \frac{Q_c}{Q_H} = \frac{T_c \ln(V_a/V_d)}{T_H \ln(V_c/V_b)} \longrightarrow (3)$$

For adiabatic process:

$$dQ + dW = dU \longrightarrow C_V dT$$

$$\downarrow \quad \downarrow$$

$$0 \quad -P dV$$

$$-P dV = C_V dT$$

$$\Rightarrow -RT \frac{dV}{V} = C_V dT$$

$$\Rightarrow \frac{dV}{V} = -\frac{C_V}{R} \frac{dT}{T} \longrightarrow (4)$$

For step a $\rightarrow$ b:

$$\int_{V_a}^{V_b} \frac{dV}{V} = -\frac{C_V}{R} \int_{T_c}^{T_H} \frac{dT}{T}$$

$$\ln \frac{V_b}{V_a} = -\frac{C_V}{R} \ln \frac{T_H}{T_c} \longrightarrow (5)$$

For step c $\rightarrow$ d:

$$\int_{V_c}^{V_d} \frac{dV}{V} = -\frac{C_V}{R} \int_{T_H}^{T_c} \frac{dT}{T}$$

$$\ln \frac{V_d}{V_c} = -\frac{C_V}{R} \ln \frac{T_c}{T_H} = +\frac{C_V}{R} \ln \frac{T_H}{T_c} \longrightarrow (6)$$

Comparing (5) & (6), $\ln\left(\frac{V_d}{V_c}\right) = \ln\left(\frac{V_a}{V_b}\right)$

$$\ln v_d - \ln v_c = \ln v_a - \ln v_b$$

$$\Rightarrow \ln v_b - \ln v_c = \ln v_a - \ln v_d$$

$$\Rightarrow \ln \frac{v_b}{v_c} = \ln \frac{v_a}{v_d}$$

$$\Rightarrow \frac{\ln (v_a/v_d)}{\ln (v_c/v_b)} = -1 \quad \longrightarrow (7)$$

$$\text{From, (3)} \quad \frac{Q_c}{Q_H} = -\frac{T_c}{T_H}$$

$$\frac{|Q_c|}{|Q_H|} = \frac{T_c}{T_H} \quad \longrightarrow (8)$$

Therefore,

$$\text{Thermal efficiency, } \eta = \frac{|W|}{|Q_H|} = 1 - \left| \frac{Q_c}{Q_H} \right|$$

$$\boxed{\eta = 1 - \frac{T_c}{T_H}} \quad \longrightarrow (9)$$

Eqⁿ. (9) shows that the thermal efficiency of a Carnot engine can approach unity only when T_H approaches infinity or T_c approaches zero. Neither condition exists on earth.

The cold reservoirs available on earth are the atmosphere, lakes and rivers, and the oceans, for which $T_c \approx 300\text{ K}$. Hot reservoirs are objects such as furnaces where the

temperature is maintained by combustion of fossil fuels and nuclear reactors where the temperature is maintained by combustion of fossil fuels. For these, $T_H \approx 600 \text{ K}$.

With these values, $\eta = 1 - \frac{300}{600} = 0.5$, an approximate limit for the thermal efficiency of a Carnot engine. Actual heat engines are irreversible, and η rarely exceeds 0.35.

Example: A power plant, rated at 800,000 kW, generates steam at 585 K and discards heat to a river at 295 K. If the thermal efficiency of the plant is 70% of the maximum possible value, how much heat is discarded to the river at rated power?

Solution: The maximum possible thermal efficiency is

$$\eta_{\text{max}} = 1 - \frac{T_C}{T_H} = 1 - \frac{295}{585} = 0.4957$$

$$\text{Actual efficiency} = 0.70 \eta_{\text{max}} = (0.70)(0.4957) = 0.3470$$

$$\text{We also have, } \eta = \frac{|W_{\text{net}}|}{|Q_H|} = \frac{|Q_H| - |Q_C|}{|Q_H|} = 1 - \frac{|Q_C|}{|Q_H|}$$

$$\Rightarrow \eta = 1 - \frac{|Q_C|}{|W_{\text{net}}| + |Q_C|}$$

$$\Rightarrow \frac{|Q_C|}{|W_{\text{net}}| + |Q_C|} = 1 - \eta = 0.653$$

$$\Rightarrow |Q_c| = 0.653|W_{net}| + 0.653|Q_c|$$

$$\Rightarrow (1 - 0.653)|Q_c| = 0.653|W_{net}|$$

$$\Rightarrow |Q_c| = 0.653 \frac{|W_{net}|}{0.347} = \frac{0.653 \times 800,000 \text{ kW}}{0.347}$$

$$\underline{\underline{|Q_c| = 1505476 \text{ kW}}}$$

Entropy

Lecture-19

Equation (8) for a Carnot engine may be written as.

$$\frac{|Q_H|}{T_H} = \frac{|Q_C|}{T_C}$$

The numerical value of Q_H is positive and that of Q_C is negative. The equivalent equation written without absolute-value signs is therefore

$$\frac{Q_H}{T_H} = - \frac{Q_C}{T_C}$$

$$\frac{Q_H}{T_H} + \frac{Q_C}{T_C} = 0 \quad \longrightarrow (10)$$

Thus for a complete cycle of a Carnot engine,
the two quantities Q/T associated with the absorption
and rejection of heat by the working fluid of the
engine sum to zero. The working fluid of a cyclic
engine periodically returns to its initial state, and its
properties, e.g., temperature, pressure and internal energy,
return to their initial values. Indeed, a primary charac-
teristic of a property is that the sum of its changes is zero
for any complete cycle.

Thus, for a Carnot cycle eqⁿ (10) suggests the existence of a property whose changes are given by the quantities Q/T .

Thus, (10) may be written as -

$$\oint \frac{dQ_{rev}}{T} = 0 \quad \rightarrow (11)$$

where the circle in the integral sign signifies integration over the cycle and the subscript "rev" indicates that the cycle is reversible.

Thus the quantities $\frac{dQ_{rev}}{T}$ sum to zero for the cycle, exhibiting the characteristic of a property. The property is called entropy and its differential changes are

$$ds^t = \frac{dQ_{rev}}{T} \quad \rightarrow (12)$$

where s^t is the total entropy of the system.

Alternatively, $dQ_{rev} = T ds^t \quad \rightarrow (13)$

- * Δs^t is independent of path and is a property change.
- * If the process is reversible and adiabatic, $dQ_{rev} = 0$;
then $ds^t = 0$. Thus, the entropy of a system is constant
during a reversible adiabatic process, and the process is said
to be isentropic.

The discussion of entropy can be summarized as follows:
→ Entropy owes its existence to the second law, from which it arises in much the same way as internal energy does from the first law. Equation (12) is the ultimate source of all equations that relate the entropy to measurable quantities. It does not represent a definition of entropy; there is none in the context of classical thermodynamics. What it provides is the means for calculating changes in this property. Its essential nature is summarized by the following axiom:

There exists a property called entropy 'S', which is an intrinsic property of a system, functionally related to the measurable coordinates which characterize the system. For a reversible process, changes in this property are given by-

$$dS^t = \frac{dQ_{rev}}{T}$$

→ The change in entropy of any system undergoing a finite reversible process is-

$$\Delta S^t = \int \frac{dQ_{rev}}{T} \longrightarrow (14)$$

* The entropy change of a system caused by the transfer of heat can always be calculated by $\int dQ/T$, whether the heat transfer is accomplished reversibly or irreversibly.

→ When a system undergoes an irreversible process between two equilibrium states, the entropy change of the system is evaluated by application of Eq. (14) to an arbitrarily chosen reversible process that accomplishes the same change of state as the actual process. Integration is not carried out for the irreversible path. Because entropy is a state function, the entropy changes of the irreversible and reversible processes are identical.

Mathematical statement of the Second Law:

Consider two heat reservoirs, one at temperature T_H and a second at the lower temperature T_C . Let a quantity of heat ' Q ' be transferred from the hotter to the cooler reservoir. The entropy changes of the reservoirs at T_H and at T_C are:

$$\Delta S_H^t = -\frac{|Q|}{T_H} \quad \text{and} \quad \Delta S_C^t = \frac{|Q|}{T_C}$$

These two entropy changes are added to give-

$$\begin{aligned} \Delta S_{\text{total}} &= \Delta S_H^t + \Delta S_C^t \\ &= -\frac{|Q|}{T_H} + \frac{|Q|}{T_C} = |Q| \left(\frac{1}{T_C} - \frac{1}{T_H} \right) \\ &= \frac{|Q|(T_H - T_C)}{T_H T_C} \end{aligned}$$

Because $T_H > T_C$, the total entropy change as a result of this irreversible process is positive.

Also, ΔS_{total} becomes smaller as the difference $T_H - T_C$ gets smaller. When T_H is only infinitesimally higher than T_C , the heat transfer is reversible, and ΔS_{total} approaches zero. Thus for the process of irreversible heat transfer, ΔS_{total} is always positive, approaching zero as the process becomes reversible.

* Every process proceeds in such a direction that the total entropy change associated with it is positive, the limiting value of zero being attained only by a reversible process. No process is possible for which the total entropy decreases.

$$\boxed{\Delta S_{\text{total}} \geq 0}$$

$$\boxed{\Delta S_{\text{system}} + \Delta S_{\text{surroundings}} \geq 0}$$

Ex. A 40-kg steel casting ($C_p = 0.5 \text{ kJ kg}^{-1} \text{ K}^{-1}$) at a temperature of 450°C (723.15 K) is quenched in 150 kg of oil ($C_p = 2.5 \text{ kJ kg}^{-1} \text{ K}^{-1}$) at 25°C . If there are no heat losses, what is the change of entropy of (a) the casting, (b) the oil, and (c) both considered together?

Solution: The final temperature 't' of the oil and the steel casting is found by an energy balance.

$$(40)(0.5)(450 - t) = (150)(2.5)(t - 25)$$

$$\Rightarrow 20(450 - t) = 375(t - 25)$$

$$\Rightarrow 9000 - 20t = 375t - 9375$$

$$\Rightarrow 9000 + 9375 = 375t + 20t = \cancel{355t} \quad 395t$$

$$\underline{t = 46.52^\circ\text{C.}}$$

(a) change in entropy of the casting:

$$\begin{aligned} \Delta S^t &= m \int_{T_1}^{T_2} \frac{C_p dT}{T} = m C_p \ln \frac{T_2}{T_1} \\ &= (40)(0.5) \ln \frac{273.15 + 46.52}{273.15 + 450} \\ &= -16.33 \text{ kJ/K.} \end{aligned}$$

(b) change in entropy of the oil:

$$\Delta S^t = (150)(2.5) \ln \frac{273.15 + 46.52}{273.15 + 25} = 26.13 \text{ kJ/K.}$$

(c) total entropy change:

$$\begin{aligned}\Delta S_{\text{total}} &= -16.33 + 26.13 \\ &= \underline{\underline{9.8 \text{ kJ/K}}}\end{aligned}$$

Carnot's Theorem:

For two given heat reservoirs no engine can have a thermal efficiency higher than that of a Carnot engine.

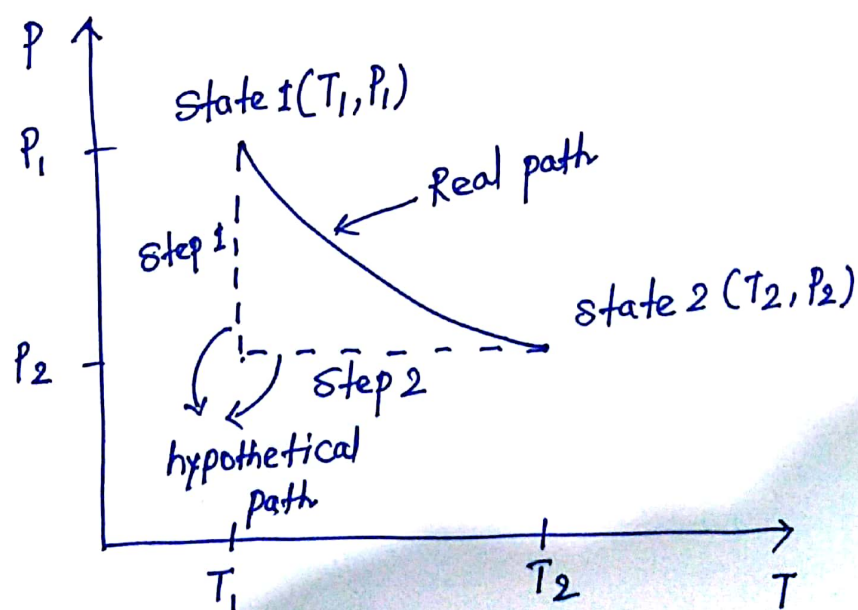
Corollary to Carnot's theorem:

The thermal efficiency of a Carnot engine depends only on the temperature levels and not upon the working substance of the engine.

calculation of ΔS for an ideal gas:

Lecture-20

This section illustrates how to calculate the change in entropy of an ideal gas between two states if 'P' and 'T' for each state are known. We will define the initial state as state 1, at P_1 and T_1 , and the final state as state 2, at P_2 and T_2 . Since entropy is a state function, we can construct any path that is convenient between state 1 and state 2 to calculate ΔS . Figure illustrates such a hypothetical path. We choose a reversible process for our hypothetical path so that we can apply the definition of entropy. The first step consists of isothermal expansion, while the second step is isobaric heating. To find ΔS , we will calculate the entropy change for each step and add them together. Details of the analysis for each step follow.



Step 1: Reversible, isothermal expansion.

The change in internal energy for an ideal gas is zero; thus, the differential energy balance is:

$$dU = dQ_{rev} + dW_{rev} = 0$$

$$\Rightarrow dQ_{rev} = -dW_{rev} = PdV$$

Thus,

$$\Delta S_{step 1} = \int \frac{dQ_{rev}}{T} = \int \frac{P}{T} dV$$

Using the ideal gas law,

$$\frac{P}{T} = \frac{R}{V}$$

$$\begin{aligned} & R T_1 / P_2 \\ & = \int_{V_1} \frac{R}{V} dV \end{aligned}$$

$$= \cancel{R \ln} \frac{RT_1 P_2}{P_1 P_2}$$

$$= R \ln \left(\frac{RT_1}{P_2 V_1} \right)$$

$$= R \ln \left(\frac{P_1 V_1}{P_2 V_1} \right)$$

$$= R \ln \left(\frac{P_1}{P_2} \right) = -R \ln \left(\frac{P_2}{P_1} \right)$$

[For step 1:

$$P_1 V_1 = RT_1$$

& $P_2 V = RT_1$ (at the end of state 1]

$$P_1 V_1 = P_2 V$$

$$\Rightarrow V = \frac{P_1 V_1}{P_2} = \frac{RT_1}{P_2}]$$

Step 2: Reversible, isobaric heating.

Applying the first law gives:

$$dU = dQ_{\text{rev}} + dW_{\text{rev}} = dQ_{\text{rev}} - PdV$$

$$\begin{aligned}\Rightarrow dQ_{\text{rev}} &= dU + PdV \\ &= dU + PdV + VdP \\ &= dU + d(PV) \\ &= d(U + PV) = dH\end{aligned}$$

$$\text{Thus, } \Delta S_{\text{step 2}} = \int \frac{dQ_{\text{rev}}}{T} = \int \frac{dH}{T} = \int_{T_1}^{T_2} \frac{C_p dT}{T}$$

Therefore,

$$\Delta S = \Delta S_{\text{step 1}} + \Delta S_{\text{step 2}}$$

$$\Delta S = \int_{T_1}^{T_2} \frac{C_p dT}{T} - R \ln\left(\frac{P_2}{P_1}\right)$$

The above equation is true for the entropy change associated with an ideal gas between state 1 and state 2. In this expression, ΔS just depends on other properties, C_p, T, P - so it is independent of path. Therefore, the above equation can be applied to any process, be it reversible or irreversible.

Example: A piston-cylinder device initially contains 0.5 m^3 of an ideal gas at 150 kPa and 20°C . The gas is subjected to a constant external pressure of 400 kPa and compressed in an isothermal process. Assume the surroundings are at 20°C . Take $C_p = 25 R$ and assume the ideal gas model holds.

- (a) Determine the heat transfer (in kJ) during the process.
- (b) What is the entropy change of the system, surroundings, and universe?
- (c) Is the process reversible, irreversible or impossible?

Soln: (a) Applying 1st Law of thermodynamics,

$$\Delta U = Q + W$$

Since the process is isothermal, $\Delta U = 0$

$$\Rightarrow Q = -W = +P_{\text{ext}}(V_2 - V_1)$$

For ideal gas at const. temp.

$$P_1 V_1 = P_2 V_2$$

$$\therefore V_2 = \frac{P_1 V_1}{P_2}$$

Thus, $Q = -W = + P_2 \left[\frac{P_1 V_1}{P_2} - V_1 \right]$

$$= \cancel{+ P_1 V_1} + P_2 V_1 - P_1 V_1$$

$$= \cancel{V_1 (P_2 - P_1)} = V_1 (P_1 - P_2)$$

$$= \cancel{(0.5 \text{ m}^3)} () = (0.5 \text{ m}^3) (150 - 450) \text{ kPa}$$

$$= \underline{\underline{-125 \text{ kJ}}}$$

(b) Entropy change of the system is -

$$\Delta S_{\text{sys}} = \int_{T_1}^{T_2} \frac{C_p dT}{T} - R \ln \left(\frac{P_2}{P_1} \right)$$

As C_p is constant & Temp is constant,
the first term is zero.

$$\Delta S_{\text{sys}} = -R \ln \left(\frac{P_2}{P_1} \right) = -8.314 \times \ln \left(\frac{400}{150} \right) \text{ J/mol.k.}$$

$$= -8.15 \text{ J/mol.k.}$$

Thus, total entropy change of the system,

$$= n \Delta S_{\text{sys}} = \left(\frac{PV}{RT} \right)_1 \Delta S_{\text{sys}}$$

$$= \frac{(150 \times 10^3 \text{ Pa})(0.5 \text{ m}^3)}{(8.314 \text{ J/mol.k})(293 \text{ K})} \times -8.15 \frac{\text{J}}{\text{K}}$$

$$= -0.25 \frac{\text{kJ}}{\text{K}}$$

The entropy change of the surroundings:

$$\Delta S_{\text{surr}} = \frac{Q_{\text{surr}}}{T} = -\frac{Q_{\text{sys}}}{T} = \frac{125 \text{ KJ}}{293 \text{ K}} = 0.43 \frac{\text{KJ}}{\text{K}}$$

The entropy change of the universe is equal to that of the system and the surroundings:

$$\Delta S_{\text{univ}} = \Delta S_{\text{sys}} + \Delta S_{\text{surr}}$$

$$= -0.25 + 0.43$$

$$= 0.18 \frac{\text{KJ}}{\text{K}}$$

(c) Since the entropy of the universe increases, this process is irreversible.

CALCULATION OF ENTROPY CHANGES

4.6.1 Phase Change

The entropy change in phase transitions like fusion, vaporisation, or transition from one crystalline form to another can be evaluated from the values of the latent heat of phase change and the temperature at which the change is carried out. The phase changes can be treated as changes occurring reversibly at constant temperature. For example, the entropy of vaporisation ΔS_V is found out as

$$\Delta S_V = \frac{\Delta H_V}{T} \quad (4.25)$$

EXAMPLE 4.6 Calculate the entropy of evaporation of dry saturated steam at 500 kPa.

Data: From the steam tables, latent heat of vaporisation, $\Delta H_V = 2106$ kJ/kg; Saturation temperature of steam = 425 K.

Solution By Eq. (4.25), entropy change accompanying vaporisation is $\Delta S_V = 2106/425 = 4.96$ kJ/kg K

4.6.2 Processes involving Ideal Gases

For a differential change in the thermodynamic state of a closed system, the first law of thermodynamics [Eq. (2.5)] can be written as

$$dQ = dU + dW$$

When the process is reversible and the work involved is only work of expansion ($P dV$), the above equation can be modified as

$$dQ_R = dU + P dV$$

Since this infinitesimal change in the state of the system can be assumed to occur at constant temperature T , the entropy change by Eq. (4.1) is

$$dS = \frac{dU + P dV}{T} \quad (4.26)$$

For an ideal gas, $dU = C_V dT$ and $P = RT/V$.

$$dS = \frac{C_V dT + RT (dV/V)}{T} = C_V \frac{dT}{T} + R \frac{dV}{V}$$

Assuming that C_V is independent of temperature, this equation can be integrated for a finite change from state 1 to state 2 giving for one mole of an ideal gas,

$$\Delta S = C_V \ln \frac{T_2}{T_1} + R \ln \frac{V_2}{V_1} \quad (4.27)$$

where the suffixes 1 and 2 indicate the properties of the gas at state 1 and state 2 respectively. Equation (4.27) can be used for the evaluation of entropy change accompanying the change in states of ideal gases. It can be put in another form also. We know that for ideal gases,

$$C_V = C_P - R \quad (4.28)$$

and

$$\frac{V_2}{V_1} = \frac{P_1}{P_2} \frac{T_2}{T_1} \quad (4.29)$$

Substituting Eqs. (4.28) and (4.29) into Eq. (4.27), we obtain the following:

$$\Delta S = C_p \ln \frac{T_2}{T_1} - R \ln \frac{P_2}{P_1} \quad (4.30)$$

Referring to Eqs. (4.27) and (4.30), we see that for constant volume process

$$\Delta S = C_v \ln \frac{T_2}{T_1} \quad (4.31)$$

For constant pressure process, we have

$$\Delta S = C_p \ln \frac{T_2}{T_1} \quad (4.32)$$

For an isothermal process, we obtain

$$\Delta S = R \ln \frac{V_2}{V_1} = R \ln \frac{P_1}{P_2} \quad (4.33)$$

Though the above equations are derived on the premise that the processes are reversible, they can be used for irreversible processes occurring between the same terminal conditions as well. This is because the change in entropy depends only on the end states and not on the history of the system.

EXAMPLE 4.7 Determine the change in entropy when 2 kg of a gas at 277 K is heated at constant volume to a temperature of 368 K. Take the specific heat at constant volume = 1.42 kJ/kg K.

Solution Entropy change accompanying a constant volume process is given by Eq. (4.31). For $m = 2$ kg,

$$\Delta S = mC_v \ln \frac{T_2}{T_1} = 2.0(1.42) \ln \frac{368}{277} = 0.8067 \text{ kJ/K}$$

EXAMPLE 4.8 Calculate the entropy change when 1 kmol of an ideal gas at 300 K and 10 bar expands through a throttle to a pressure of 1 bar, both pressures being maintained constant during the process by suitable means.

Solution During throttling enthalpy is unchanged. For an ideal gas enthalpy being a function of temperature alone, the temperature remains unchanged during the process. Therefore, entropy change accompanying the process can be computed by Eq. (4.33).

$$\Delta S = R \ln \frac{P_1}{P_2} = 8.314 \ln \frac{10}{1} = 19.14 \text{ kJ/kmol K}$$

EXAMPLE 4.9 What is the change in entropy when 1 kmol of an ideal gas at 335 K and 10 bar is expanded irreversibly to 300 K and 1 bar? $C_P = 29.3$ kJ/kmol K.

Solution The entropy change in this process is given by Eq. (4.30)

$$\begin{aligned}\Delta S &= C_P \ln \frac{T_2}{T_1} - R \ln \frac{P_2}{P_1} \\ &= (29.3) \ln \frac{300}{335} - 8.314 \ln \frac{1}{10} = 15.91 \text{ kJ/kmol K}\end{aligned}$$

4.6.3 Adiabatic Mixing Process

When two substances at different temperatures are mixed together adiabatically, both will attain an intermediate temperature, say, T . The change in entropy of each is calculated as

$$\Delta S = \int \frac{dQ_R}{T} = \int_{T_1}^T C_P \frac{dT}{T} \quad (4.34)$$

where T_1 denotes its initial temperature. The total entropy change is then obtained by adding the individual changes. Equation (4.34) can be used for the calculation of change in entropy in processes like mixing of two fluid streams or quenching of metallic bodies in liquids.

EXAMPLE 4.10 Ten kilograms water at 375 K is mixed adiabatically with 30 kg water at 275 K. What is the change in entropy? Assume that the specific heat of water is 4.2 kJ/kg K and is independent of temperature.

Solution Let T be the final temperature attained by the system. Then the heat balance gives

$$10(375 - T) = 30(T - 275)$$

Solving this, $T = 300$ K. Let ΔS_1 be the change in entropy of the hot water and let ΔS_2 be that of cold water. Then by Eq. (4.34),

$$\Delta S_1 = 10 \times 4.2 \times \ln \frac{300}{375} = -9.37 \text{ kJ/K}$$

$$\Delta S_2 = 30 \times 4.2 \times \ln \frac{300}{275} = 10.96 \text{ kJ/K}$$

The total entropy change is

$$\Delta S = \Delta S_1 + \Delta S_2 = 1.59 \text{ kJ/K}$$

EXAMPLE 4.11 A steel casting at a temperature 725 K and weighing 35 kg is quenched in 150 kg oil at 275 K. If there are no heat losses, determine the change in entropy. The specific heat (C_p) of steel is 0.88 kJ/kg K and that of oil is 2.5 kJ/kg K.

Solution Let T be the final temperature attained by the system. Then the heat balance gives

$$35(0.88) (725 - T) = 150(2.5) (T - 275)$$

where T is the final temperature attained by the system. Solving this, we get, $T = 309.15$ K. Let ΔS_1 be the change in entropy of the casting and let ΔS_2 be that of oil. Then,

$$\Delta S_1 = 35 \times 0.88 \times \ln \frac{309.15}{725} = -26.25 \text{ kJ/K}$$

$$\Delta S_2 = 150 \times 2.5 \times \ln \frac{309.15}{275} = 43.90 \text{ kJ/K}$$

The entropy change of the casting and oil together is

$$-26.25 + 43.90 \text{ kJ/K} = 17.65 \text{ kJ/K}$$

4.6.4 Isothermal Mixing of Ideal Gases

Consider a mixture of two or more ideal gases at pressure P and temperature T . Let the mole fraction of the components in the mixture be represented by x_i . The entropy change resulting from the irreversible process of mixing of ideal gases in their pure state at temperature T and pressure P to form the mixture at the same temperature and pressure can be computed by the following equation, the proof of which is provided in Chapter 7 [see Eq. (7.122)].

$$\Delta S = -R \sum x_i \ln x_i \quad (4.35)$$

Gibbs paradox. When two distinct intermingling ideal gases are mixed, the resulting entropy change is given by Eq. (4.35). For an equimolar mixture, the entropy change is,

$$\Delta S = -R (0.5 \ln 0.5 + 0.5 \ln 0.5) = -R \ln 0.5 = R \ln 2.0$$

This is true as long as the gases are different, no matter how nearly identical they are. But, when the gases are the same, the change in entropy on mixing should be zero. This curious result is known as the *Gibb's paradox*.

EXAMPLE 4.12 Assuming that air is a mixture of 21% oxygen and 79% nitrogen by volume, calculate entropy of 1 kmol air relative to pure oxygen and nitrogen, all at the same temperature and pressure.

Solution According to Eq. (4.35), entropy change accompanying the process of mixing pure oxygen and nitrogen to form 1 kmol air is

$$\Delta S = -8.314(0.21 \ln 0.21 + 0.79 \ln 0.79) = 4.27 \text{ kJ/kmol K}$$

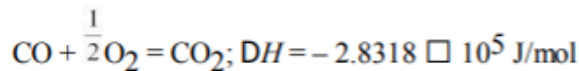
This value represents entropy of 1 kmol air relative to pure components.

4.6.5 Chemical Reactions

The entropy changes accompanying chemical reactions are evaluated through the use of absolute entropies of the various components taking part in the reaction. Let S_P denote the sum of the entropies of the reactants and S_R denotes that of the products. Then the entropy change accompanying the reaction is given by

$$\Delta S = S_P - S_R \quad (4.36)$$

EXAMPLE 4.13 Calculate the entropy change for the following gas phase reaction occurring at 1 bar and 298 K.



The absolute entropies of CO, oxygen and CO₂ are respectively 198 J/mol K, 205.2 kJ/kmol K and 213.8 J/kmol K. Can you calculate the entropy change as the ratio of heat of reaction to the temperature of the reaction? Why?

Solution Refer Eq. (4.36). The reactants are CO and oxygen. The product is CO₂.

$$S_P = 213.8 \text{ J/K}, S_R = 198 + 0.5 \times 205.2 = 300.6 \text{ J/K}$$

$$\Delta S = 213.8 - 300.6 = -86.8 \text{ J/K}$$

Since the reaction is highly irreversible, entropy change cannot be calculated as the ratio of heat of reaction to the temperature.

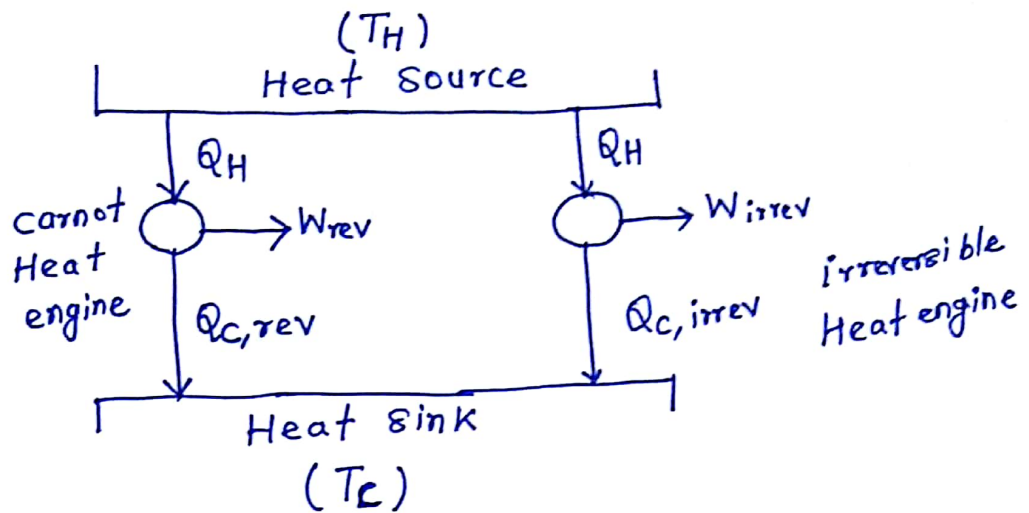
$$\Delta S \neq \left(\frac{\Delta H}{T} = \frac{-2.8318 \times 10^5}{298} = -950.27 \text{ J/K} \right)$$

The heat of reaction ($-\Delta H$) is the heat liberated when the reaction occurred irreversibly. If the reaction were carried out reversibly, for example, in an electrolytic cell with the generation of electric energy, the heat liberated would be ($-T\Delta S$). Therefore, the difference between these two represents the heat loss because of the irreversible nature of the process, or the heat that could have been utilised for the production of useful work like electrical energy. Thus the energy available for useful work is

$$2.8318 \times 10^5 - 298 \times 86.8 = 2.57314 \times 10^5 \text{ J}$$

Clausius Inequality:

(Lecture-21)



Consider two heat engines, one a reversible (Carnot) engine and the other an irreversible heat engine. Assume that both engines accept the same amount of heat ' Q_H ' from the heat source. Since the irreversible engine must be less efficient than the Carnot engine, it must reject more heat to the sink than that rejected by the Carnot engine. i.e. $Q_{C,irrev} > Q_{C,rev}$.

$$\text{Let } dQ = Q_{C,irrev} - Q_{C,rev}$$

For Carnot heat engine:

$$\oint \frac{dQ}{T} = \frac{|Q_H|}{T_H} - \frac{|Q_C|}{T_C}$$

But for an ideal gas, as a working fluid,

$$\frac{|Q_H|}{T_H} = \frac{|Q_C|}{T_C}$$

$$\therefore \oint \frac{dQ}{T} = 0. \quad [\text{For Reversible heat engine}]$$

The cyclic integral for an irreversible heat engine!

$$\begin{aligned}\oint \frac{dQ}{T} &= \frac{Q_H}{T_H} - \frac{Q_{C, \text{irrev}}}{T_C} \\&= \frac{Q_H}{T_H} - \left[\frac{Q + Q_{C, \text{rev}}}{T_C} \right] \\&= \frac{Q_H}{T_H} - \frac{Q}{T_C} - \frac{Q_{C, \text{rev}}}{T_C} \\&= \underbrace{\left[\frac{Q_H}{T_H} - \frac{Q_{C, \text{rev}}}{T_C} \right]}_{\oint \frac{dQ}{T} \text{ for reversible cycle}} - \frac{Q}{T_C}\end{aligned}$$

$$= -\frac{Q}{T_C}$$

$$\text{i.e. } \boxed{\oint \frac{dQ}{T} < 0}$$

Thus, for any reversible or irreversible heat engine,

$$\boxed{\oint \frac{dQ}{T} \leq 0}$$

→ Clausius inequality.

for reversible process:

$$\boxed{ds = \frac{dQ_{\text{rev}}}{T}}$$

Assume reversible and irreversible paths between two states.

' dU ' will be same for both the paths.

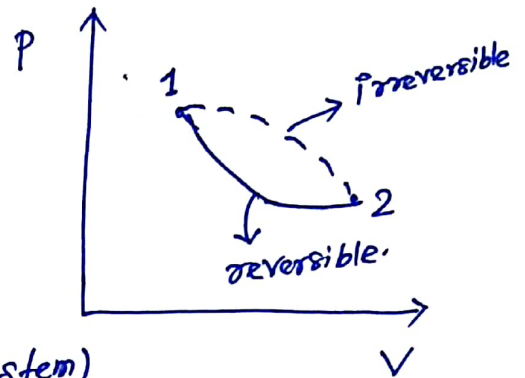
Thus,

$$dU = dQ_{\text{irrev.}} + dW_{\text{irrev.}} = dQ_{\text{rev.}} + dW_{\text{rev.}}$$

$$\Rightarrow dQ_{\text{rev.}} - dQ_{\text{irrev.}} = dW_{\text{irrev.}} - dW_{\text{rev.}}$$

$$\text{Since, } dW_{\text{irrev.}} > dW_{\text{rev.}}$$

(dW is work done on the system)



$$\Rightarrow dQ_{\text{rev.}} - dQ_{\text{irrev.}} \geq 0$$

$$\Rightarrow \frac{dQ_{\text{rev.}}}{T} \geq \frac{dQ_{\text{irrev.}}}{T}$$

$\downarrow$
 ds

$$\Rightarrow \boxed{ds \geq \frac{dQ_{\text{irrev.}}}{T}} \rightarrow \text{Clausius inequality.}$$

For an isolated system,
 $dQ_{\text{irrev.}} = 0$

Thus,

$$\boxed{ds \geq 0}$$

i.e. entropy of an isolated system can never decrease. It always increases and remains constant only when the process is reversible. This is known as the principle of increase of entropy. It is the quantitative statement of the Second Law.

The Third Law of thermodynamics

The entropy of a perfect crystalline substance is zero at ~~the~~ absolute zero temperature.

→ This allows us to determine the absolute entropy.

→ Entropy for substances are always positive.

$$\lim_{T \rightarrow 0} S = 0.$$

⇒ principle of the unattainability of the absolute zero:

It is impossible by any procedure, no matter how idealized, to reduce any assembly to the absolute zero in a finite number of operations and within a finite time.

⇒ ~~and~~ for any solid, let S_0 be the entropy at 0 K and S be the entropy at T K, then

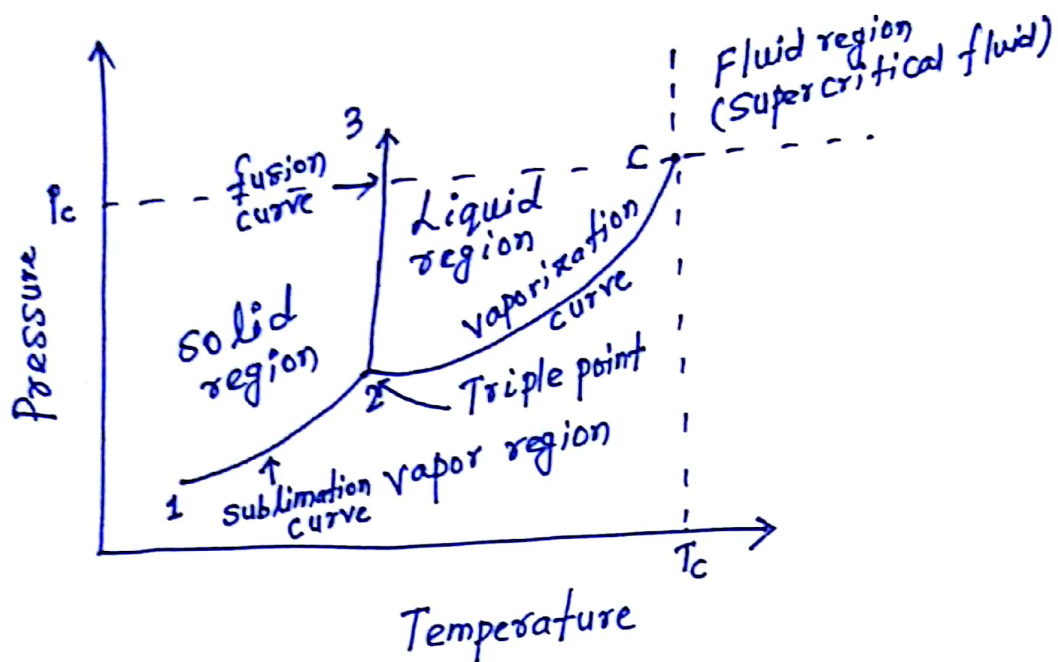
$$\Delta S = S - S_0 = \int_0^T \frac{C_p dT}{T}$$

Since, $S_0 = 0$ @ 0 K, from 3rd law of therm.

$$S = \int_0^T \frac{C_p dT}{T}$$

Lecture-10

Volumetric properties of pure fluids (PVT behaviour)



P-T diagram for a pure substance

Lines 1-2 and 2-c represent for a pure substance conditions of pressure and temperature at which solid and liquid phases exist in equilibrium with a vapor phase. These vapor pressure vs. temperature lines characterize solid/vapor (1-2) and liquid/vapor (2-c) equilibrium relationships. The solid/liquid equilibrium relationship is represented by line 2-3. The three lines display conditions of 'p' and 'T' at which two phases may coexist, and divide the diagram into single-phase regions. Line 1-2, the sublimation curve, separates the solid and gas regions; line 2-3, the fusion curve, separates the solid and liquid regions; line 2-c, the vaporization curve, separates the liquid and gas regions.

point 'C' is known as the critical point; its coordinates P_c and T_c are the highest pressure and highest temperature at which a pure chemical species is observed to exist in vapor/liquid equilibrium.

The three lines meet at the triple point, where the three phases coexist in equilibrium.

* According to the phase rule, the triple point is invariant ($F=0$). If the system exists along any of the two-phase lines, it is univariant ($F=1$), whereas in the single-phase regions it is divariant ($F=2$).

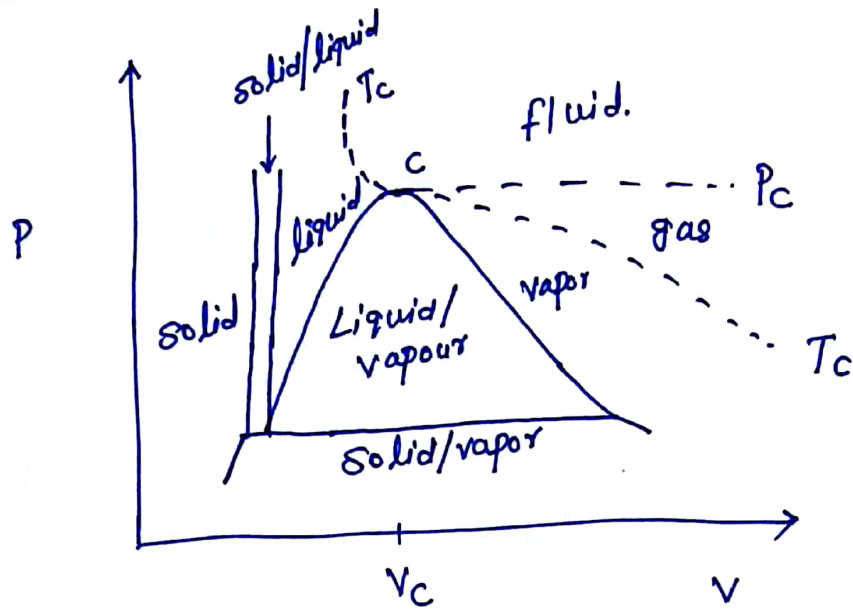
* Water in an open flask is obviously a liquid in contact through a meniscus with air. If the flask is sealed and the air is pumped out, water vaporizes to replace the air, and H_2O fills the flask. The liquid water resides at the bottom of the flask because its density is much greater than that of water vapor, and the two phases are in equilibrium at conditions represented by a point on curve 2-C. The properties of liquid and vapor are very different. However, if the temperature is raised so that the equilibrium state progresses upward along curve 2-C, the properties of the two phases become more and more nearly alike; at point 'C' they become identical and the meniscus disappears.

* The gas region is sometimes divided into two parts, as indicated by the dotted vertical line. A gas to the left of this line, which can be condensed either by compression at constant temperature or by cooling at constant pressure is called a vapour. A fluid existing at a temperature greater than T_c is said to be supercritical. An example is atmospheric air.

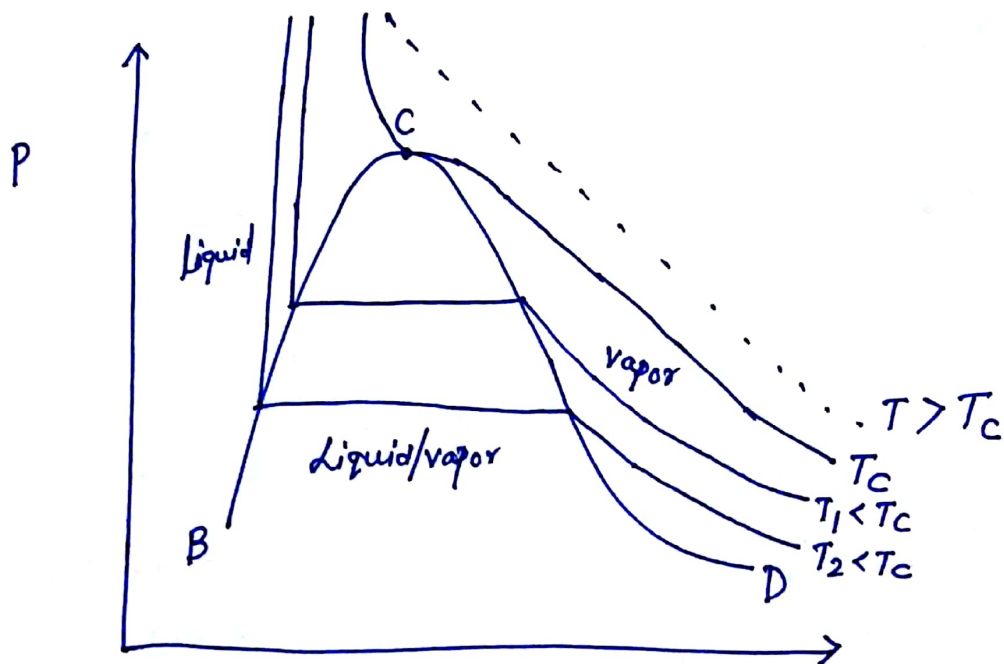
* A phase is generally considered a liquid if vaporization results from pressure reduction at constant temperature.

A phase is considered a gas if condensation results from temperature reduction at constant pressure. Since neither process can be initiated in the region beyond the dashed lines, it is called the fluid region.

PV-diagram



PT-diagram doesn't provide any information about volume; it merely displays the phase boundaries on a PT-diagram. On a PV-diagram, these boundaries in turn become regions where two phases - solid/liquid, solid/vapor and liquid/vapor - coexist in equilibrium.



Liquid, liquid/vapor, vapor regions with isotherms

The lines labeled T_1 and T_2 are for subcritical temperatures, and consist of three segments. The horizontal segment of each isotherm represents all possible mixtures of liquid and vapor in equilibrium, ranging from 100% liquid at the left end to 100% vapor at the right end.

The locus of these end points is the dome-shaped curve labeled BCD, the left half of which (B to C) represents single-phase liquids at their vaporization (boiling) temperatures, and the right half (C to D), single-phase vapors at their condensation temperatures. Liquids and vapors represented by BCD are said to be saturated, and coexisting phases are connected by the horizontal segment of the isotherm at the saturation pressure specific to the isotherm.

The two-phase liquid/vapor region lies under dome BCD; the subcooled-liquid region lies to the left of the saturated-liquid curve BC, and the superheated-vapor region lies to right of the saturated-vapor curve CD. Isotherms in the subcooled-liquid region are very steep, because liquid volumes change little with large changes in pressure. The horizontal segment of the isotherms in the two-phase region become progressively shorter at higher temperatures, being ultimately reduced to a point at C.

Subcooled liquid and saturated liquid

Consider a piston-cylinder device containing liquid water at 20°C and 1 atm pressure. Under these conditions, water exists in the liquid phase, and it is called a compressed liquid or a subcooled liquid, meaning that it is not about to vaporize. As heat is transferred, the temperature keeps rising until it reaches 100°C . At this point water is still a liquid, but any heat addition will cause some of the liquid to vaporize. That is, a phase-change process from liquid to vapor is about to take place. A liquid that is about to vaporize is called a saturated liquid.

Saturated vapor and Superheated vapor

Once boiling starts, the temperature stops rising until the liquid is completely vaporized. During a boiling process, the only change we will observe is a large increase in the volume and a steady decline in the liquid level as a result of more liquid turning to vapor. As we continue transferring heat, the vaporization process continues until the last drop of liquid is vaporized. At this point, the entire cylinder is filled with vapor. ~~that~~ Any heat loss from this vapor will cause some of the vapor to condense. A vapor that is about to condense is called a saturated vapor.

Once the phase-change process is completed, we are back to a single-phase region (this time vapor), and further transfer of heat results in an increase in both the temperature and the specific volume. Let us say, the temperature of the vapor is 300°C and if we transfer some heat from the vapor; the temperature may drop somewhat but no condensation will take place as long as the temperature remains above 100°C (for $p = 1 \text{ atm}$). A vapor that is not about to condense is called a superheated vapor.

		Saturation pressure		Steam Table							
t °C	T K	P kPa	Specific vol (m³/kg)		Internal Energy (kJ/kg)		Enthalpy (kJ/kg)		Entropy (kJ/kg·K)		
			Sat. Liq.	Sat. vap.	Sat. Liq.	Sat. vap.	Sat. Liq.	Sat. vap.	Sat. Liq.	Sat. vap.	
100	373.15	101.33	1.044	1673.0	419	2506.5	419.1	2676.0	1.3069	7.3559	

- * At a given pressure, the temperature at which a pure substance changes phase is called the saturation temperature.
- * At a given temperature, the pressure at which a pure substance changes phase is called the saturation pressure.

E.g. At a pressure of 101.325 kPa , T_{sat} is 99.97°C .

At a temperature of 99.97°C , P_{sat} is 101.325 kPa .

The subscript 'f' is used to denote properties of a saturated liquid, and the subscript 'g' to denote the properties of a saturated vapor. These symbols are commonly used in thermodynamics. Another subscript commonly used is 'fg', which denotes the difference between the saturated vapor and saturated liquid values of the same property.

For example,

v_f = specific volume of saturated liquid

v_g = specific volume of saturated vapor.

v_{fg} = difference between v_g and v_f

$$\text{i.e. } v_{fg} = v_g - v_f.$$

Example.: A rigid tank contains 50 kg of saturated liquid water at 90°C. Determine the pressure in the tank and the volume of the tank.

Solution: Rigid tank contains saturated liquid water at 90°C. Therefore, from steam tables, saturation pressure at 90°C is:

$$\text{Total vol} = \text{molar vol.} \times \text{mass}$$

$$P_{\text{sat @ 90°C}} = 70.11 \text{ kPa.}$$

The specific volume of the saturated liquid at 90°C

$$\text{is: } v_f @ 90^\circ\text{C} = 1.036 \text{ cm}^3/\text{g}.$$

$$\begin{aligned} \text{Then the total volume of the tank} &= (50 \text{ kg}) \left(1.036 \frac{\text{cm}^3}{\text{g}} \right) \\ &= 0.0518 \text{ m}^3. \end{aligned}$$

Saturated liquid-vapor mixture

During a vaporization process, a substance exists as part liquid and part vapor. That is, it is a mixture of saturated liquid and saturated vapor. To analyze the mixture properly, we need to know the proportions of the liquid and vapor phases in the mixture. This is done by defining a new property called the quality (x):

$$x = \frac{m_{\text{vapor}}}{m_{\text{total}}}$$

$$\begin{aligned} \text{where, } m_{\text{total}} &= m_{\text{liquid}} + m_{\text{vapor}} \\ &= m_f + m_g \end{aligned}$$

Its value is between 0 and 1.

For saturated liquid, $x = 0$.

For saturated vapor, $x = 1$.

Consider a tank that contains a saturated liquid-vapor mixture. The volume occupied by saturated liquid is V_f , and the volume occupied by saturated ~~vapor~~ vapor is V_g . The total volume is the sum of the two:

$$V = V_f + V_g$$

Since, $V = mv$

Total vol = molar vol. x mass

$$m_t v_{avg} = m_f v_f + m_g v_g$$

Since, $m_t = m_f + m_g$

$$\Rightarrow m_t v_{avg} = (m_t - m_g) v_f + m_g v_g$$

Dividing by m_t ,

$$v_{avg} = (1 - x) v_f + x v_g$$

$$= v_f - x v_f + x v_g$$

$$= v_f + x(v_g - v_f)$$

$$v_{avg} = v_f + x v_{fg}$$

Similarly, $u_{avg} = u_f + x u_{fg} \quad (\text{kJ/kg})$

$$h_{avg} = h_f + x h_{fg} \quad (\text{kJ/kg})$$

Example: A rigid tank contains 10 kg of water at 90°C. If 8 kg of water is in the liquid form and the rest is in the vapor form, determine (a) the pressure in the tank, and (b) the volume of the tank.

Solution: At 90°C , saturation pressure is-

$$P_{\text{sat @ } 90^{\circ}\text{C}} = 70.11 \text{ kPa.}$$

$$\text{At } 90^{\circ}\text{C}, \quad v_f = 0.001036 \text{ m}^3/\text{kg}$$

$$v_g = 2.3613 \text{ m}^3/\text{kg.}$$

Thus, total volume of the tank,

$$V = V_f + V_g$$

$$= m_f v_f + m_g v_g$$

$$= (8 \text{ kg}) (0.001036 \text{ m}^3/\text{kg}) + (2 \text{ kg}) (2.3613 \text{ m}^3/\text{kg})$$

$$= \underline{\underline{4.74 \text{ m}^3.}}$$

Single-phase Region

For the regions of the ^{phase} diagram where a single phase exists, a relation connecting P , V , and T can be written. Expressed analytically, as $f(P, V, T) = 0$, such a relation is known as a PVT equation of state. It relates pressure, molar or specific volume, and temperature for a pure homogeneous fluid in equilibrium states. The simplest equation of state is ideal-gas equation of state.

An equation of state may be solved for any one of the three quantities P , V or T as a function of the other two. For example, if ' V ' is considered a function of ' T ' and ' P ', then $V = V(T, P)$, and

$$dV = \left(\frac{\partial V}{\partial T} \right)_P dT + \left(\frac{\partial V}{\partial P} \right)_T dP \rightarrow (1)$$

The partial derivatives in this equation have definite physical meanings, and are related to two properties, commonly tabulated for liquids, and defined as follows:

• Volume expansivity:

$$\beta = \frac{1}{V} \left(\frac{\partial V}{\partial T} \right)_P \rightarrow (2)$$

• Isothermal compressibility:

$$\kappa = - \frac{1}{V} \left(\frac{\partial V}{\partial P} \right)_T \rightarrow (3)$$

Eqⁿ. (1), (2) and (3), gives-

$$\frac{dV}{V} = \beta dT - \kappa dP \rightarrow (4)$$

If ' β ' and ' κ ' are weak functions of temp. and pressure.

$$\ln \frac{V_2}{V_1} = \beta (T_2 - T_1) - \kappa (P_2 - P_1) \rightarrow (5)$$

Example: For liquid acetone at 20°C and 1 bar,
 $\beta = 1.487 \times 10^{-3} \text{ } ^\circ\text{C}^{-1}$; $\kappa = 62 \times 10^{-6} \text{ bar}^{-1}$; $V = 1.287 \frac{\text{cm}^3}{\text{g}}$

For acetone, find the

- value of $(\partial P / \partial T)_V$ at 20°C and 1 bar.
- pressure generated by heating at constant 'V' from 20°C and 1 bar to 30°C.
- change in volume for a change from 20°C and 1 bar to 0°C and 10 bar.

Solution:- ^(a) From equation (4), at constant volume,
 $dv=0$

$$\text{i.e. } \beta dT - \kappa dp = 0$$

$$\Rightarrow \left(\frac{\partial p}{\partial T} \right)_v = \frac{\beta}{\kappa} = \frac{1.487 \times 10^{-3}}{62 \times 10^{-6}} = \underline{\underline{24 \text{ bar} \cdot ^\circ\text{C}^{-1}}}$$

(b) If ' β ' and ' κ ' are assumed constant in the 10°C temperature interval, then at constant volume, from eqⁿ. (4),

$$\Delta p = \frac{\beta}{\kappa} \Delta T = 24(10) = 240 \text{ bar}$$

$$\text{and, } p_2 = p_1 + \Delta p = 1 + 240 = \underline{\underline{241 \text{ bar.}}}$$

(c) From eqⁿ. (5),

$$\ln \frac{v_2}{v_1} = (1.487 \times 10^{-3})(-20) - (62 \times 10^{-6})(9) \\ = -0.0303$$

$$\frac{v_2}{v_1} = 0.9702$$

$$\text{and } v_2 = (0.9702)(1.287) \\ = \underline{\underline{1.249 \text{ cm}^3/\text{g}}}$$

$$\text{Then, } \Delta v = v_2 - v_1 = 1.249 - 1.287 \\ = \underline{\underline{-0.038 \text{ cm}^3/\text{g}}}$$

Virial Equations of state

~~The two forms of the virial expansion~~

Expressing 'PV' for an isotherm by a power series in p:

$$PV = a + bP + cP^2 + \dots \dots \dots \rightarrow (1)$$

If $b = aB'$, $c = aC'$, etc. then,

$$PV = a(1 + B'P + C'P^2 + D'P^3 + \dots) \rightarrow (2)$$

where a, B', C' , etc. are constants for a given temperature and a given chemical species.

* In principle, the right side of Eq. (2) is an infinite series. However, in practice a finite number of terms is used. In fact, PVT data show that at low pressures truncation after two terms often provides satisfactory results.

* Parameters B', C' etc are species dependent and functions of temperature, but parameter 'a' is found by experiment to be the same function of temperature for all chemical species.

* The virial equation of state has a sound theoretical foundation; it can be derived from first principles using statistical mechanics.

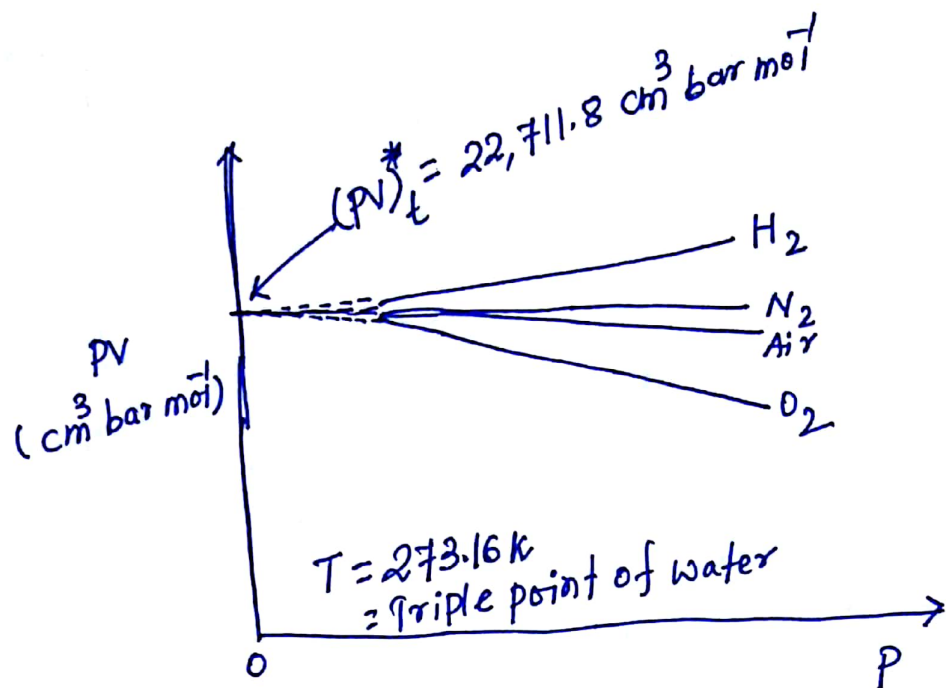


Figure 8 shows a plot of PV vs. P for four gases at the triple-point temperature of water. The limiting value of PV as $P \rightarrow 0$ is the same for all of the gases.

In this limit, Eq. (2) becomes—
(denoted by the asterisk)

$$(PV)^* = a = f(T) \quad \rightarrow (3)$$

The simplest function is defined as

$$(PV)^* = a = RT \quad \rightarrow (4)$$

[directly proportional to T , with
' R ' as the proportionality constant]

Assign the value of 273.16 to the temperature,

$$(PV)^*_t = R \times 273.16 \quad \rightarrow (5)$$

↓
universal gas constant

its numerical value is determined by means of Eqⁿ (5) from experimental pVT data:

$$R = \frac{(pV)_t^*}{273.16 \text{ K}} \longrightarrow (6)$$

Because pVT data cannot in fact be taken at zero pressure, data taken at finite pressures are extrapolated to the zero-pressure state. The accepted value of $(pV)_t^*$ is $22,711.8 \text{ bar cm}^3 \text{ mol}^{-1}$, leading to the following value of R:

$$R = \frac{22,711.8 \text{ cm}^3 \text{ bar mol}^{-1}}{273.16 \text{ K}}$$

$$\boxed{R = 83.1447 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K}^{-1}}$$

A useful auxiliary thermodynamic property is defined by the equation:

$$Z = \frac{V_{\text{real}}}{V_{\text{ideal}}}$$

$$\text{since, } V_{\text{ideal}} = \frac{RT}{P}$$

$$\text{Thus, } Z = \frac{V_{\text{real}}}{(RT/P)}$$

$$\boxed{Z = \frac{PV_r}{RT}} \longrightarrow (7)$$

This dimensionless ratio is called the compressibility factor.

With this definition and with $a = RT$, Eqⁿ. (2) becomes:

$$\checkmark \quad \boxed{Z = 1 + B'P + C'P^2 + D'P^3 + \dots}$$

→ (8)

An alternate expression for 'Z' is also in common use:

$$\checkmark \quad \boxed{Z = 1 + \frac{B}{V} + \frac{C}{V^2} + \frac{D}{V^3} + \dots}$$

→ (9)

Both of these equations are known as virial expansions,
and the parameters B' , C' , D' , etc. and B , C , D , etc. are called
virial coefficients. Parameters B' and B are second virial
coefficients; C' and C are third virial coefficients etc.
For a given gas the virial coefficients are functions
of temperature only.

The two sets of coefficients in Eqs. (8) and (9) are related as follows:

$$B' = \frac{B}{RT} \rightarrow (10a)$$

$$C' = \frac{C - B^2}{(RT)^2} \rightarrow (10b)$$

$$D' = \frac{D - 3BC + 2B^3}{(RT)^3} \rightarrow (10c)$$

reduces to a power series in $1/V$ which may be compared term by term with Eq. (9) to yield the given relations.

{ To derive these relations, we set $Z = PV/RT$ in Eqⁿ. (9), and solve for P . This allows elimination of ' P ' on the right of Eqⁿ. (8). The resulting equation

(page-4)

Many other equations of state have been proposed for gases, but the virial equations are the only ones firmly based on statistical mechanics, which provides physical significance to the virial coefficients. Thus, the term B/v arises on account of interactions between pairs of molecules; the C/v^2 term, on account of three-body interactions; etc.

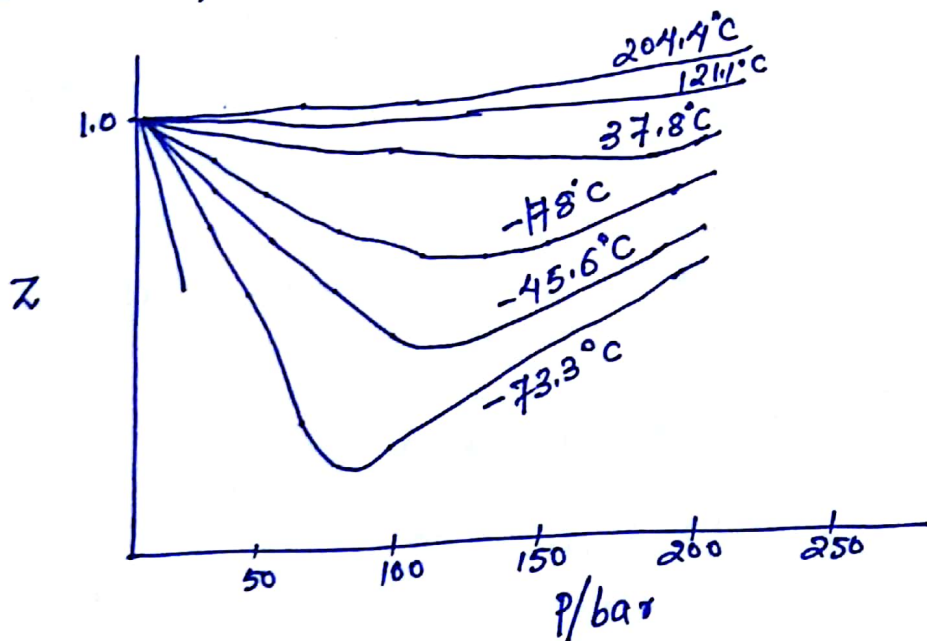
Because the terms B/v , C/v^2 etc. of the virial expansion arise on account of molecular interactions, the virial coefficients B, C , etc., would be zero when no such interactions to exist, and the virial expansion would reduce to

$$Z=1 \quad \text{or} \quad pv = RT$$

Molecular interactions do in fact exist, and influence the observed behavior of real gases. As pressure is reduced at constant temperature, v increases and the contributions of the terms, B/v , C/v^2 ..., decrease. For $p \rightarrow 0$, Z approaches unity, not because of any change in the virial coefficients, but because v becomes infinite. Thus, in the limit as $p \rightarrow 0$, the equation of state reduces to the same simple form as for the hypothetical case of $B=C=\dots=0$; i.e. $Z \rightarrow 1$ or $pv \rightarrow RT$.

Application of the virial Equations

The two forms of the virial expansion given by Eqs. (8) and (9) are infinite series. For engineering purposes their use is practical only where convergence is very rapid, that is, where two or three terms suffice for reasonably close approximations to the values of the series. This is realized for gases and vapors at low to moderate pressures.



compressibility-factor graph for methane

Figure shows a compressibility-factor graph for methane. Values of the compressibility factor Z are plotted vs. pressure for various constant temperatures. All isotherms originate at the value $Z=1$ for $P=0$, and the isotherms are nearly straight lines at low pressures.

Thus the tangent to an isotherm at $p=0$ is a good approximation of the isotherm from $p \rightarrow 0$ to some finite pressure. Differentiation of Eq. (8) for a given temperature gives

$$\left(\frac{\partial Z}{\partial P}\right)_T = B' + 2C'P + 3D'P^2 + \dots$$

from which $\left(\frac{\partial Z}{\partial P}\right)_{T; p=0} = B'$

Thus, the equation of the tangent line is

$$Z = 1 + B'P,$$

a result also given by truncating Eq. (8) to two terms.

A more common form of this equation results from substitution for B' by Eq. (10a):

Moderate pressures
(up to ~ 15 bar)

$$\boxed{Z = \frac{PV}{RT} = 1 + \frac{BP}{RT}} \longrightarrow (11)$$

This equation expresses a direct proportionality between Z and P , and is often applied to vapors at subcritical temperatures up to their saturation pressures.

Equation (9) as well may be truncated to two terms for application at low pressures:

$$\boxed{Z = \frac{PV}{RT} = 1 + \frac{B}{V}} \longrightarrow (12)$$

Eqⁿ. (11) is more convenient in application and is normally at least as accurate as Eqⁿ. (12). Thus, when the virial equation is truncated to two terms, Eqⁿ. (11) is preferred.

The second virial coefficient 'B' is substance dependent and a function of temperature. Experimental values are available for a number of gases. Moreover, estimation of second virial coefficients is possible where no data are available (will be discussed in next classes).

For pressures above the range of applicability of Eqⁿ. (11) but below the critical pressure, the virial equation truncated to three terms often provides excellent results. In this case Eqⁿ. (9) is far superior to Eqⁿ. (8). Thus when the virial equation is truncated to three terms, the appropriate form is.

(From 15 to 50 bar)

$$\boxed{Z = \frac{PV}{RT} = 1 + \frac{B}{V} + \frac{C}{V^2}} \longrightarrow (13)$$

This equation can be solved directly for pressure, but is cubic in volume. Solution for 'v' is readily accomplished by an iterative scheme.

values of 'c', depend on the gas and on temperature.

However, much less is known about third virial coefficients than about second virial coefficients.

Because virial coefficients beyond the third are rarely known and because the virial expansion with more than three terms becomes unwieldy, its use is uncommon.

Example: Reported values for the virial coefficients of isopropanol vapor at 200°C are:

$$B = -388 \text{ cm}^3/\text{mol}$$

$$C = -26000 \text{ cm}^6/\text{mol}^2$$

Calculate V and z for isopropanol vapor at 200°C and 10 bar by (a) the ideal-gas equation

$$(b) z = \frac{PV}{RT} = 1 + \frac{BP}{RT}$$

$$(c) z = \frac{PV}{RT} = 1 + \frac{B}{V} + \frac{C}{V^2}$$

Solution: $T = 473.15 \text{ K}$, $R = 83.14 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K}^{-1}$

(a) For an ideal gas, $z=1$, and

$$V = \frac{RT}{P} = \frac{(83.14 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K}^{-1})(473.15 \text{ K})}{(10 \text{ bar})}$$

$$\underline{\underline{V = 3934 \text{ cm}^3 \text{ mol}^{-1}}}$$

(b) $\frac{PV}{RT} = 1 + \frac{BP}{RT}$

$$\Rightarrow V = \frac{RT}{P} + B$$

$$= 3934 - 388$$

$$\underline{\underline{V = 3546 \text{ cm}^3 \text{ mol}^{-1}}}$$

$$\text{Thus, } z = \frac{PV}{RT} = \frac{(10 \text{ bar})(3546 \text{ cm}^3 \text{ mol}^{-1})}{(83.14 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K}^{-1})(473.15 \text{ K})}$$

$$\underline{\underline{z = 0.9014}}$$

(c) $\frac{PV}{RT} = \left(1 + \frac{B}{V} + \frac{C}{V^2}\right)$

$$\Rightarrow V = \frac{RT}{P} \left[1 + \frac{B}{V} + \frac{C}{V^2}\right]$$

$$\text{For iteration; } V_{i+1} = \frac{RT}{P} \left[1 + \frac{B}{V_i} + \frac{C}{V_i^2}\right]$$

For 1st iteration, $i=0$, and

$$V_1 = \frac{RT}{P} \left[1 + \frac{B}{V_0} + \frac{C}{V_0^2}\right] \text{ where } V_0 = 3934.$$

$$V_1 = 3934 \left[1 - \frac{388}{3934} - \frac{26,000}{(3934)^2} \right] = 3539 \text{ cm}^3/\text{mol.}$$

$$V_2 = 3934 \left[1 - \frac{388}{3539} - \frac{26,000}{(3539)^2} \right] = 3495 \text{ cm}^3/\text{mol.}$$

$$V_3 = 3934 \left[1 - \frac{388}{3495} - \frac{26,000}{(3495)^2} \right] = 3488 \text{ cm}^3/\text{mol.}$$

$$V_4 = 3934 \left[1 - \frac{388}{3488} - \frac{26,000}{(3488)^2} \right] = 3488 \text{ cm}^3/\text{mol}$$

Thus, $V = 3488 \text{ cm}^3/\text{mol.}$

and $z = \frac{PV}{RT} = \frac{10 \times 3488}{83.14 \times 473.15} = 0.8866.$

$z = 0.8866$

Cubic Equations of state

- Simplest equations capable of representing both liquid and vapor behavior.
- Polynomial equations that are cubic in molar volume.

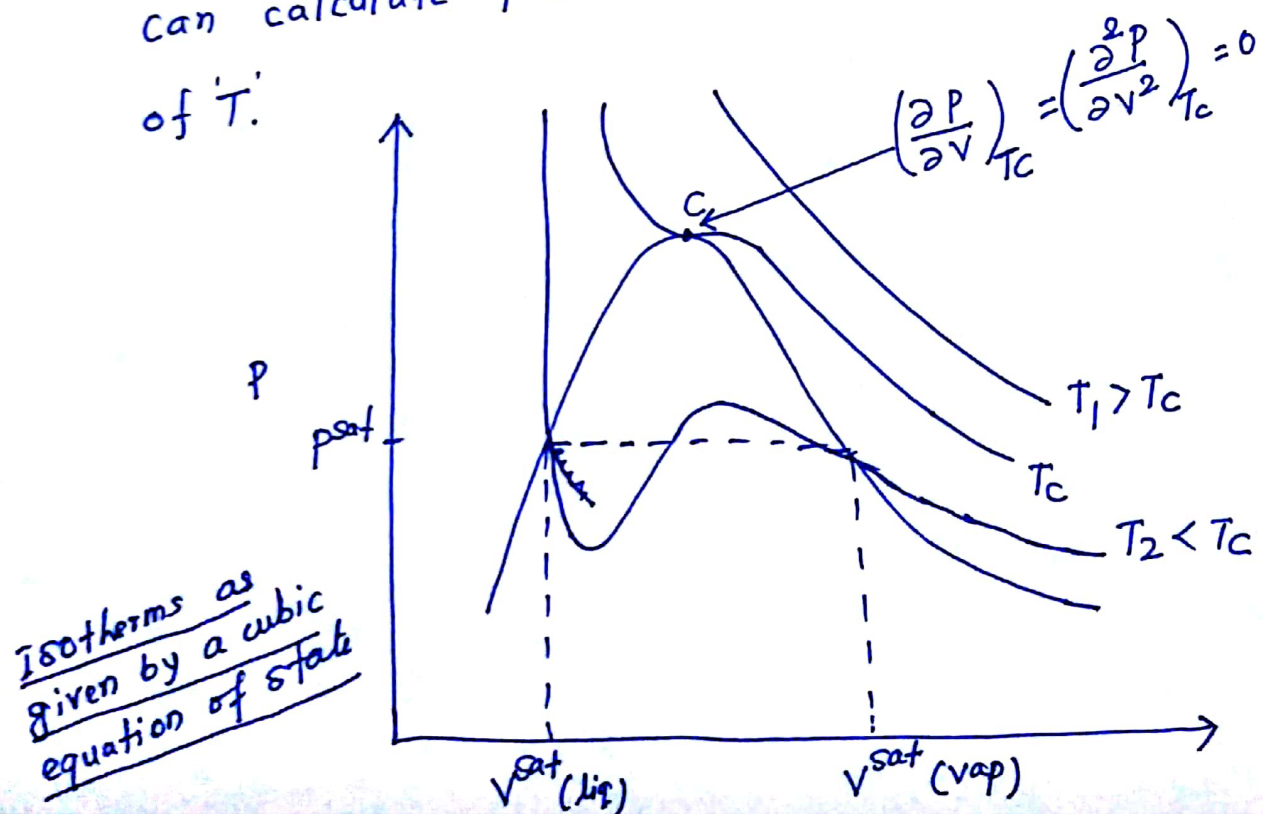
The Van der Waals Equation of state

The first practical cubic equation of state was proposed by Van der Waals in 1873:

$$P = \frac{RT}{V-b} - \frac{a}{V^2} \quad \rightarrow (1)$$

Here, 'a' and 'b' are positive constants; when they are zero, the ideal-gas equation is recovered.

Given values of 'a' and 'b' for a particular fluid, one can calculate 'P' as a function of 'V' for various values of 'T'.



The above figure is a schematic PV diagram showing three isotherms. For the isotherms $T_1 > T_c$, pressure is a monotonically decreasing function with increasing molar volume. The critical isotherm contains the horizontal inflection at 'c' characteristic of the critical point. For the isotherm $T_2 < T_c$, the pressure decreases rapidly in the subcooled-liquid region with increasing V ; after crossing the saturated-liquid line, it goes through a minimum, rises to a maximum, and then decreases, crossing the saturated-vapor line and continuing downward into the superheated-vapor region.

Experimental isotherms do not exhibit this smooth transition from saturated liquid to saturated vapor; rather they contain a horizontal segment within the two-phase region where saturated liquid and saturated vapor coexist in varying proportions at the saturation pressure.

Cubic equations of state have three volume roots. Physically meaningful values of V are always real, positive and greater than constant b .

Inside dome $\rightarrow$ $\left[\begin{array}{l} \text{Smallest root} \equiv V^{\text{sat}}(\text{liq}) \\ \text{Largest root} \equiv V^{\text{sat}}(\text{vap}) \end{array} \right]$ The third root is of no significance.

Above the critical point there is one positive, real root and two roots containing imaginary numbers. Only the positive, real root represents a physical value - the volume of the supercritical fluid.

Determination of van der Waals parameters:

To use the van der Waals equation, the parameters 'a' and 'b' must be determined for a species of interest.

The most accurate values are obtained by fitting experimental PVT data. However, for cubic equations of state, suitable estimates are usually found from values for the critical constants T_c and P_c . Because the critical isotherm exhibits a horizontal inflection at the critical point, we may impose the mathematical conditions:

$$\left(\frac{\partial P}{\partial V}\right)_{T_c} = \left(\frac{\partial^2 P}{\partial V^2}\right)_{T_c} = 0 \quad \longrightarrow (2)$$

Thus, at the critical point we have:

$$P_c = \frac{RT_c}{V_c - b} - \frac{a}{V_c^2} \quad \longrightarrow (3)$$

$$\left(\frac{\partial P}{\partial V}\right)_{T_c} = 0 = \frac{-RT_c}{(V_c - b)^2} + \frac{2a}{V_c^3} \quad \longrightarrow (4)$$

$$\left(\frac{\partial^2 P}{\partial V^2}\right)_{T_c} = 0 = \frac{2RT_c}{(V_c - b)^3} - \frac{6a}{V_c^4} \quad \longrightarrow (5)$$

Multiply Eqⁿ. (4) by 2 and Eqⁿ. (5) by $(V_c - b)$ and add them together, we get:

$$\frac{4a}{V_c^3} - \frac{6a(V_c - b)}{V_c^4} = 0$$

$$\Rightarrow \frac{2a}{V_c^3} = \frac{3a(V_c - b)}{V_c^4}$$

$$\Rightarrow 2V_c = 3V_c - 3b$$

$$\boxed{V_c = 3b}$$

→ (6)

using eqⁿ. (6) in eqⁿ. (4),

$$\frac{2a}{V_c^3} = \frac{RT_c}{(3b - b)^2} = \frac{RT_c}{4b^2}$$

$$\Rightarrow \frac{2a}{(3b)^3} = \frac{RT_c}{4b^2}$$

$$\Rightarrow \frac{2a}{27b^3} = \frac{RT_c}{4b^2} \Rightarrow a = \frac{27}{8} RT_c b = \frac{27}{8} RT_c \left(\frac{V_c}{3}\right)$$

$$\boxed{a = \frac{9}{8} RT_c V_c} \rightarrow (7)$$

$$\Rightarrow \boxed{a = \frac{9}{8} RT_c b}$$

→ (7)

~~Using (6) in (3),~~

$$P_c = \frac{RT_c}{3b - b} - \frac{9}{8} \frac{RT_c b}{V_c^2}$$

$$= \frac{RT_c}{2b} - \frac{9 RT_c b}{8 V_c^2} = \frac{RT_c}{2b} - \frac{9 RT_c b}{8 (3b)^2}$$

$$= \frac{RT_c}{2b} - \frac{RT_c}{8b} = \frac{4RT_c - RT_c}{8b} = \frac{3RT_c}{8b}$$

$$\boxed{b = \frac{3}{8} \frac{RT_c}{P_c}} \longrightarrow (8)$$

using eq. (7) in (3),

$$\begin{aligned} P_c &= \frac{RT_c}{V_c - b} - \frac{9}{8} \frac{RT_c V_c}{V_c^2} \\ &= \frac{RT_c}{3b - b} - \frac{9}{8} \frac{RT_c}{V_c} \\ &= \frac{RT_c}{2b} - \frac{9}{8} \frac{RT_c}{V_c} \\ &= \frac{RT_c}{2b} - \frac{9}{8} \frac{RT_c}{(3b)} = \frac{RT_c}{2b} - \frac{3RT_c}{8b} \\ &= \frac{4RT_c - 3RT_c}{8b} = \frac{RT_c}{8b} \end{aligned}$$

$$\boxed{b = \frac{RT_c}{8P_c}} \longrightarrow (8)$$

From, (7), $a = \frac{9}{8} RT_c (3b)$

$$= \frac{27}{8} RT_c \left(\frac{RT_c}{8P_c} \right)$$

$$\therefore \boxed{a = \frac{27}{64} \frac{(RT_c)^2}{P_c}} \longrightarrow (9)$$

We now have an equation of state for which we ~~are~~ only need critical property data to solve for the parameters.

we can calculate the compressibility factor at the critical point,

$$Z_c = \frac{P_c V_c}{R T_c} = \frac{P_c}{R T_c} (3b) = \frac{3P_c}{R T_c} \times \frac{1}{8} \frac{R T_c}{P_c}$$

$$Z_c = \frac{3}{8} = 0.375$$

$$\boxed{Z_c = 0.375} \longrightarrow (10)$$

i.e. a single value for Z_c applicable alike to all substances.

Experimental values for the compressibility factor at the critical point are around 0.29 for simple species and usually less for complex species. Thus, the value predicted by the van der Waals equation is considerably high - indicating its limitations in predicting PVT behavior.

A Generic Cubic Equation of State (Lecture-14/15)

Since the introduction of the van der Waals equation, several hundred cubic equations of state have been proposed. All are special cases of the equation:

$$P = \frac{RT}{(V-b)} - \frac{\theta(V-\eta)}{(V-b)(V^2 + \kappa V + \lambda)} \rightarrow (1)$$

Here, b, θ, η, κ and λ are parameters which in general depend on temperature and (for mixtures) composition. Although this equation appears to possess great flexibility, it has inherent limitations because of its cubic form. It reduces to the van der Waals equation when $\eta = b$, $\theta = a$, and $\kappa = \lambda = 0$.

An important class of cubic equations results from the preceding equation with the assignments:

For a given equation, $\eta = b$; $\theta = a(T)$; $\kappa = (\epsilon + \sigma)b$; $\lambda = \epsilon\sigma b^2$ $\rightarrow (2)$

For a given equation, ϵ and σ are pure numbers, the same for all substances, whereas parameters $a(T)$ and b are substance dependent.

$$P = \frac{RT}{(V-b)} - \frac{a(T)(V-b)}{(V-b)[V^2 + (\epsilon + \sigma)bV + \epsilon\sigma b^2]}$$

$$= \frac{RT}{(V-b)} - \frac{a(T)}{(V^2 + \epsilon bV + \sigma bV + \epsilon\sigma b^2)}$$

$$= \frac{RT}{V-b} - \frac{a(T)}{V(V + \epsilon b) + \sigma b(V + \epsilon b)}$$

$$P = \frac{RT}{(V-b)} - \frac{a(T)}{(V + \epsilon b)(V + \sigma b)}$$

$\rightarrow (3)$ It is thus transformed into an expression general enough to serve as a generic cubic equation of state, which reduces to all others of interest here upon assignment of appropriate parameters. (page-1)

$$a(T) = \Psi \frac{\alpha(T_r) R^2 T_c^2}{P_c} \longrightarrow (4)$$

Here $\alpha(T_r)$ is an empirical expression, specific to a particular equation of state.

$$b = \Omega \frac{RT_c}{P_c} \longrightarrow (5)$$

In these equations, ' Ω ' and ' Ψ ' are pure numbers, independent of substance and determined for a particular equation of state from the values assigned to ' ϵ ' and ' σ '.

Vapor and Vapor-Like Roots of the Generic Cubic Equation (Largest root) of state:

Multiply Eqⁿ. (3) through by $\frac{V-b}{RT}$. Thus,

$$P \frac{(V-b)}{RT} = \frac{\cancel{RT}}{\cancel{V-b}} \times \frac{\cancel{V-b}}{\cancel{RT}} - \frac{V-b}{RT} \frac{a(T)}{(V+\epsilon b)(V+\sigma b)}$$

$$\Rightarrow \frac{PV}{RT} - \frac{Pb}{RT} = 1 - \frac{V-b}{RT} \frac{a(T)}{(V+\epsilon b)(V+\sigma b)}$$

$$\Rightarrow \frac{PV}{RT} = 1 + \frac{Pb}{RT} - \frac{V-b}{RT} \frac{a(T)}{(V+\epsilon b)(V+\sigma b)}$$

$$\Rightarrow \boxed{V = \frac{RT}{P} + b - \frac{a(T)}{P} \frac{(V-b)}{(V+\epsilon b)(V+\sigma b)}} \rightarrow (6)$$

* Solution for 'V' is found by iteration.

* An initial estimated for 'V' is the ideal-gas value RT/P .

* For iteration, this value is substituted on the right side of Eq. (6). The resulting value of 'V' on the left is then returned to the right side, and the process continues until the change in 'V' is suitably small.

An equation for 'z' equivalent to Eq. (6) is obtained by substituting $v = zRT/p$.

Thus,

$$\frac{zRT}{p} = \frac{RT}{p} + b - \frac{a(T)}{p} \frac{\left(\frac{zRT}{p} - b\right)}{\left(\frac{zRT}{p} + \epsilon b\right)\left(\frac{zRT}{p} + \sigma b\right)}$$

Defining two dimensionless quantities,

$$\beta = \frac{bp}{RT}$$

→ (7)

$$q = \frac{a(T)}{bRT}$$

→ (8)

Therefore,

$$z = 1 + \frac{bp}{RT} - \frac{a(T)}{p} \cdot \frac{p}{RT} \cdot \frac{\left(\frac{zRT}{p} - b\right)}{\left(\frac{zRT}{p} + \epsilon b\right)\left(\frac{zRT}{p} + \sigma b\right)}$$

$$z = 1 + \beta - \underbrace{\frac{a(T)}{RT} \cdot \frac{p}{RT}}_{(q\beta)} \cdot \frac{(z - \beta)}{(z + \epsilon\beta)(z + \sigma\beta)}$$

$$z = 1 + \beta - q\beta \frac{(z - \beta)}{(z + \epsilon\beta)(z + \sigma\beta)} \rightarrow (9)$$

- * Iterative solution of Eq. (9) starts with the value of $z=1$ substituted on the right side. The calculated value of 'z' is returned to the right side and the process continues to convergence.
- * The final value of 'z' yields the volume root through $v = zRT/p$.

Liquid and Liquid-Like Roots of the Generic cubic Equation of state:

From Eqⁿ. (6),

$$V = \frac{RT}{P} + b - \frac{a(T)}{P} \frac{(V-b)}{(V+\epsilon b)(V+\sigma b)}$$

$$\Rightarrow \left(V - \frac{RT}{P} - b\right) = - \frac{a(T)}{P} \frac{(V-b)}{(V+\epsilon b)(V+\sigma b)}$$

$$\Rightarrow \left(V - \frac{RT}{P} - b\right) \frac{P(V+\epsilon b)(V+\sigma b)}{a(T)} = -V + b$$

$$\Rightarrow V = b - \left(V - \frac{RT}{P} - b\right) \frac{P}{a(T)} (V+\epsilon b)(V+\sigma b)$$

$$= b - \left(\frac{PV - RT - Pb}{a(T)}\right) P (V+\epsilon b)(V+\sigma b)$$

This equation with a starting value of $V=b$ on the right side converges upon iteration to a liquid or liquid-like root. $\rightarrow$ (10)

$$V = b + (V+\epsilon b)(V+\sigma b) \left(\frac{RT + bP - PV}{a(T)} \right)$$

Substituting, $V = \frac{ZRT}{P}$ in Eqⁿ. (10),

$$\frac{ZRT}{P} = b + \left(\frac{ZRT}{P} + \epsilon b\right) \left(\frac{ZRT}{P} + \sigma b\right) \left(\frac{RT + bP - ZRT}{a(T)} \right)$$

$$\Rightarrow Z = \frac{Pb}{RT} + \frac{RT}{P} \left(Z + \frac{\epsilon bP}{RT} \right) \frac{RT}{P} \left(Z + \frac{\sigma bP}{RT} \right) \frac{RT}{a(T)} \left(1 + \frac{bP}{RT} - Z \right)$$

$$= \beta + \frac{RT}{P} \cdot \frac{RT}{P} \cdot \frac{RT}{a(T)} (Z + \epsilon \beta) (Z + \sigma \beta) (1 + \beta - Z)$$

$$Z = \beta + (Z + \epsilon \beta) (Z + \sigma \beta) \left(\frac{1 + \beta - Z}{2\beta} \right) \rightarrow (11)$$

* For iteration a starting value of $Z=\beta$ is substituted on the right side. Once 'Z' is known, the volume is

$$V = \frac{ZRT}{P}$$

Parameter Assignments for Equations of state

<u>Eq. of state</u>	<u>$\alpha(T_r)$</u>	<u>σ</u>	<u>ϵ</u>	<u>Ω</u>	<u>Ψ</u>	<u>Z_c</u>
VdW(1873)	1	0	0	1/8	27/64	3/8
RK(1949)	$T_r^{-1/2}$	1	0	0.08664	0.42748	1/3
SRK(1972)	α_{SRK}	1	0	0.08664	0.42748	1/3
PR(1976)	α_{PR}	$1+\sqrt{2}$	$1-\sqrt{2}$	0.07780	0.45724	0.30740

$$\alpha_{SRK}(T_r; \omega) = [1 + m(1 - T_r^{1/2})]^2$$

$$\rightarrow (0.480 + 1.574\omega - 0.176\omega^2)$$

$$\alpha_{PR}(T_r; \omega) = [1 + m(1 - T_r^{1/2})]^2$$

$$\rightarrow (0.37464 + 1.54226\omega - 0.26992\omega^2)$$

RK $\equiv$ Redlich/Kwong

SRK $\equiv$ Soave/Redlich/Kwong

PR $\equiv$ Peng-Robinson.

Example : 3.9 (from Smith)

Given that the vapor pressure of n-butane at 350 K is 9.4573 bar. Find the molar volumes of

(a) Saturated vapor, and

(b) Saturated-liquid n-butane at these conditions

using, 1) VdW; 2) RK; 3) SRK & 4) PR EOS.

$$R = 83.14 \frac{\text{cm}^3 \text{bar}}{\text{mol K}}$$

Solution: For n-butane, $T_c = 425.1 \text{ K}$
 $P_c = 37.96 \text{ bar}$.

$$\text{Thus, } T_r = \frac{T}{T_c} = \frac{350}{425.1} = 0.8233$$

$$P_r = \frac{P}{P_c} = \frac{9.4573}{37.96} = 0.2491$$

(a) For Saturated vapor:

The generalized cubic EOS is given by -

$$Z = 1 + \beta - q\beta \frac{(Z - \beta)}{(Z + \epsilon\beta)(Z + \sigma\beta)}$$

$$\text{where, } \beta = \frac{bP}{RT} \text{ \& } q = \frac{a(T)}{bRT}$$

$$\text{and } a(T) = \Psi \frac{\alpha(T_r) R^2 T_c^2}{P_c}$$

$$\text{\& } b = \Omega \frac{RT_c}{P_c}$$

1). For vdW EOS:

$$a(T) = \frac{27}{64} \frac{(1)(83.14)^2 (425.1)^2}{(37.96)}$$

$$\therefore a(T) = 13882249 \text{ cm}^6 \text{ bar mol}^{-2}$$

$$b = \frac{1}{8} \times \frac{83.14 \times 425.1}{37.96}$$

$$\therefore b = 116.3818 \text{ cm}^3 \text{ mol}^{-1}$$

$$\text{So, } \beta = \frac{bP}{RT} = \frac{(116.3818 \text{ cm}^3 \text{ mol}^{-1})(9.4573 \text{ bar})}{(83.14 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K})(350 \text{ K})}$$

$$\therefore \beta = 0.0378.$$

$$Z = \frac{a(T)}{bRT} = \frac{13882249 \text{ cm}^6 \text{ bar mol}^{-2}}{(116.3818 \text{ cm}^3 \text{ mol}^{-1})(83.14 \text{ cm}^3 \text{ bar mol}^{-1} \text{ K})(350 \text{ K})}$$

$$\therefore Z = 4.0992$$

So, the above Eqⁿ. reduces to-

$$Z = 1 + 0.0378 - (4.0992)(0.0378) \frac{(Z - 0.0378)}{Z^2}$$

$$Z = 1.0378 - 0.1549 \frac{(Z - 0.0378)}{Z^2}$$

Starting the iteration with an initial value of $Z=1$,

$$Z_1 = 1.0378 - 0.1549 \frac{(1 - 0.0378)}{1^2} = 0.8888$$

$$Z_2 = 1.0378 - 0.1549 \frac{(0.8888 - 0.0378)}{0.8888^2} = 0.8709$$

$$Z_3 = 0.8677; Z_4 = 0.8671; Z_5 = 0.8669; \boxed{Z_6 = 0.8669}$$

$$\text{Thus, } Z_6 V = \frac{ZRT}{P} = \frac{0.8669 \times 83.14 \times 350}{9.4573} = \boxed{2667 \text{ cm}^3 \text{ mol}^{-1}}$$

(page-8)

2). for RK EOS:

$$a(T) = 15502897 \text{ cm}^6 \text{ bar mol}^{-2}$$

$$b = 80.6665 \text{ cm}^3 \text{ mol}^{-1}$$

$$\beta = 0.0262$$

$$q = 6.6045$$

Thus,
$$Z = 1.0262 - 0.1730 \frac{(Z - 0.0262)}{Z(Z + 0.0262)}$$

So, starting with $Z=1$

$$Z_1 = 0.8620; Z_2 = 0.8373; Z_3 = 0.8321; Z_4 = 0.8310; Z_5 = 0.8307$$

$$\boxed{Z_6 = 0.8307}$$

$$\therefore \boxed{V = 2556 \text{ cm}^3 \text{ mol}^{-1}}$$

3). For SRK EOS:

$$a(T) = 16266231 \text{ cm}^6 \text{ bar mol}^{-2}; \alpha = 1.1512$$

$$b = 80.6665 \text{ cm}^3 \text{ mol}^{-1}$$

$$\beta = 0.0262$$

$$q = 6.9042$$

Thus,
$$Z = 1.0262 - 0.1809 \frac{(Z - 0.0262)}{Z(Z + 0.0262)}$$

$$\text{Now, } Z_1 = 0.8545; Z_2 = 0.8271; Z_3 = 0.8209;$$

$$Z_4 = 0.8195; Z_5 = 0.8191; \boxed{Z_6 = 0.8190}$$

$$\therefore \boxed{V = 2520 \text{ cm}^3 \text{ mol}^{-1}}$$

4.) For PR Eos:

$$\alpha = 1.1284$$

$$a(T) = 16977875 \text{ cm}^6 \text{ bar mol}^{-2}$$

$$b = 72.4360 \text{ cm}^3/\text{mol}$$

$$\beta = 0.0235$$

$$q = 8.0547$$

$$\text{Jhw, } Z = 1.0235 - 0.1893 \frac{(Z - 0.0235)}{(Z - 0.0097)(Z + 0.0567)}$$

$$Z_1 = 0.8469; Z_2 = 0.8175; Z_3 = 0.8107; Z_4 = 0.8090;$$

$$Z_5 = 0.8086; Z_6 = 0.8085; \boxed{Z_7 = 0.8085}$$

$$\boxed{V = 2488 \text{ cm}^3/\text{mol}}$$

Theorem of corresponding states (Lecture-16)

Experimental observation shows that compressibility factor for different fluids exhibit similar behaviour when correlated as a function of reduced temperature T_r and reduced pressure P_r ; by definition,

$$T_r = \frac{T}{T_c} \quad \text{and} \quad P_r = \frac{P}{P_c}$$

These dimensionless thermodynamic co-ordinates provide the basis for the simplest form of the theorem of corresponding states:

"All fluids, when compared at the same reduced temperature and reduced pressure, have approximately the same compressibility factor, and all deviate from ideal-gas behavior to about the same degree."

Corresponding-states correlations of z based on this theorem are called two-parameter correlation, because they require use of the two reducing parameters ' T_c ' and ' P_c '. Although these correlations are very nearly exact for the simple fluids (argon, krypton and xenon) systematic deviations are observed for more complex fluids.

Appreciable improvement results from introduction of a third corresponding-states parameter (in addition to T_c and P_c), characteristic of molecular structure; the most popular such parameter is the acentric factor, introduced by K.S. Pitzer and co-workers (1955).

$$\omega = -1 - \log (P_r^{\text{sat}})_{T_r=0.7} \longrightarrow (1)$$

Therefore, ' ω ' can be determined for any fluid from T_c , P_c and a single vapor-pressure measurement made at $T_r = 0.7$.

Three-parameter theorem of corresponding states:

All fluids having the same value of ' ω ', when compared at the same ' T_r ' and ' P_r ', have about the same value of ' z ', and all deviate from ideal-gas behaviour to about the same degree.

Generalized correlations for gases

Generalized correlations find widespread use. Most popular are correlations of the kind developed by Pitzer and coworkers for the compressibility factor Z and for the second virial coefficient B .

Pitzer correlations for the compressibility factor:

The correlation for Z is:

$$Z = Z^0 + \omega Z^1 \quad \rightarrow (2)$$

where Z^0 and Z^1 are functions of both T_r and P_r .

[Values of Z^0 and Z^1 as functions of T_r and P_r are given in Appendix E as Tables E.1 through E.4]

Pitzer correlations for the second virial coefficient:
[Tabular nature of the generalized compressibility factor correlation is a disadvantage]

The simplest form of the virial equation:

$$Z = 1 + B'P = 1 + \frac{BP}{RT} \quad \rightarrow (3)$$

$$P = P_c P_r \text{ and } T = T_c T_r$$

$$Z = 1 + \frac{BP_c P_r}{RT_c T_r} = 1 + \hat{B} \frac{P_r}{T_r} \quad \rightarrow (4)$$

where $\hat{B}$ is a reduced second virial coefficient,

$$\hat{B} = \frac{B P_c}{R T_c} \rightarrow (5)$$

Pitzer and coworkers proposed a correlation,

$$\hat{B} = B^0 + \omega B^1 \rightarrow (6)$$

Thus, eqⁿ. (4) and (6), gives -

$$Z = 1 + (B^0 + \omega B^1) \frac{P_r}{T_r}$$

$$Z = 1 + B^0 \frac{P_r}{T_r} + \omega B^1 \frac{P_r}{T_r} \rightarrow (7)$$

Comparison with eqⁿ. (2), gives -

$$Z^0 = 1 + B^0 \frac{P_r}{T_r} \rightarrow (8)$$

$$Z^1 = B^1 \frac{P_r}{T_r} \rightarrow (9)$$

where,

$$B^0 = 0.083 - \frac{0.422}{T_r^{1.6}} \rightarrow (10)$$

$$B^1 = 0.139 - \frac{0.172}{T_r^{4.2}} \rightarrow (11)$$

Example: Determine the molar volume of *n*-butane at 510 K and 25 bar by each of the following:

(a) The ideal-gas equation.

(b) Eqⁿ. (4), Eqⁿ. (8) - Eqⁿ. (11).

Experimental
value = 1480.7
cm³/mol.

Solution: (a) $V = \frac{RT}{P} = \frac{83.14 \times 510}{25} = 1696.1 \text{ cm}^3/\text{mol.}$

(b) $T_c = 425.1 \text{ K}; P_c = 37.96 \text{ bar.}$

$$T_r = \frac{T}{T_c} = \frac{510}{425.1} = 1.2$$

$$P_r = \frac{P}{P_c} = \frac{25}{37.96} = 0.659$$

$$B^0 = 0.083 - \frac{0.422}{T_r^{1.6}} = 0.083 - \frac{0.422}{(1.2)^{1.6}}$$

$$B^0 = -0.232$$

$$B^1 = 0.139 - \frac{0.172}{T_r^{4.2}} = 0.139 - \frac{0.172}{1.2^{4.2}}$$

$$B^1 = 0.059$$

$$\hat{B} = B^0 + \omega B^1 = -0.232 + (0.2)(0.059)$$

Thus,

$$\hat{B} = -0.220$$

$$\therefore Z = 1 - 0.22 \times \frac{0.659}{1.2} = \underline{\underline{0.879}}$$

$$\& \quad V = \frac{ZRT}{P} = \frac{0.879 \times 83.14 \times 510}{25} = 1491 \text{ cm}^3/\text{mol.}$$

Generalized correlations for liquids

Although the molar volumes of liquids can be calculated by means of generalized cubic equations of state, the results are often not of high accuracy. Generalized equations are available for the estimation of molar volumes of saturated liquids. The simplest equation, proposed by Rackett is,

$$V^{\text{sat}} = V_c Z_c (1 - T_r)^{2/7}$$

An alternate form is:

$$Z^{\text{sat}} = \frac{P_r}{T_r} Z_c [1 + (1 - T_r)^{2/7}]$$

Example : For ammonia at 310 K, estimate the density of the saturated liquid. Exp. = 29.14 cm³/mol.

Solⁿ For ammonia, $T_c = 405.7 \text{ K}$.

$$T_r = \frac{T}{T_c} = \frac{310}{405.7} = 0.7641$$

$$V_c = 72.5 \text{ cm}^3/\text{mol}; Z_c = 0.242$$

$$V^{\text{sat}} = (72.5)(0.242) [1 + (1 - 0.7641)^{2/7}]$$

$$V^{\text{sat}} = 28.35 \text{ cm}^3/\text{mol}.$$

Properties of Water and Steam (Thermodynamic Properties of Ordinary Water Substance)

Based on the NIST Steam Tables
For ME209 Thermodynamics
at IITBombay

Indian Institute of Technology Bombay



22 July 2016

Introduction

These tables are created using the NIST Steam Tables.

Please see the link:

<http://www.nist.gov/srd/upload/NISTIR5078.htm> (referred on 2014.02.06).

The reader should refer to the NIST Steam Tables for original data.

The original tabulation, created by, National Institute of Standards and Technology (NIST, www.nist.gov), is made available by NIST as a public service. A relevant part of the disclaimer from NIST (www.nist.gov/public_affairs/disclaimer.cfm) is reproduced here.

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About These Tables

While preparing these tables, the following modifications were made:

- The nomenclature is different, and so is the tabular format.
- Density (ρ) is not tabulated, only specific volume (v) is tabulated.
- Values of thermal (internal) energy ($u = h - pv$) are computed and tabulated.

Please note:

- The tabulation is restricted to 1000°C and 100 MPa.
- Defined (and hence, exact) values are printed in boldface.
- Some metastable states are tabulated for convenient interpolation. These are marked with an asterisk(*) prefixed to the value in the first column. Please see Table 3, pressures upto 0.13 MPa.

Nomenclature

h	specific enthalpy	kJ/kg
p	pressure	MPa
s	specific entropy	kJ/kg K
T	temperature	°C
u	specific thermal (internal) energy	kJ/kg
v	specific volume	m ³ /kg

Subscripts

c	critical point
f	saturated liquid
fg	difference between saturated liquid and dry saturated vapour
g	dry saturated vapour
sat	saturation
tp	triple point

Table 1
Saturation Line
Base: Temperature

Saturated Water and Steam (Temperature-based)

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
0.01	0.0006117	0.00100021	205.991	0	2374.9	0.00	2500.9	2500.9	0	9.1555	9.1555
1	0.0006571	0.00100015	192.439	4.18	2376.2	4.18	2502.7	2498.6	0.01526	9.1291	9.1138
2	0.0007060	0.00100011	179.758	8.39	2377.7	8.39	2504.6	2496.2	0.03061	9.1027	9.0720
3	0.0007581	0.00100008	168.008	12.60	2379.0	12.60	2506.4	2493.8	0.04589	9.0765	9.0306
4	0.0008135	0.00100007	157.116	16.81	2380.4	16.81	2508.2	2491.4	0.06110	9.0505	8.9894
5	0.0008726	0.00100008	147.011	21.02	2381.8	21.02	2510.1	2489.0	0.07625	9.0248	8.9486
6	0.0009354	0.00100011	137.633	25.22	2383.2	25.22	2511.9	2486.7	0.09134	8.9993	8.9080
7	0.0010021	0.00100014	128.923	29.43	2384.5	29.43	2513.7	2484.3	0.10637	8.9741	8.8677
8	0.0010730	0.00100020	120.829	33.63	2386.0	33.63	2515.6	2481.9	0.12133	8.9491	8.8278
9	0.0011483	0.00100026	113.304	37.82	2387.3	37.82	2517.4	2479.6	0.13624	8.9243	8.7881
10	0.0012282	0.00100035	106.303	42.02	2388.6	42.02	2519.2	2477.2	0.15109	8.8998	8.7487
11	0.0013130	0.00100044	99.787	46.22	2390.0	46.22	2521.0	2474.8	0.16587	8.8754	8.7096
12	0.0014028	0.00100055	93.719	50.41	2391.4	50.41	2522.9	2472.5	0.18061	8.8513	8.6707
13	0.0014981	0.00100067	88.064	54.60	2392.8	54.60	2524.7	2470.1	0.19528	8.8274	8.6321
14	0.0015990	0.00100080	82.793	58.79	2394.1	58.79	2526.5	2467.7	0.20990	8.8037	8.5938
15	0.0017058	0.00100094	77.875	62.98	2395.5	62.98	2528.3	2465.4	0.22446	8.7803	8.5558
16	0.0018188	0.00100110	73.286	67.17	2396.9	67.17	2530.2	2463.0	0.23897	8.7570	8.5180
17	0.0019384	0.00100127	69.001	71.36	2398.2	71.36	2532.0	2460.6	0.25343	8.7339	8.4805
18	0.0020647	0.00100145	64.998	75.54	2399.6	75.54	2533.8	2458.3	0.26783	8.7111	8.4433
19	0.0021983	0.00100164	61.256	79.73	2400.9	79.73	2535.6	2455.9	0.28218	8.6884	8.4063
20	0.0023393	0.00100184	57.757	83.91	2402.3	83.91	2537.4	2453.5	0.29648	8.6660	8.3695
21	0.0024882	0.00100205	54.483	88.10	2403.7	88.10	2539.3	2451.2	0.31073	8.6437	8.3330
22	0.0026453	0.00100228	51.418	92.28	2405.1	92.28	2541.1	2448.8	0.32493	8.6217	8.2967
23	0.0028111	0.00100251	48.548	96.46	2406.4	96.46	2542.9	2446.4	0.33908	8.5998	8.2607
24	0.0029858	0.00100275	45.858	100.65	2407.8	100.65	2544.7	2444.0	0.35318	8.5781	8.2250
25	0.0031699	0.00100301	43.337	104.83	2409.1	104.83	2546.5	2441.7	0.36722	8.5566	8.1894
26	0.0033639	0.00100327	40.973	109.01	2410.5	109.01	2548.3	2439.3	0.38123	8.5353	8.1541
27	0.0035681	0.00100354	38.754	113.19	2411.8	113.19	2550.1	2436.9	0.39518	8.5142	8.1191
28	0.0037831	0.00100382	36.672	117.37	2413.2	117.37	2551.9	2434.6	0.40908	8.4933	8.0842
29	0.0040092	0.00100411	34.716	121.55	2414.5	121.55	2553.7	2432.2	0.42294	8.4725	8.0496
30	0.0042470	0.00100441	32.878	125.73	2415.9	125.73	2555.5	2429.8	0.43675	8.4520	8.0152
31	0.0044969	0.00100472	31.151	129.91	2417.2	129.91	2557.3	2427.4	0.45052	8.4316	7.9810
32	0.0047596	0.00100504	29.526	134.09	2418.7	134.09	2559.2	2425.1	0.46424	8.4113	7.9471
33	0.0050354	0.00100537	27.998	138.26	2420.0	138.27	2561.0	2422.7	0.47792	8.3913	7.9134
34	0.0053251	0.00100570	26.560	142.44	2421.4	142.45	2562.8	2420.3	0.49155	8.3714	7.8799
35	0.0056290	0.00100605	25.205	146.62	2422.6	146.63	2564.5	2417.9	0.50513	8.3517	7.8466
36	0.0059479	0.00100640	23.929	150.80	2424.0	150.81	2566.3	2415.5	0.51867	8.3321	7.8135
37	0.0062823	0.00100676	22.727	154.98	2425.3	154.99	2568.1	2413.1	0.53217	8.3127	7.7806
38	0.0066328	0.00100713	21.593	159.16	2426.7	159.17	2569.9	2410.8	0.54562	8.2935	7.7479
39	0.0070002	0.00100750	20.524	163.34	2428.0	163.35	2571.7	2408.4	0.55903	8.2745	7.7154
40	0.0073849	0.00100789	19.515	167.52	2429.4	167.53	2573.5	2406.0	0.57240	8.2555	7.6831

Continued ...

Saturated Water and Steam (Temperature-based), Contd.

<i>T</i> °C	<i>p</i>_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		<i>v_f</i>	<i>v_g</i>	<i>u_f</i>	<i>u_g</i>	<i>h_f</i>	<i>h_g</i>	<i>h_{fg}</i>	<i>s_f</i>	<i>s_g</i>	<i>s_{fg}</i>
40	0.0073849	0.00100789	19.515	167.52	2429.4	167.53	2573.5	2406.0	0.57240	8.2555	7.6831
41	0.0077878	0.00100828	18.563	171.70	2430.7	171.71	2575.3	2403.6	0.58573	8.2368	7.6511
42	0.0082096	0.00100868	17.664	175.88	2432.1	175.89	2577.1	2401.2	0.59901	8.2182	7.6192
43	0.0086508	0.00100909	16.814	180.06	2433.4	180.07	2578.9	2398.8	0.61225	8.1998	7.5875
44	0.0091124	0.00100950	16.011	184.24	2434.7	184.25	2580.6	2396.4	0.62545	8.1815	7.5560
45	0.0095950	0.00100992	15.252	188.42	2436.1	188.43	2582.4	2394.0	0.63861	8.1633	7.5247
46	0.010099	0.00101036	14.534	192.61	2437.4	192.62	2584.2	2391.6	0.65173	8.1453	7.4936
47	0.010627	0.00101079	13.855	196.79	2438.8	196.80	2586.0	2389.2	0.66481	8.1275	7.4627
48	0.011177	0.00101124	13.212	200.97	2440.1	200.98	2587.8	2386.8	0.67785	8.1098	7.4320
49	0.011752	0.00101169	12.603	205.15	2441.4	205.16	2589.5	2384.4	0.69085	8.0922	7.4014
50	0.012352	0.00101215	12.027	209.33	2442.7	209.34	2591.3	2381.9	0.70381	8.0748	7.3710
51	0.012978	0.00101262	11.481	213.51	2444.1	213.52	2593.1	2379.5	0.71673	8.0576	7.3408
52	0.013631	0.00101309	10.963	217.70	2445.4	217.71	2594.8	2377.1	0.72961	8.0404	7.3108
53	0.014312	0.00101357	10.472	221.88	2446.7	221.89	2596.6	2374.7	0.74245	8.0234	7.2810
54	0.015022	0.00101406	10.006	226.05	2448.0	226.07	2598.3	2372.3	0.75526	8.0066	7.2513
55	0.015762	0.00101455	9.5643	230.24	2449.3	230.26	2600.1	2369.8	0.76802	7.9898	7.2218
56	0.016533	0.00101505	9.1448	234.42	2450.6	234.44	2601.8	2367.4	0.78075	7.9732	7.1925
57	0.017336	0.00101556	8.7466	238.60	2452.0	238.62	2603.6	2365.0	0.79344	7.9568	7.1633
58	0.018171	0.00101608	8.3683	242.79	2453.2	242.81	2605.3	2362.5	0.80610	7.9404	7.1343
59	0.019041	0.00101660	8.0089	246.97	2454.6	246.99	2607.1	2360.1	0.81871	7.9242	7.1055
60	0.019946	0.00101713	7.6672	251.16	2455.9	251.18	2608.8	2357.7	0.83129	7.9081	7.0769
61	0.020888	0.00101766	7.3424	255.35	2457.2	255.37	2610.6	2355.2	0.84384	7.8922	7.0484
62	0.021867	0.00101821	7.0335	259.53	2458.5	259.55	2612.3	2352.8	0.85634	7.8764	7.0200
63	0.022885	0.00101875	6.7396	263.72	2459.8	263.74	2614.0	2350.3	0.86882	7.8607	6.9918
64	0.023943	0.00101931	6.4598	267.91	2461.1	267.93	2615.8	2347.8	0.88125	7.8451	6.9638
65	0.025042	0.00101987	6.1935	272.09	2462.4	272.12	2617.5	2345.4	0.89365	7.8296	6.9359
66	0.026183	0.00102044	5.9399	276.27	2463.7	276.30	2619.2	2342.9	0.90602	7.8142	6.9082
67	0.027368	0.00102101	5.6984	280.46	2465.0	280.49	2621.0	2340.5	0.91835	7.7990	6.8807
68	0.028599	0.00102159	5.4682	284.65	2466.3	284.68	2622.7	2338.0	0.93064	7.7839	6.8532
69	0.029876	0.00102218	5.2488	288.84	2467.6	288.87	2624.4	2335.5	0.94291	7.7689	6.8260
70	0.031201	0.00102277	5.0395	293.04	2468.9	293.07	2626.1	2333.0	0.95513	7.7540	6.7989
71	0.032575	0.00102337	4.8400	297.23	2470.1	297.26	2627.8	2330.5	0.96733	7.7392	6.7719
72	0.034000	0.00102398	4.6496	301.42	2471.4	301.45	2629.5	2328.1	0.97949	7.7246	6.7451
73	0.035478	0.00102459	4.4680	305.60	2472.7	305.64	2631.2	2325.6	0.99161	7.7100	6.7184
74	0.037009	0.00102521	4.2945	309.80	2474.0	309.84	2632.9	2323.1	1.0037	7.6955	6.6918
75	0.038595	0.00102584	4.1289	313.99	2475.2	314.03	2634.6	2320.6	1.0158	7.6812	6.6654
76	0.040239	0.00102647	3.9708	318.18	2476.5	318.22	2636.3	2318.1	1.0278	7.6670	6.6392
77	0.041941	0.00102710	3.8197	322.38	2477.8	322.42	2638.0	2315.6	1.0398	7.6528	6.6130
78	0.043703	0.00102775	3.6752	326.58	2479.1	326.62	2639.7	2313.0	1.0517	7.6388	6.5871
79	0.045527	0.00102840	3.5372	330.76	2480.3	330.81	2641.3	2310.5	1.0637	7.6249	6.5612
80	0.047414	0.00102905	3.4052	334.96	2481.5	335.01	2643.0	2308.0	1.0756	7.6111	6.5355

Continued ...

Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
80	0.047414	0.00102905	3.4052	334.96	2481.5	335.01	2643.0	2308.0	1.0756	7.6111	6.5355
81	0.049367	0.00102972	3.2789	339.16	2482.8	339.21	2644.7	2305.5	1.0874	7.5973	6.5099
82	0.051387	0.00103038	3.1581	343.36	2484.1	343.41	2646.4	2302.9	1.0993	7.5837	6.4844
83	0.053476	0.00103106	3.0425	347.55	2485.3	347.61	2648.0	2300.4	1.1111	7.5702	6.4591
84	0.055635	0.00103174	2.9318	351.75	2486.6	351.81	2649.7	2297.9	1.1229	7.5567	6.4339
85	0.057867	0.00103243	2.8258	355.95	2487.8	356.01	2651.3	2295.3	1.1346	7.5434	6.4088
86	0.060173	0.00103312	2.7244	360.16	2489.1	360.22	2653.0	2292.8	1.1463	7.5302	6.3838
87	0.062556	0.00103382	2.6271	364.36	2490.3	364.42	2654.6	2290.2	1.1580	7.5170	6.3590
88	0.065017	0.00103452	2.5340	368.56	2491.5	368.63	2656.3	2287.6	1.1696	7.5040	6.3343
89	0.067558	0.00103524	2.4447	372.76	2492.7	372.83	2657.9	2285.1	1.1813	7.4910	6.3097
90	0.070182	0.00103595	2.3591	376.97	2493.9	377.04	2659.5	2282.5	1.1929	7.4781	6.2853
91	0.072890	0.00103668	2.2770	381.17	2495.2	381.25	2661.2	2279.9	1.2044	7.4653	6.2609
92	0.075684	0.00103741	2.1982	385.38	2496.4	385.46	2662.8	2277.3	1.2160	7.4526	6.2367
93	0.078568	0.00103814	2.1227	389.59	2497.6	389.67	2664.4	2274.7	1.2275	7.4400	6.2126
94	0.081541	0.00103888	2.0502	393.80	2498.8	393.88	2666.0	2272.1	1.2389	7.4275	6.1886
95	0.084608	0.00103963	1.9806	398.00	2500.0	398.09	2667.6	2269.5	1.2504	7.4151	6.1647
96	0.087771	0.00104038	1.9137	402.21	2501.2	402.30	2669.2	2266.9	1.2618	7.4027	6.1409
97	0.091030	0.00104114	1.8496	406.43	2502.4	406.52	2670.8	2264.3	1.2732	7.3904	6.1172
98	0.094390	0.00104191	1.7879	410.63	2503.6	410.73	2672.4	2261.7	1.2846	7.3783	6.0937
99	0.097852	0.00104268	1.7287	414.85	2504.8	414.95	2674.0	2259.0	1.2959	7.3661	6.0702
100	0.10142	0.00104346	1.6718	419.06	2506.0	419.17	2675.6	2256.4	1.3072	7.3541	6.0469
101	0.10509	0.00104425	1.6171	423.28	2507.2	423.39	2677.1	2253.8	1.3185	7.3422	6.0237
102	0.10887	0.00104504	1.5644	427.50	2508.4	427.61	2678.7	2251.1	1.3297	7.3303	6.0006
103	0.11277	0.00104583	1.5139	431.71	2509.6	431.83	2680.3	2248.5	1.3410	7.3185	5.9775
104	0.11678	0.00104664	1.4652	435.93	2510.7	436.05	2681.8	2245.8	1.3522	7.3068	5.9546
105	0.12090	0.00104744	1.4184	440.14	2511.9	440.27	2683.4	2243.1	1.3633	7.2952	5.9318
106	0.12515	0.00104826	1.3733	444.37	2513.0	444.50	2684.9	2240.4	1.3745	7.2836	5.9091
107	0.12952	0.00104908	1.3300	448.59	2514.2	448.73	2686.5	2237.7	1.3856	7.2721	5.8865
108	0.13401	0.00104991	1.2882	452.81	2515.4	452.95	2688.0	2235.1	1.3967	7.2607	5.8640
109	0.13863	0.00105074	1.2480	457.03	2516.5	457.18	2689.5	2232.4	1.4078	7.2493	5.8416
110	0.14338	0.00105158	1.2093	461.27	2517.7	461.42	2691.1	2229.6	1.4188	7.2381	5.8193
111	0.14826	0.00105243	1.1720	465.49	2518.8	465.65	2692.6	2226.9	1.4298	7.2269	5.7970
112	0.15328	0.00105328	1.1361	469.72	2520.0	469.88	2694.1	2224.2	1.4408	7.2157	5.7749
113	0.15844	0.00105414	1.1014	473.95	2521.1	474.12	2695.6	2221.5	1.4518	7.2047	5.7529
114	0.16374	0.00105500	1.0680	478.18	2522.2	478.35	2697.1	2218.7	1.4628	7.1937	5.7309
115	0.16918	0.00105588	1.0358	482.41	2523.4	482.59	2698.6	2216.0	1.4737	7.1828	5.7091
116	0.17477	0.00105675	0.99522	486.65	2526.2	486.83	2700.1	2213.2	1.4846	7.1719	5.6873
117	0.18052	0.00105764	0.97486	490.89	2525.5	491.08	2701.5	2210.5	1.4954	7.1611	5.6657
118	0.18641	0.00105853	0.94598	495.12	2526.7	495.32	2703.0	2207.7	1.5063	7.1504	5.6441
119	0.19246	0.00105942	0.91811	499.36	2527.8	499.56	2704.5	2204.9	1.5171	7.1397	5.6226
120	0.19867	0.00106033	0.89121	503.60	2528.8	503.81	2705.9	2202.1	1.5279	7.1291	5.6012

Continued ...

Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
120	0.19867	0.00106033	0.89121	503.60	2528.8	503.81	2705.9	2202.1	1.5279	7.1291	5.6012
121	0.20505	0.00106123	0.86525	507.84	2530.0	508.06	2707.4	2199.3	1.5387	7.1186	5.5799
122	0.21159	0.00106215	0.84019	512.09	2531.0	512.31	2708.8	2196.5	1.5494	7.1081	5.5587
123	0.21830	0.00106307	0.81598	516.33	2532.2	516.56	2710.3	2193.7	1.5602	7.0977	5.5375
124	0.22518	0.00106400	0.79261	520.58	2533.2	520.82	2711.7	2190.9	1.5709	7.0873	5.5165
125	0.23224	0.00106494	0.77003	524.82	2534.3	525.07	2713.1	2188.0	1.5816	7.0770	5.4955
126	0.23947	0.00106588	0.74821	529.07	2535.3	529.33	2714.5	2185.2	1.5922	7.0668	5.4746
127	0.24689	0.00106683	0.72713	533.33	2536.4	533.59	2715.9	2182.3	1.6029	7.0566	5.4538
128	0.25450	0.00106778	0.70675	537.58	2537.4	537.85	2717.3	2179.5	1.6135	7.0465	5.4330
129	0.26229	0.00106874	0.68705	541.84	2538.5	542.12	2718.7	2176.6	1.6241	7.0364	5.4124
130	0.27028	0.00106971	0.66800	546.09	2539.6	546.38	2720.1	2173.7	1.6346	7.0264	5.3918
131	0.27846	0.00107068	0.64959	550.35	2540.6	550.65	2721.5	2170.8	1.6452	7.0165	5.3713
132	0.28685	0.00107166	0.63177	554.61	2541.6	554.92	2722.8	2167.9	1.6557	7.0066	5.3509
133	0.29543	0.00107265	0.61454	558.87	2542.6	559.19	2724.2	2165.0	1.6662	6.9967	5.3305
134	0.30423	0.00107365	0.59786	563.14	2543.6	563.47	2725.5	2162.1	1.6767	6.9869	5.3102
135	0.31323	0.00107465	0.58173	567.40	2544.7	567.74	2726.9	2159.1	1.6872	6.9772	5.2900
136	0.32245	0.00107566	0.56611	571.67	2545.7	572.02	2728.2	2156.2	1.6976	6.9675	5.2699
137	0.33188	0.00107667	0.55099	575.94	2546.6	576.30	2729.5	2153.2	1.7081	6.9579	5.2498
138	0.34154	0.00107769	0.53636	580.22	2547.6	580.59	2730.8	2150.3	1.7185	6.9483	5.2298
139	0.35143	0.00107872	0.52218	584.49	2548.6	584.87	2732.1	2147.3	1.7289	6.9388	5.2099
140	0.36154	0.00107976	0.50845	588.77	2549.6	589.16	2733.4	2144.3	1.7392	6.9293	5.1901
141	0.37189	0.00108080	0.49516	593.05	2550.6	593.45	2734.7	2141.3	1.7496	6.9199	5.1703
142	0.38247	0.00108185	0.48227	597.33	2551.5	597.74	2736.0	2138.3	1.7599	6.9105	5.1506
143	0.39329	0.00108291	0.46979	601.61	2552.5	602.04	2737.3	2135.2	1.7702	6.9011	5.1309
144	0.40437	0.00108397	0.45769	605.90	2553.4	606.34	2738.5	2132.2	1.7805	6.8919	5.1114
145	0.41568	0.00108504	0.44596	610.19	2554.4	610.64	2739.8	2129.2	1.7907	6.8826	5.0919
146	0.42726	0.00108612	0.43459	614.48	2555.3	614.94	2741.0	2126.1	1.8010	6.8734	5.0724
147	0.43909	0.00108720	0.42357	618.77	2556.3	619.25	2742.3	2123.0	1.8112	6.8643	5.0530
148	0.45118	0.00108830	0.41288	623.07	2557.2	623.56	2743.5	2119.9	1.8214	6.8552	5.0337
149	0.46354	0.00108940	0.40251	627.37	2558.1	627.87	2744.7	2116.9	1.8316	6.8461	5.0145
150	0.47616	0.00109050	0.39245	631.66	2559.0	632.18	2745.9	2113.7	1.8418	6.8371	4.9953
151	0.48907	0.00109162	0.38269	635.97	2559.9	636.50	2747.1	2110.6	1.8520	6.8281	4.9761
152	0.50225	0.00109274	0.37323	640.26	2560.8	640.81	2748.3	2107.5	1.8621	6.8192	4.9571
153	0.51571	0.00109387	0.36404	644.58	2561.8	645.14	2749.5	2104.3	1.8722	6.8103	4.9380
154	0.52946	0.00109501	0.35512	648.88	2562.7	649.46	2750.7	2101.2	1.8823	6.8014	4.9191
155	0.54350	0.00109615	0.34646	653.19	2563.5	653.79	2751.8	2098.0	1.8924	6.7926	4.9002
156	0.55784	0.00109730	0.33805	657.51	2564.4	658.12	2753.0	2094.8	1.9025	6.7838	4.8814
157	0.57247	0.00109846	0.32989	661.82	2565.2	662.45	2754.1	2091.6	1.9125	6.7751	4.8626
158	0.58742	0.00109963	0.32196	666.14	2566.1	666.79	2755.2	2088.4	1.9225	6.7664	4.8439
159	0.60267	0.00110081	0.31426	670.47	2566.9	671.13	2756.3	2085.2	1.9326	6.7578	4.8252
160	0.61823	0.00110199	0.30678	674.79	2567.7	675.47	2757.4	2082.0	1.9426	6.7491	4.8066

Continued ...

Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
160	0.61823	0.00110199	0.30678	674.79	2567.7	675.47	2757.4	2082.0	1.9426	6.7491	4.8066
161	0.63412	0.00110318	0.29951	679.12	2568.6	679.82	2758.5	2078.7	1.9525	6.7406	4.7880
162	0.65033	0.00110438	0.29245	683.45	2569.4	684.17	2759.6	2075.5	1.9625	6.7320	4.7695
163	0.66686	0.00110559	0.28559	687.78	2570.3	688.52	2760.7	2072.2	1.9725	6.7235	4.7511
164	0.68373	0.00110680	0.27892	692.12	2571.1	692.88	2761.8	2068.9	1.9824	6.7150	4.7327
165	0.70093	0.00110803	0.27243	696.46	2571.8	697.24	2762.8	2065.6	1.9923	6.7066	4.7143
166	0.71848	0.00110926	0.26612	700.80	2572.7	701.60	2763.9	2062.3	2.0022	6.6982	4.6960
167	0.73638	0.00111050	0.25999	705.14	2573.4	705.96	2764.9	2058.9	2.0121	6.6898	4.6778
168	0.75462	0.00111175	0.25403	709.49	2574.2	710.33	2765.9	2055.6	2.0220	6.6815	4.6596
169	0.77322	0.00111300	0.24823	713.85	2575.0	714.71	2766.9	2052.2	2.0318	6.6732	4.6414
170	0.79219	0.00111427	0.24259	718.20	2575.7	719.08	2767.9	2048.8	2.0417	6.6650	4.6233
171	0.81152	0.00111554	0.23710	722.55	2576.5	723.46	2768.9	2045.4	2.0515	6.6567	4.6053
172	0.83122	0.00111682	0.23176	726.92	2577.3	727.85	2769.9	2042.0	2.0613	6.6485	4.5872
173	0.85130	0.00111811	0.22656	731.28	2577.9	732.23	2770.8	2038.6	2.0711	6.6404	4.5693
174	0.87176	0.00111941	0.22150	735.65	2578.7	736.63	2771.8	2035.1	2.0809	6.6322	4.5514
175	0.89260	0.00112072	0.21658	740.02	2579.4	741.02	2772.7	2031.7	2.0906	6.6241	4.5335
176	0.91384	0.00112204	0.21179	744.39	2580.1	745.42	2773.6	2028.2	2.1004	6.6161	4.5157
177	0.93547	0.00112336	0.20712	748.77	2580.7	749.82	2774.5	2024.7	2.1101	6.6080	4.4979
178	0.95751	0.00112470	0.20258	753.15	2581.4	754.23	2775.4	2021.2	2.1198	6.6000	4.4802
179	0.97995	0.00112604	0.19815	757.54	2582.1	758.64	2776.3	2017.7	2.1296	6.5920	4.4625
180	1.0028	0.00112740	0.19384	761.92	2582.8	763.05	2777.2	2014.2	2.1392	6.5840	4.4448
181	1.0261	0.00112876	0.18964	766.31	2583.5	767.47	2778.1	2010.6	2.1489	6.5761	4.4272
182	1.0498	0.00113013	0.18555	770.71	2584.1	771.90	2778.9	2007.0	2.1586	6.5682	4.4096
183	1.0739	0.00113151	0.18157	775.10	2584.8	776.32	2779.8	2003.4	2.1683	6.5603	4.3921
184	1.0985	0.00113290	0.17769	779.51	2585.4	780.75	2780.6	1999.8	2.1779	6.5525	4.3746
185	1.1235	0.00113430	0.17390	783.92	2586.0	785.19	2781.4	1996.2	2.1875	6.5447	4.3571
186	1.1489	0.00113571	0.17021	788.33	2586.6	789.63	2782.2	1992.6	2.1971	6.5369	4.3397
187	1.1748	0.00113713	0.16662	792.73	2587.3	794.07	2783.0	1988.9	2.2067	6.5291	4.3223
188	1.2011	0.00113856	0.16311	797.15	2587.9	798.52	2783.8	1985.3	2.2163	6.5213	4.3050
189	1.2280	0.00114000	0.15969	801.57	2588.4	802.97	2784.5	1981.6	2.2259	6.5136	4.2877
190	1.2552	0.00114145	0.15636	806.00	2589.0	807.43	2785.3	1977.9	2.2355	6.5059	4.2704
191	1.2830	0.00114291	0.15311	810.42	2589.6	811.89	2786.0	1974.1	2.2450	6.4982	4.2532
192	1.3112	0.00114438	0.14994	814.86	2590.1	816.36	2786.7	1970.4	2.2546	6.4906	4.2360
193	1.3399	0.00114586	0.14685	819.29	2590.6	820.83	2787.4	1966.6	2.2641	6.4830	4.2188
194	1.3691	0.00114736	0.14383	823.74	2591.2	825.31	2788.1	1962.8	2.2736	6.4754	4.2017
195	1.3988	0.00114886	0.14089	828.18	2591.7	829.79	2788.8	1959.0	2.2832	6.4678	4.1846
196	1.4290	0.00115037	0.13802	832.64	2592.3	834.28	2789.5	1955.2	2.2926	6.4602	4.1676
197	1.4597	0.00115189	0.13522	837.09	2592.7	838.77	2790.1	1951.4	2.3021	6.4527	4.1505
198	1.4909	0.00115343	0.13248	841.54	2593.3	843.26	2790.8	1947.5	2.3116	6.4451	4.1335
199	1.5227	0.00115497	0.12982	846.00	2593.7	847.76	2791.4	1943.6	2.3211	6.4376	4.1166
200	1.5549	0.00115653	0.12721	850.47	2594.2	852.27	2792.0	1939.7	2.3305	6.4302	4.0996

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Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
200	1.5549	0.00115653	0.12721	850.47	2594.2	852.27	2792.0	1939.7	2.3305	6.4302	4.0996
201	1.5877	0.00115809	0.12467	854.94	2594.7	856.78	2792.6	1935.8	2.3400	6.4227	4.0827
202	1.6210	0.00115967	0.12218	859.42	2595.1	861.30	2793.2	1931.9	2.3494	6.4152	4.0658
203	1.6549	0.00116126	0.11976	863.90	2595.5	865.82	2793.7	1927.9	2.3588	6.4078	4.0490
204	1.6893	0.00116286	0.11739	868.39	2596.0	870.35	2794.3	1923.9	2.3683	6.4004	4.0322
205	1.7243	0.00116448	0.11508	872.87	2596.4	874.88	2794.8	1919.9	2.3777	6.3930	4.0154
206	1.7598	0.00116610	0.11282	877.37	2596.8	879.42	2795.3	1915.9	2.3871	6.3856	3.9986
207	1.7959	0.00116774	0.11061	881.86	2597.3	883.96	2795.9	1911.9	2.3964	6.3783	3.9819
208	1.8326	0.00116939	0.10846	886.37	2597.5	888.51	2796.3	1907.8	2.4058	6.3710	3.9651
209	1.8698	0.00117105	0.10635	890.88	2597.9	893.07	2796.8	1903.7	2.4152	6.3636	3.9484
210	1.9077	0.00117272	0.10429	895.39	2598.3	897.63	2797.3	1899.6	2.4245	6.3563	3.9318
211	1.9461	0.00117441	0.10228	899.91	2598.7	902.20	2797.7	1895.5	2.4339	6.3490	3.9151
212	1.9851	0.00117611	0.10031	904.44	2599.0	906.77	2798.1	1891.4	2.4432	6.3417	3.8985
213	2.0247	0.00117782	0.098394	908.97	2599.3	911.35	2798.5	1887.2	2.4526	6.3345	3.8819
214	2.0650	0.00117954	0.096516	913.50	2599.6	915.94	2798.9	1883.0	2.4619	6.3272	3.8653
215	2.1058	0.00118128	0.094679	918.04	2599.9	920.53	2799.3	1878.8	2.4712	6.3200	3.8488
216	2.1473	0.00118303	0.092884	922.58	2600.3	925.12	2799.7	1874.6	2.4805	6.3128	3.8323
217	2.1894	0.00118479	0.091129	927.14	2600.5	929.73	2800.0	1870.3	2.4898	6.3056	3.8158
218	2.2322	0.00118657	0.089413	931.69	2600.7	934.34	2800.3	1866.0	2.4991	6.2984	3.7993
219	2.2756	0.00118836	0.087734	936.26	2601.1	938.96	2800.7	1861.7	2.5084	6.2912	3.7828
220	2.3196	0.00119017	0.086092	940.82	2601.2	943.58	2800.9	1857.4	2.5177	6.2840	3.7663
221	2.3643	0.00119198	0.084486	945.39	2601.4	948.21	2801.2	1853.0	2.5269	6.2768	3.7499
222	2.4096	0.00119382	0.082916	949.97	2601.7	952.85	2801.5	1848.6	2.5362	6.2697	3.7335
223	2.4556	0.00119567	0.081379	954.55	2601.9	957.49	2801.7	1844.2	2.5455	6.2625	3.7171
224	2.5023	0.00119753	0.079875	959.14	2602.0	962.14	2801.9	1839.8	2.5547	6.2554	3.7007
225	2.5497	0.00119940	0.078403	963.74	2602.2	966.80	2802.1	1835.4	2.5640	6.2483	3.6843
226	2.5978	0.00120130	0.076964	968.34	2602.4	971.46	2802.3	1830.9	2.5732	6.2412	3.6680
227	2.6466	0.00120320	0.075554	972.95	2602.5	976.13	2802.5	1826.4	2.5824	6.2341	3.6516
228	2.6960	0.00120512	0.074175	977.56	2602.7	980.81	2802.7	1821.8	2.5917	6.2270	3.6353
229	2.7462	0.00120706	0.072825	982.19	2602.8	985.50	2802.8	1817.3	2.6009	6.2199	3.6190
230	2.7971	0.00120902	0.071503	986.81	2602.9	990.19	2802.9	1812.7	2.6101	6.2128	3.6027
231	2.8487	0.00121098	0.070210	991.44	2603.0	994.89	2803.0	1808.1	2.6193	6.2057	3.5864
232	2.9010	0.00121297	0.068943	996.08	2603.1	999.60	2803.1	1803.5	2.6285	6.1987	3.5702
233	2.9541	0.00121497	0.067702	1000.7	2603.1	1004.3	2803.1	1798.8	2.6377	6.1916	3.5539
234	3.0080	0.00121699	0.066488	1005.3	2603.2	1009.0	2803.2	1794.1	2.6469	6.1845	3.5376
235	3.0625	0.00121902	0.065298	1010.1	2603.2	1013.8	2803.2	1789.4	2.6561	6.1775	3.5214
236	3.1179	0.00122108	0.064133	1014.7	2603.2	1018.5	2803.2	1784.7	2.6653	6.1704	3.5052
237	3.1740	0.00122315	0.062991	1019.4	2603.2	1023.3	2803.1	1779.9	2.6745	6.1634	3.4890
238	3.2308	0.00122523	0.061873	1024.0	2603.2	1028.0	2803.1	1775.1	2.6836	6.1564	3.4727
239	3.2885	0.00122734	0.060778	1028.8	2603.1	1032.8	2803.0	1770.3	2.6928	6.1493	3.4565
240	3.3469	0.00122946	0.059705	1033.5	2603.2	1037.6	2803.0	1765.4	2.7020	6.1423	3.4403

Continued ...

Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
240	3.3469	0.00122946	0.059705	1033.5	2603.2	1037.6	2803.0	1765.4	2.7020	6.1423	3.4403
241	3.4062	0.00123160	0.058654	1038.1	2603.1	1042.3	2802.9	1760.5	2.7111	6.1353	3.4241
242	3.4662	0.00123376	0.057623	1042.8	2603.0	1047.1	2802.7	1755.6	2.7203	6.1282	3.4079
243	3.5270	0.00123594	0.056613	1047.5	2602.9	1051.9	2802.6	1750.7	2.7295	6.1212	3.3918
244	3.5887	0.00123813	0.055624	1052.3	2602.8	1056.7	2802.4	1745.7	2.7386	6.1142	3.3756
245	3.6512	0.00124035	0.054654	1057.0	2602.6	1061.5	2802.2	1740.7	2.7478	6.1072	3.3594
246	3.7145	0.00124259	0.053703	1061.8	2602.5	1066.4	2802.0	1735.6	2.7569	6.1002	3.3432
247	3.7786	0.00124484	0.052771	1066.5	2602.4	1071.2	2801.8	1730.6	2.7661	6.0931	3.3270
248	3.8436	0.00124712	0.051857	1071.3	2602.2	1076.1	2801.5	1725.5	2.7752	6.0861	3.3109
249	3.9095	0.00124941	0.050961	1076.0	2602.0	1080.9	2801.2	1720.3	2.7844	6.0791	3.2947
250	3.9762	0.00125173	0.050083	1080.8	2601.8	1085.8	2800.9	1715.2	2.7935	6.0721	3.2785
251	4.0438	0.00125407	0.049222	1085.5	2601.6	1090.6	2800.6	1710.0	2.8027	6.0650	3.2624
252	4.1122	0.00125643	0.048377	1090.3	2601.4	1095.5	2800.3	1704.7	2.8118	6.0580	3.2462
253	4.1815	0.00125881	0.047548	1095.1	2601.1	1100.4	2799.9	1699.5	2.8210	6.0510	3.2300
254	4.2518	0.00126121	0.046736	1099.9	2600.8	1105.3	2799.5	1694.2	2.8301	6.0439	3.2138
255	4.3229	0.00126364	0.045938	1104.7	2600.5	1110.2	2799.1	1688.8	2.8392	6.0369	3.1977
256	4.3949	0.00126609	0.045156	1109.6	2600.1	1115.2	2798.6	1683.5	2.8484	6.0298	3.1815
257	4.4679	0.00126856	0.044389	1114.4	2599.9	1120.1	2798.2	1678.1	2.8575	6.0228	3.1653
258	4.5417	0.00127106	0.043637	1119.2	2599.5	1125.0	2797.7	1672.6	2.8667	6.0157	3.1491
259	4.6165	0.00127358	0.042898	1124.1	2599.1	1130.0	2797.1	1667.2	2.8758	6.0087	3.1329
260	4.6923	0.00127612	0.042173	1129.0	2598.7	1135.0	2796.6	1661.6	2.8849	6.0016	3.1167
261	4.7689	0.00127869	0.041462	1133.8	2598.3	1139.9	2796.0	1656.1	2.8941	5.9945	3.1004
262	4.8466	0.00128128	0.040764	1138.7	2597.8	1144.9	2795.4	1650.5	2.9032	5.9874	3.0842
263	4.9252	0.00128390	0.040079	1143.6	2597.4	1149.9	2794.8	1644.9	2.9124	5.9804	3.0680
264	5.0047	0.00128655	0.039406	1148.5	2597.0	1154.9	2794.2	1639.2	2.9215	5.9732	3.0517
265	5.0853	0.00128922	0.038746	1153.4	2596.5	1160.0	2793.5	1633.5	2.9307	5.9661	3.0354
266	5.1668	0.00129192	0.038098	1158.3	2596.0	1165.0	2792.8	1627.8	2.9398	5.9590	3.0192
267	5.2494	0.00129465	0.037462	1163.2	2595.4	1170.0	2792.1	1622.0	2.9490	5.9519	3.0029
268	5.3329	0.00129740	0.036837	1168.2	2594.9	1175.1	2791.3	1616.2	2.9582	5.9447	2.9866
269	5.4174	0.00130019	0.036223	1173.2	2594.3	1180.2	2790.5	1610.3	2.9673	5.9376	2.9703
270	5.5030	0.00130300	0.035621	1178.1	2593.7	1185.3	2789.7	1604.4	2.9765	5.9304	2.9539
271	5.5896	0.00130584	0.035029	1183.1	2593.0	1190.4	2788.8	1598.5	2.9857	5.9232	2.9376
272	5.6772	0.00130871	0.034448	1188.1	2592.4	1195.5	2788.0	1592.5	2.9948	5.9160	2.9212
273	5.7659	0.00131161	0.033877	1193.0	2591.8	1200.6	2787.1	1586.5	3.0040	5.9088	2.9048
274	5.8556	0.00131455	0.033317	1198.0	2591.0	1205.7	2786.1	1580.4	3.0132	5.9016	2.8884
275	5.9464	0.00131751	0.032766	1203.1	2590.4	1210.9	2785.2	1574.3	3.0224	5.8944	2.8720
276	6.0383	0.00132051	0.032225	1208.1	2589.6	1216.1	2784.2	1568.1	3.0316	5.8871	2.8555
277	6.1312	0.00132354	0.031693	1213.2	2588.8	1221.3	2783.1	1561.9	3.0408	5.8798	2.8390
278	6.2252	0.00132661	0.031171	1218.1	2588.1	1226.4	2782.1	1555.6	3.0500	5.8725	2.8225
279	6.3203	0.00132971	0.030657	1223.3	2587.2	1231.7	2781.0	1549.3	3.0592	5.8652	2.8060
280	6.4166	0.00133284	0.030153	1228.3	2586.4	1236.9	2779.9	1543.0	3.0685	5.8579	2.7894

Continued ...

Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
280	6.4166	0.00133284	0.030153	1228.3	2586.4	1236.9	2779.9	1543.0	3.0685	5.8579	2.7894
281	6.5139	0.00133602	0.029657	1233.4	2585.5	1242.1	2778.7	1536.6	3.0777	5.8506	2.7729
282	6.6124	0.00133922	0.029169	1238.5	2584.6	1247.4	2777.5	1530.1	3.0869	5.8432	2.7563
283	6.7120	0.00134247	0.028690	1243.7	2583.7	1252.7	2776.3	1523.6	3.0962	5.8358	2.7396
284	6.8128	0.00134575	0.028219	1248.7	2582.7	1257.9	2775.0	1517.1	3.1054	5.8284	2.7229
285	6.9147	0.00134907	0.027756	1253.9	2581.8	1263.2	2773.7	1510.5	3.1147	5.8209	2.7062
286	7.0177	0.00135243	0.027301	1259.1	2580.8	1268.6	2772.4	1503.8	3.1240	5.8135	2.6895
287	7.1220	0.00135584	0.026853	1264.2	2579.8	1273.9	2771.0	1497.1	3.1333	5.8060	2.6727
288	7.2274	0.00135928	0.026413	1269.5	2578.7	1279.3	2769.6	1490.4	3.1426	5.7985	2.6559
289	7.3340	0.00136277	0.025981	1274.6	2577.7	1284.6	2768.2	1483.5	3.1519	5.7909	2.6390
290	7.4418	0.00136630	0.025555	1279.8	2576.5	1290.0	2766.7	1476.7	3.1612	5.7834	2.6222
291	7.5508	0.00136987	0.025136	1285.1	2575.4	1295.4	2765.2	1469.7	3.1705	5.7758	2.6052
292	7.6610	0.00137349	0.024724	1290.4	2574.2	1300.9	2763.6	1462.7	3.1799	5.7681	2.5883
293	7.7725	0.00137716	0.024319	1295.6	2573.0	1306.3	2762.0	1455.7	3.1892	5.7605	2.5712
294	7.8852	0.00138087	0.023921	1300.9	2571.8	1311.8	2760.4	1448.6	3.1986	5.7528	2.5542
295	7.9991	0.00138464	0.023529	1306.2	2570.5	1317.3	2758.7	1441.4	3.2080	5.7451	2.5371
296	8.1143	0.00138845	0.023143	1311.5	2569.2	1322.8	2757.0	1434.2	3.2174	5.7373	2.5199
297	8.2308	0.00139231	0.022763	1316.8	2567.8	1328.3	2755.2	1426.9	3.2268	5.7295	2.5027
298	8.3485	0.00139623	0.022390	1322.1	2566.5	1333.8	2753.4	1419.5	3.2362	5.7217	2.4854
299	8.4676	0.00140020	0.022022	1327.5	2565.0	1339.4	2751.5	1412.1	3.2457	5.7138	2.4681
300	8.5879	0.00140423	0.021660	1332.9	2563.6	1345.0	2749.6	1404.6	3.2552	5.7059	2.4507
301	8.7095	0.00140831	0.021304	1338.3	2562.2	1350.6	2747.7	1397.1	3.2647	5.6979	2.4333
302	8.8325	0.00141245	0.020953	1343.8	2560.6	1356.3	2745.7	1389.4	3.2742	5.6899	2.4158
303	8.9568	0.00141665	0.020608	1349.2	2559.1	1361.9	2743.7	1381.7	3.2837	5.6819	2.3982
304	9.0824	0.00142091	0.020268	1354.7	2557.5	1367.6	2741.6	1374.0	3.2932	5.6738	2.3806
305	9.2094	0.00142524	0.019933	1360.2	2555.8	1373.3	2739.4	1366.1	3.3028	5.6657	2.3629
306	9.3378	0.00142963	0.019604	1365.7	2554.1	1379.0	2737.2	1358.2	3.3124	5.6575	2.3452
307	9.4675	0.00143408	0.019279	1371.2	2552.5	1384.8	2735.0	1350.2	3.3220	5.6493	2.3273
308	9.5986	0.00143861	0.018960	1376.8	2550.7	1390.6	2732.7	1342.1	3.3316	5.6411	2.3094
309	9.7311	0.00144320	0.018645	1382.4	2549.0	1396.4	2730.4	1334.0	3.3413	5.6327	2.2915
310	9.8651	0.00144787	0.018335	1387.9	2547.0	1402.2	2727.9	1325.7	3.3510	5.6244	2.2734
311	10.000	0.00145261	0.018029	1393.6	2545.2	1408.1	2725.5	1317.4	3.3607	5.6159	2.2553
312	10.137	0.00145743	0.017728	1399.2	2543.3	1414.0	2723.0	1309.0	3.3704	5.6074	2.2370
313	10.275	0.00146232	0.017431	1404.9	2541.3	1419.9	2720.4	1300.5	3.3802	5.5989	2.2187
314	10.415	0.00146730	0.017139	1410.5	2539.3	1425.8	2717.8	1291.9	3.3900	5.5903	2.2003
315	10.556	0.00147236	0.016851	1416.3	2537.2	1431.8	2715.1	1283.2	3.3998	5.5816	2.1818
316	10.699	0.00147751	0.016567	1422.0	2535.0	1437.8	2712.3	1274.5	3.4097	5.5729	2.1632
317	10.843	0.00148275	0.016287	1427.8	2532.9	1443.9	2709.5	1265.6	3.4195	5.5641	2.1445
318	10.989	0.00148809	0.016011	1433.6	2530.7	1450.0	2706.6	1256.6	3.4295	5.5552	2.1257
319	11.136	0.00149351	0.015739	1439.5	2528.3	1456.1	2703.6	1247.5	3.4394	5.5462	2.1068
320	11.284	0.00149904	0.015471	1445.3	2526.0	1462.2	2700.6	1238.4	3.4494	5.5372	2.0878

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Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
320	11.284	0.00149904	0.015471	1445.3	2526.0	1462.2	2700.6	1238.4	3.4494	5.5372	2.0878
321	11.434	0.00150467	0.015206	1451.2	2523.6	1468.4	2697.5	1229.1	3.4595	5.5281	2.0686
322	11.586	0.00151040	0.014945	1457.1	2521.1	1474.6	2694.3	1219.7	3.4695	5.5189	2.0494
323	11.740	0.00151625	0.014688	1463.1	2518.7	1480.9	2691.1	1210.2	3.4797	5.5096	2.0300
324	11.895	0.00152221	0.014434	1469.1	2516.0	1487.2	2687.7	1200.6	3.4898	5.5003	2.0105
325	12.051	0.00152829	0.014183	1475.1	2513.4	1493.5	2684.3	1190.8	3.5000	5.4908	1.9908
326	12.209	0.00153449	0.013936	1481.2	2510.7	1499.9	2680.8	1180.9	3.5103	5.4813	1.9710
327	12.369	0.00154081	0.013692	1487.2	2507.9	1506.3	2677.3	1170.9	3.5206	5.4717	1.9511
328	12.530	0.00154727	0.013451	1493.4	2505.1	1512.8	2673.6	1160.8	3.5309	5.4619	1.9310
329	12.693	0.00155387	0.013213	1499.6	2502.2	1519.3	2669.9	1150.6	3.5413	5.4521	1.9108
330	12.858	0.00156061	0.012979	1505.8	2499.1	1525.9	2666.0	1140.2	3.5518	5.4422	1.8903
331	13.024	0.00156751	0.012747	1512.1	2496.1	1532.5	2662.1	1129.6	3.5623	5.4321	1.8698
332	13.193	0.00157456	0.012518	1518.3	2493.0	1539.1	2658.1	1118.9	3.5729	5.4219	1.8490
333	13.362	0.00158177	0.012292	1524.8	2489.7	1545.9	2653.9	1108.1	3.5835	5.4116	1.8281
334	13.534	0.00158915	0.012068	1531.1	2486.4	1552.6	2649.7	1097.1	3.5943	5.4012	1.8069
335	13.707	0.00159671	0.011847	1537.6	2483.0	1559.5	2645.4	1085.9	3.6050	5.3906	1.7856
336	13.882	0.00160447	0.011629	1544.0	2479.5	1566.3	2640.9	1074.6	3.6159	5.3799	1.7640
337	14.059	0.00161241	0.011413	1550.6	2475.8	1573.3	2636.3	1063.0	3.6268	5.3691	1.7422
338	14.238	0.00162057	0.011200	1557.2	2472.1	1580.3	2631.6	1051.3	3.6378	5.3581	1.7202
339	14.418	0.00162895	0.010989	1563.9	2468.4	1587.4	2626.8	1039.4	3.6489	5.3469	1.6980
340	14.601	0.00163755	0.010781	1570.6	2464.4	1594.5	2621.8	1027.3	3.6601	5.3356	1.6755
341	14.785	0.00164640	0.010574	1577.5	2460.5	1601.8	2616.8	1015.0	3.6714	5.3241	1.6527
342	14.971	0.00165551	0.010370	1584.3	2456.3	1609.1	2611.5	1002.5	3.6828	5.3124	1.6296
343	15.159	0.00166490	0.010168	1591.2	2452.0	1616.4	2606.1	989.7	3.6943	5.3005	1.6063
344	15.349	0.00167457	0.0099674	1598.2	2447.6	1623.9	2600.6	976.7	3.7059	5.2885	1.5826
345	15.541	0.00168456	0.0097690	1605.3	2443.1	1631.5	2594.9	963.4	3.7176	5.2762	1.5586
346	15.734	0.00169488	0.0095724	1612.4	2438.4	1639.1	2589.0	949.9	3.7295	5.2636	1.5342
347	15.930	0.00170556	0.0093776	1619.7	2433.6	1646.9	2583.0	936.1	3.7414	5.2509	1.5094
348	16.128	0.00171662	0.0091844	1627.1	2428.6	1654.8	2576.7	922.0	3.7536	5.2379	1.4843
349	16.328	0.00172810	0.0089927	1634.6	2423.5	1662.8	2570.3	907.5	3.7659	5.2246	1.4587
350	16.529	0.00174002	0.0088024	1642.1	2418.1	1670.9	2563.6	892.7	3.7784	5.2110	1.4326
351	16.733	0.00175243	0.0086134	1649.8	2412.7	1679.1	2556.8	877.6	3.7910	5.1971	1.4061
352	16.939	0.00176536	0.0084257	1657.6	2406.9	1687.5	2549.6	862.1	3.8039	5.1829	1.3790
353	17.147	0.00177888	0.0082390	1665.6	2401.0	1696.1	2542.3	846.2	3.8170	5.1683	1.3514
354	17.358	0.00179302	0.0080533	1673.7	2394.8	1704.8	2534.6	829.8	3.8303	5.1534	1.3231
355	17.570	0.00180786	0.0078684	1681.9	2388.4	1713.7	2526.6	812.9	3.8439	5.1380	1.2942
356	17.785	0.00182347	0.0076841	1690.4	2381.7	1722.8	2518.4	795.5	3.8577	5.1222	1.2645
357	18.002	0.00183993	0.0075003	1699.1	2374.8	1732.2	2509.8	777.6	3.8719	5.1059	1.2340
358	18.221	0.00185733	0.0073168	1707.9	2367.5	1741.7	2500.8	759.0	3.8864	5.0891	1.2026
359	18.442	0.00187578	0.0071332	1716.9	2359.8	1751.5	2491.4	739.8	3.9014	5.0717	1.1703
360	18.666	0.00189541	0.0069493	1726.3	2351.8	1761.7	2481.5	719.8	3.9167	5.0536	1.1369

Continued ...

Saturated Water and Steam (Temperature-based), Contd.

T °C	p_{sat} MPa	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
360	18.666	0.00189541	0.0069493	1726.3	2351.8	1761.7	2481.5	719.8	3.9167	5.0536	1.1369
361	18.892	0.00191635	0.0067649	1735.9	2343.3	1772.1	2471.1	699.0	3.9325	5.0347	1.1023
362	19.121	0.00193879	0.0065795	1745.8	2334.4	1782.9	2460.2	677.3	3.9488	5.0151	1.0663
363	19.352	0.00196290	0.0063925	1756.1	2324.9	1794.1	2448.6	654.5	3.9656	4.9945	1.0288
364	19.585	0.00198894	0.0062035	1766.7	2314.7	1805.7	2436.2	630.5	3.9831	4.9727	0.9896
365	19.821	0.0020172	0.0060115	1777.8	2303.7	1817.8	2422.9	605.2	4.0014	4.9497	0.9483
366	20.060	0.0020480	0.0058157	1789.4	2292.0	1830.5	2408.7	578.2	4.0205	4.9251	0.9046
367	20.302	0.0020821	0.0056145	1801.5	2279.1	1843.8	2393.1	549.2	4.0406	4.8986	0.8580
368	20.546	0.0021201	0.0054061	1814.5	2264.8	1858.1	2375.9	517.8	4.0621	4.8697	0.8076
369	20.793	0.0021636	0.0051875	1828.5	2248.7	1873.5	2356.6	483.1	4.0853	4.8376	0.7523
370	21.044	0.0022152	0.0049544	1844.1	2230.2	1890.7	2334.5	443.8	4.1112	4.8012	0.6901
371	21.297	0.0022798	0.0046995	1862.0	2208.2	1910.6	2308.3	397.7	4.1412	4.7586	0.6175
372	21.554	0.0023682	0.0044084	1884.3	2180.5	1935.3	2275.5	340.3	4.1785	4.7059	0.5274
373	21.814	0.0025083	0.0040450	1915.0	2141.6	1969.7	2229.8	260.1	4.2308	4.6334	0.4026
T_c	22.064	0.0031056		2015.8		2084.3		0	4.4070		0

$T_c = 373.946$ °C

Table 2
Saturation Line
Base: Pressure

Saturated Water and Steam (Pressure-based)

$$p_{tp} = 611.657 \text{ Pa} = 0.000611657 \text{ MPa}$$

p MPa	T_{sat} °C	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
p_{tp}	0.01	0.00100021	205.991	0	2374.9	0.00	2500.9	2500.9	0	9.1555	9.1555
0.0007	1.881	0.00100011	181.217	7.89	2377.4	7.89	2504.3	2496.5	0.02878	9.1058	9.0770
0.0008	3.761	0.00100008	159.640	15.81	2380.1	15.81	2507.8	2492.0	0.05748	9.0567	8.9992
0.0009	5.444	0.00100009	142.757	22.89	2382.4	22.89	2510.9	2488.0	0.08297	9.0135	8.9305
0.0010	6.970	0.00100014	129.178	29.30	2384.5	29.30	2513.7	2484.4	0.10591	8.9749	8.8690
0.0012	9.654	0.00100032	108.670	40.57	2388.2	40.57	2518.6	2478.0	0.14595	8.9082	8.7623
0.0014	11.969	0.00100054	93.899	50.28	2391.3	50.28	2522.8	2472.5	0.18015	8.8521	8.6719
0.0016	14.010	0.00100080	82.743	58.83	2394.1	58.83	2526.5	2467.7	0.21004	8.8035	8.5935
0.0018	15.837	0.00100108	74.011	66.49	2396.7	66.49	2529.9	2463.4	0.23662	8.7608	8.5241
0.0020	17.495	0.00100136	66.987	73.43	2398.9	73.43	2532.9	2459.4	0.26056	8.7226	8.4620
0.0024	20.414	0.00100193	56.375	85.65	2402.9	85.65	2538.2	2452.5	0.30239	8.6567	8.3544
0.0028	22.935	0.00100249	48.729	96.19	2406.4	96.19	2542.8	2446.6	0.33816	8.6012	8.2631
0.0032	25.158	0.00100305	42.952	105.49	2409.4	105.49	2546.8	2441.3	0.36945	8.5533	8.1838
0.0036	27.152	0.00100358	38.430	113.83	2412.1	113.83	2550.4	2436.6	0.39729	8.5110	8.1138
0.0040	28.960	0.00100410	34.791	121.39	2414.5	121.39	2553.7	2432.3	0.42239	8.4734	8.0510
0.0045	31.012	0.00100473	31.131	129.96	2417.3	129.96	2557.4	2427.4	0.45069	8.4313	7.9806
0.0050	32.874	0.00100533	28.185	137.74	2419.8	137.75	2560.7	2423.0	0.47620	8.3938	7.9176
0.0055	34.581	0.00100590	25.762	144.87	2422.1	144.88	2563.8	2418.9	0.49945	8.3599	7.8605
0.0060	36.159	0.00100645	23.733	151.47	2424.2	151.48	2566.6	2415.2	0.52082	8.3290	7.8082
0.0065	37.627	0.00100699	22.009	157.60	2426.2	157.61	2569.3	2411.6	0.54060	8.3007	7.7601
0.0070	39.000	0.00100750	20.524	163.34	2428.0	163.35	2571.7	2408.4	0.55903	8.2745	7.7154
0.0075	40.290	0.00100800	19.233	168.74	2429.8	168.75	2574.0	2405.3	0.57627	8.2501	7.6738
0.0080	41.509	0.00100848	18.099	173.83	2431.4	173.84	2576.2	2402.4	0.59249	8.2273	7.6348
0.0085	42.663	0.00100895	17.095	178.66	2433.0	178.67	2578.3	2399.6	0.60780	8.2060	7.5982
0.0090	43.761	0.00100940	16.199	183.24	2434.4	183.25	2580.2	2397.0	0.62230	8.1858	7.5635
0.0095	44.807	0.00100984	15.396	187.62	2435.8	187.63	2582.1	2394.5	0.63607	8.1668	7.5308
0.010	45.806	0.00101027	14.670	191.80	2437.2	191.81	2583.9	2392.1	0.64920	8.1488	7.4996
0.011	47.683	0.00101110	13.412	199.64	2439.7	199.65	2587.2	2387.5	0.67372	8.1154	7.4417
0.012	49.419	0.00101188	12.358	206.90	2442.0	206.91	2590.3	2383.4	0.69628	8.0849	7.3887
0.013	51.034	0.00101263	11.462	213.66	2444.1	213.67	2593.1	2379.4	0.71717	8.0570	7.3398
0.014	52.547	0.00101335	10.691	219.98	2446.1	219.99	2595.8	2375.8	0.73664	8.0311	7.2945
0.016	55.313	0.00101471	9.4306	231.55	2449.7	231.57	2600.6	2369.1	0.77201	7.9846	7.2126
0.018	57.798	0.00101597	8.4431	241.94	2453.0	241.96	2605.0	2363.0	0.80355	7.9437	7.1402
0.020	60.058	0.00101716	7.6480	251.40	2455.9	251.42	2608.9	2357.5	0.83202	7.9072	7.0752
0.024	64.053	0.00101934	6.4453	268.13	2461.2	268.15	2615.9	2347.7	0.88191	7.8442	6.9623
0.028	67.518	0.00102131	5.5778	282.63	2465.6	282.66	2621.8	2339.2	0.92472	7.7912	6.8664
0.032	70.586	0.00102312	4.9215	295.49	2469.6	295.52	2627.1	2331.6	0.96228	7.7453	6.7830
0.036	73.345	0.00102480	4.4072	307.05	2473.1	307.09	2631.8	2324.7	0.99579	7.7050	6.7092
0.040	75.857	0.00102638	3.9930	317.58	2476.4	317.62	2636.1	2318.4	1.0261	7.6690	6.6429
0.045	78.715	0.00102821	3.5759	329.57	2480.0	329.62	2640.9	2311.2	1.0603	7.6288	6.5686
0.050	81.317	0.00102993	3.2400	340.49	2483.2	340.54	2645.2	2304.7	1.0912	7.5930	6.5018

Continued ...

Saturated Water and Steam (Pressure-based), Contd.

<i>p</i> MPa	<i>T</i>_{sat} °C	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		<i>v_f</i>	<i>v_g</i>	<i>u_f</i>	<i>u_g</i>	<i>h_f</i>	<i>h_g</i>	<i>h_{fg}</i>	<i>s_f</i>	<i>s_g</i>	<i>s_{fg}</i>
0.050	81.317	0.00102993	3.2400	340.49	2483.2	340.54	2645.2	2304.7	1.0912	7.5930	6.5018
0.055	83.709	0.00103154	2.9635	350.53	2486.2	350.59	2649.2	2298.6	1.1194	7.5606	6.4412
0.060	85.926	0.00103307	2.7317	359.85	2489.0	359.91	2652.9	2292.9	1.1454	7.5311	6.3857
0.065	87.993	0.00103452	2.5346	368.53	2491.6	368.60	2656.3	2287.7	1.1696	7.5040	6.3345
0.070	89.932	0.00103590	2.3648	376.68	2493.9	376.75	2659.4	2282.7	1.1921	7.4790	6.2869
0.075	91.758	0.00103723	2.2170	384.36	2496.1	384.44	2662.4	2277.9	1.2132	7.4557	6.2425
0.080	93.486	0.00103850	2.0871	391.63	2498.2	391.71	2665.2	2273.5	1.2330	7.4339	6.2009
0.085	95.125	0.00103972	1.9720	398.53	2500.2	398.62	2667.8	2269.2	1.2518	7.4135	6.1617
0.090	96.687	0.00104091	1.8694	405.11	2502.1	405.20	2670.3	2265.1	1.2696	7.3943	6.1246
0.095	98.178	0.00104205	1.7772	411.38	2503.9	411.48	2672.7	2261.2	1.2866	7.3761	6.0895
0.10	99.606	0.00104315	1.6939	417.40	2505.5	417.50	2674.9	2257.4	1.3028	7.3588	6.0561
0.11	102.292	0.00104527	1.5495	428.73	2508.8	428.84	2679.2	2250.3	1.3330	7.3269	5.9938
0.12	104.784	0.00104727	1.4284	439.23	2511.7	439.36	2683.1	2243.7	1.3609	7.2977	5.9367
0.13	107.109	0.00104917	1.3253	449.05	2514.3	449.19	2686.6	2237.5	1.3868	7.2709	5.8840
0.14	109.292	0.00105099	1.2366	458.27	2516.9	458.42	2690.0	2231.6	1.4110	7.2461	5.8351
0.15	111.349	0.00105273	1.1593	466.97	2519.2	467.13	2693.1	2226.0	1.4337	7.2230	5.7893
0.16	113.297	0.00105440	1.0914	475.21	2521.4	475.38	2696.0	2220.7	1.4551	7.2014	5.7463
0.17	115.148	0.00105600	1.0312	483.04	2523.5	483.22	2698.8	2215.6	1.4753	7.1812	5.7059
0.18	116.911	0.00105756	0.97747	490.51	2525.5	490.70	2701.4	2210.7	1.4945	7.1621	5.6676
0.19	118.596	0.00105906	0.92924	497.65	2527.3	497.85	2703.9	2206.0	1.5127	7.1440	5.6313
0.20	120.210	0.00106052	0.88568	504.49	2529.1	504.70	2706.2	2201.5	1.5302	7.1269	5.5967
0.21	121.759	0.00106193	0.84614	511.07	2530.8	511.29	2708.5	2197.2	1.5469	7.1106	5.5638
0.22	123.250	0.00106330	0.81007	517.40	2532.4	517.63	2710.6	2193.0	1.5628	7.0951	5.5323
0.23	124.686	0.00106464	0.77704	523.50	2534.0	523.74	2712.7	2188.9	1.5782	7.0803	5.5021
0.24	126.072	0.00106594	0.74668	529.38	2535.4	529.64	2714.6	2185.0	1.5930	7.0661	5.4731
0.25	127.411	0.00106722	0.71866	535.07	2536.8	535.34	2716.5	2181.1	1.6072	7.0524	5.4452
0.26	128.708	0.00106846	0.69273	540.59	2538.2	540.87	2718.3	2177.4	1.6210	7.0394	5.4184
0.27	129.965	0.00106968	0.66865	545.95	2539.5	546.24	2720.0	2173.8	1.6343	7.0268	5.3925
0.28	131.185	0.00107086	0.64624	551.14	2540.8	551.44	2721.7	2170.3	1.6471	7.0146	5.3675
0.29	132.370	0.00107203	0.62533	556.19	2542.0	556.50	2723.3	2166.8	1.6596	7.0029	5.3433
0.30	133.522	0.00107317	0.60576	561.11	2543.2	561.43	2724.9	2163.5	1.6717	6.9916	5.3199
0.31	134.644	0.00107429	0.58741	565.89	2544.3	566.22	2726.4	2160.2	1.6835	6.9807	5.2972
0.32	135.737	0.00107539	0.57017	570.56	2545.3	570.90	2727.8	2157.0	1.6949	6.9701	5.2752
0.33	136.802	0.00107647	0.55395	575.10	2546.5	575.46	2729.3	2153.8	1.7060	6.9598	5.2538
0.34	137.842	0.00107753	0.53864	579.54	2547.5	579.91	2730.6	2150.7	1.7168	6.9498	5.2330
0.35	138.857	0.00107857	0.52418	583.88	2548.5	584.26	2732.0	2147.7	1.7274	6.9401	5.2128
0.36	139.849	0.00107960	0.51050	588.13	2549.4	588.52	2733.2	2144.7	1.7377	6.9307	5.1931
0.37	140.819	0.00108061	0.49753	592.28	2550.4	592.68	2734.5	2141.8	1.7477	6.9216	5.1739
0.38	141.769	0.00108161	0.48522	596.34	2551.3	596.75	2735.7	2139.0	1.7575	6.9126	5.1551
0.39	142.698	0.00108259	0.47352	600.32	2552.2	600.74	2736.9	2136.2	1.7671	6.9040	5.1369
0.40	143.608	0.00108355	0.46238	604.22	2553.1	604.65	2738.1	2133.4	1.7765	6.8955	5.1190

Continued ...

Saturated Water and Steam (Pressure-based), Contd.

p MPa	T_{sat} °C	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
0.40	143.608	0.00108355	0.46238	604.22	2553.1	604.65	2738.1	2133.4	1.7765	6.8955	5.1190
0.42	145.375	0.00108544	0.44165	611.79	2554.8	612.25	2740.3	2128.0	1.7946	6.8791	5.0846
0.44	147.076	0.00108729	0.42274	619.10	2556.4	619.58	2742.4	2122.8	1.8120	6.8636	5.0516
0.46	148.716	0.00108908	0.40542	626.14	2557.9	626.64	2744.4	2117.7	1.8287	6.8487	5.0199
0.48	150.300	0.00109084	0.38950	632.95	2559.3	633.47	2746.3	2112.8	1.8448	6.8344	4.9895
0.50	151.831	0.00109255	0.37481	639.54	2560.7	640.09	2748.1	2108.0	1.8604	6.8207	4.9603
0.52	153.314	0.00109423	0.36120	645.93	2562.1	646.50	2749.9	2103.4	1.8754	6.8075	4.9321
0.54	154.753	0.00109587	0.34858	652.13	2563.3	652.72	2751.5	2098.8	1.8899	6.7948	4.9049
0.56	156.149	0.00109748	0.33682	658.16	2564.5	658.77	2753.1	2094.4	1.9040	6.7825	4.8786
0.58	157.506	0.00109905	0.32585	664.01	2565.7	664.65	2754.7	2090.0	1.9176	6.7707	4.8531
0.60	158.826	0.00110060	0.31558	669.72	2566.8	670.38	2756.1	2085.8	1.9308	6.7592	4.8284
0.62	160.112	0.00110212	0.30596	675.28	2567.9	675.96	2757.6	2081.6	1.9437	6.7482	4.8045
0.64	161.365	0.00110362	0.29691	680.70	2568.9	681.41	2758.9	2077.5	1.9562	6.7374	4.7813
0.66	162.587	0.00110509	0.28840	686.00	2570.0	686.73	2760.3	2073.5	1.9684	6.7270	4.7587
0.68	163.781	0.00110654	0.28036	691.17	2570.9	691.92	2761.5	2069.6	1.9802	6.7169	4.7367
0.70	164.946	0.00110796	0.27277	696.22	2571.9	697.00	2762.8	2065.8	1.9918	6.7071	4.7153
0.72	166.086	0.00110936	0.26559	701.17	2572.7	701.97	2763.9	2062.0	2.0031	6.6975	4.6944
0.74	167.200	0.00111075	0.25879	706.02	2573.6	706.84	2765.1	2058.2	2.0141	6.6882	4.6741
0.76	168.291	0.00111211	0.25233	710.76	2574.4	711.61	2766.2	2054.6	2.0248	6.6791	4.6543
0.78	169.360	0.00111346	0.24618	715.41	2575.3	716.28	2767.3	2051.0	2.0354	6.6703	4.6349
0.80	170.406	0.00111478	0.24034	719.97	2576.0	720.86	2768.3	2047.4	2.0457	6.6616	4.6160
0.82	171.433	0.00111609	0.23477	724.44	2576.8	725.36	2769.3	2043.9	2.0557	6.6532	4.5975
0.84	172.440	0.00111739	0.22946	728.84	2577.6	729.78	2770.3	2040.5	2.0656	6.6449	4.5793
0.86	173.428	0.00111867	0.22438	733.15	2578.2	734.11	2771.2	2037.1	2.0753	6.6369	4.5616
0.88	174.398	0.00111993	0.21953	737.38	2578.9	738.37	2772.1	2033.8	2.0847	6.6290	4.5443
0.90	175.350	0.00112118	0.21489	741.55	2579.6	742.56	2773.0	2030.5	2.0940	6.6213	4.5272
0.92	176.287	0.00112242	0.21044	745.65	2580.3	746.68	2773.9	2027.2	2.1032	6.6137	4.5106
0.94	177.207	0.00112364	0.20617	749.67	2580.9	750.73	2774.7	2024.0	2.1121	6.6063	4.4942
0.96	178.112	0.00112485	0.20208	753.64	2581.5	754.72	2775.5	2020.8	2.1209	6.5991	4.4782
0.98	179.002	0.00112605	0.19814	757.55	2582.1	758.65	2776.3	2017.7	2.1296	6.5920	4.4624
1.00	179.878	0.00112723	0.19436	761.39	2582.7	762.52	2777.1	2014.6	2.1381	6.5850	4.4470
1.05	182.009	0.00113014	0.18552	770.75	2584.1	771.94	2778.9	2007.0	2.1587	6.5681	4.4095
1.10	184.062	0.00113299	0.17745	779.78	2585.4	781.03	2780.6	1999.6	2.1785	6.5520	4.3735
1.15	186.043	0.00113577	0.17006	788.51	2586.6	789.82	2782.2	1992.4	2.1976	6.5365	4.3390
1.20	187.957	0.00113850	0.16326	796.96	2587.8	798.33	2783.7	1985.4	2.2159	6.5217	4.3058
1.25	189.809	0.00114118	0.15699	805.15	2588.9	806.58	2785.1	1978.6	2.2337	6.5074	4.2737
1.30	191.605	0.00114380	0.15119	813.11	2590.0	814.60	2786.5	1971.9	2.2508	6.4936	4.2428
1.35	193.347	0.00114638	0.14580	820.84	2590.9	822.39	2787.7	1965.3	2.2674	6.4803	4.2129
1.40	195.039	0.00114892	0.14078	828.36	2591.7	829.97	2788.8	1958.9	2.2835	6.4675	4.1839
1.45	196.685	0.00115141	0.13609	835.68	2592.6	837.35	2789.9	1952.6	2.2992	6.4550	4.1559
1.50	198.287	0.00115387	0.13171	842.83	2593.4	844.56	2791.0	1946.4	2.3143	6.4430	4.1286

Continued ...

Saturated Water and Steam (Pressure-based), Contd.

p MPa	T_{sat} °C	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
1.50	198.287	0.00115387	0.13171	842.83	2593.4	844.56	2791.0	1946.4	2.3143	6.4430	4.1286
1.55	199.848	0.00115629	0.12760	849.80	2594.1	851.59	2791.9	1940.3	2.3291	6.4313	4.1022
1.60	201.370	0.00115868	0.12374	856.61	2594.8	858.46	2792.8	1934.4	2.3435	6.4199	4.0765
1.65	202.856	0.00116103	0.12010	863.25	2595.5	865.17	2793.7	1928.5	2.3575	6.4089	4.0514
1.70	204.307	0.00116336	0.11667	869.76	2596.2	871.74	2794.5	1922.7	2.3711	6.3981	4.0270
1.75	205.725	0.00116565	0.11343	876.13	2596.7	878.17	2795.2	1917.0	2.3845	6.3877	4.0032
1.80	207.112	0.00116792	0.11037	882.37	2597.2	884.47	2795.9	1911.4	2.3975	6.3775	3.9800
1.85	208.469	0.00117016	0.10746	888.49	2597.8	890.65	2796.6	1905.9	2.4102	6.3675	3.9573
1.90	209.798	0.00117238	0.10470	894.48	2598.3	896.71	2797.2	1900.5	2.4227	6.3578	3.9351
1.95	211.101	0.00117458	0.10208	900.37	2598.7	902.66	2797.8	1895.1	2.4348	6.3483	3.9135
2.0	212.377	0.00117675	0.099585	906.15	2599.1	908.50	2798.3	1889.8	2.4468	6.3390	3.8923
2.1	214.858	0.00118103	0.094938	917.39	2599.9	919.87	2799.3	1879.4	2.4699	6.3210	3.8511
2.2	217.249	0.00118523	0.090698	928.26	2600.6	930.87	2800.1	1869.2	2.4921	6.3038	3.8116
2.3	219.557	0.00118936	0.086815	938.79	2601.1	941.53	2800.8	1859.3	2.5136	6.2872	3.7736
2.4	221.789	0.00119343	0.083244	949.01	2601.6	951.87	2801.4	1849.6	2.5343	6.2712	3.7369
2.5	223.950	0.00119743	0.079949	958.92	2602.0	961.91	2801.9	1840.0	2.5543	6.2558	3.7015
2.6	226.046	0.00120138	0.076899	968.55	2602.4	971.67	2802.3	1830.7	2.5736	6.2409	3.6672
2.7	228.080	0.00120528	0.074066	977.93	2602.7	981.18	2802.7	1821.5	2.5924	6.2264	3.6340
2.8	230.057	0.00120913	0.071429	987.07	2602.9	990.46	2802.9	1812.4	2.6106	6.2124	3.6018
2.9	231.980	0.00121293	0.068968	995.99	2603.1	999.51	2803.1	1803.6	2.6283	6.1988	3.5705
3.0	233.853	0.00121669	0.066664	1004.6	2603.2	1008.3	2803.2	1794.8	2.6455	6.1856	3.5400
3.1	235.679	0.00122042	0.064504	1013.2	2603.2	1017.0	2803.2	1786.2	2.6623	6.1727	3.5104
3.2	237.459	0.00122410	0.062475	1021.5	2603.2	1025.4	2803.1	1777.7	2.6787	6.1602	3.4815
3.3	239.198	0.00122776	0.060564	1029.6	2603.1	1033.7	2803.0	1769.3	2.6946	6.1479	3.4533
3.4	240.897	0.00123138	0.058761	1037.6	2603.1	1041.8	2802.9	1761.0	2.7102	6.1360	3.4258
3.5	242.557	0.00123497	0.057058	1045.5	2602.9	1049.8	2802.6	1752.8	2.7254	6.1243	3.3989
3.6	244.182	0.00123854	0.055446	1053.1	2602.8	1057.6	2802.4	1744.8	2.7403	6.1129	3.3726
3.7	245.772	0.00124208	0.053918	1060.7	2602.6	1065.3	2802.1	1736.8	2.7549	6.1018	3.3469
3.8	247.330	0.00124559	0.052467	1068.1	2602.3	1072.8	2801.7	1728.9	2.7691	6.0908	3.3217
3.9	248.857	0.00124908	0.051089	1075.3	2602.1	1080.2	2801.3	1721.1	2.7831	6.0801	3.2970
4.0	250.354	0.00125256	0.049776	1082.5	2601.7	1087.5	2800.8	1713.3	2.7968	6.0696	3.2728
4.1	251.823	0.00125601	0.048525	1089.6	2601.3	1094.7	2800.3	1705.7	2.8102	6.0592	3.2491
4.2	253.264	0.00125944	0.047332	1096.4	2601.0	1101.7	2799.8	1698.1	2.8234	6.0491	3.2257
4.3	254.680	0.00126286	0.046192	1103.3	2600.6	1108.7	2799.2	1690.6	2.8363	6.0391	3.2028
4.4	256.070	0.00126626	0.045102	1109.9	2600.2	1115.5	2798.6	1683.1	2.8490	6.0293	3.1803
4.5	257.437	0.00126965	0.044059	1116.5	2599.6	1122.2	2797.9	1675.7	2.8615	6.0197	3.1582
4.6	258.780	0.00127302	0.043059	1123.0	2599.2	1128.9	2797.3	1668.4	2.8738	6.0102	3.1364
4.7	260.101	0.00127638	0.042100	1129.5	2598.6	1135.5	2796.5	1661.1	2.8859	6.0009	3.1150
4.8	261.402	0.00127973	0.041180	1135.8	2598.1	1141.9	2795.8	1653.9	2.8978	5.9917	3.0939
4.9	262.681	0.00128306	0.040296	1142.0	2597.5	1148.3	2795.0	1646.7	2.9095	5.9826	3.0731
5.0	263.941	0.00128639	0.039446	1148.2	2597.0	1154.6	2794.2	1639.6	2.9210	5.9737	3.0527

Continued ...

Saturated Water and Steam (Pressure-based), Contd.

p MPa	T_{sat} °C	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
5.1	265.181	0.00128971	0.038628	1154.3	2596.4	1160.9	2793.4	1632.5	2.9323	5.9648	3.0325
5.2	266.403	0.00129302	0.037840	1160.3	2595.7	1167.0	2792.5	1625.5	2.9435	5.9561	3.0126
5.3	267.608	0.00129632	0.037081	1166.2	2595.1	1173.1	2791.6	1618.5	2.9546	5.9475	2.9930
5.4	268.795	0.00129961	0.036348	1172.1	2594.4	1179.1	2790.7	1611.5	2.9654	5.9391	2.9736
5.5	269.965	0.00130290	0.035642	1177.9	2593.7	1185.1	2789.7	1604.6	2.9762	5.9307	2.9545
5.6	271.120	0.00130618	0.034959	1183.7	2592.9	1191.0	2788.7	1597.8	2.9868	5.9224	2.9356
5.7	272.258	0.00130946	0.034300	1189.3	2592.2	1196.8	2787.7	1590.9	2.9972	5.9142	2.9170
5.8	273.382	0.00131273	0.033662	1195.0	2591.5	1202.6	2786.7	1584.1	3.0075	5.9061	2.8985
5.9	274.490	0.00131600	0.033045	1200.5	2590.7	1208.3	2785.7	1577.4	3.0177	5.8981	2.8803
6.0	275.585	0.00131926	0.032448	1206.0	2589.9	1213.9	2784.6	1570.7	3.0278	5.8901	2.8623
6.1	276.666	0.00132253	0.031870	1211.4	2589.1	1219.5	2783.5	1564.0	3.0377	5.8823	2.8445
6.2	277.733	0.00132579	0.031309	1216.9	2588.3	1225.1	2782.4	1557.3	3.0476	5.8745	2.8269
6.3	278.787	0.00132905	0.030766	1222.1	2587.4	1230.5	2781.2	1550.7	3.0573	5.8668	2.8095
6.4	279.829	0.00133230	0.030238	1227.5	2586.6	1236.0	2780.1	1544.1	3.0669	5.8592	2.7923
6.5	280.858	0.00133556	0.029727	1232.7	2585.7	1241.4	2778.9	1537.5	3.0764	5.8516	2.7752
6.6	281.875	0.00133882	0.029230	1237.9	2584.8	1246.7	2777.7	1530.9	3.0858	5.8441	2.7583
6.7	282.880	0.00134208	0.028747	1243.0	2583.8	1252.0	2776.4	1524.4	3.0951	5.8367	2.7416
6.8	283.874	0.00134533	0.028278	1248.2	2582.9	1257.3	2775.2	1517.9	3.1043	5.8293	2.7250
6.9	284.857	0.00134859	0.027822	1253.2	2581.9	1262.5	2773.9	1511.4	3.1134	5.8220	2.7086
7.0	285.829	0.00135186	0.027378	1258.2	2581.0	1267.7	2772.6	1505.0	3.1224	5.8148	2.6924
7.1	286.790	0.00135512	0.026947	1263.2	2580.0	1272.8	2771.3	1498.5	3.1313	5.8076	2.6762
7.2	287.741	0.00135839	0.026526	1268.1	2579.0	1277.9	2770.0	1492.1	3.1402	5.8004	2.6603
7.3	288.682	0.00136166	0.026117	1273.0	2577.9	1282.9	2768.6	1485.7	3.1489	5.7933	2.6444
7.4	289.614	0.00136493	0.025718	1277.8	2577.0	1287.9	2767.3	1479.3	3.1576	5.7863	2.6287
7.5	290.535	0.00136821	0.025330	1282.6	2575.9	1292.9	2765.9	1473.0	3.1662	5.7793	2.6131
7.6	291.448	0.00137149	0.024951	1287.5	2574.9	1297.9	2764.5	1466.6	3.1747	5.7723	2.5976
7.7	292.351	0.00137477	0.024581	1292.2	2573.8	1302.8	2763.1	1460.3	3.1832	5.7654	2.5823
7.8	293.245	0.00137806	0.024221	1297.0	2572.7	1307.7	2761.6	1454.0	3.1915	5.7586	2.5671
7.9	294.131	0.00138136	0.023869	1301.6	2571.6	1312.5	2760.2	1447.7	3.1998	5.7518	2.5519
8.0	295.008	0.00138467	0.023526	1306.2	2570.5	1317.3	2758.7	1441.4	3.2081	5.7450	2.5369
8.1	295.876	0.00138797	0.023190	1310.9	2569.4	1322.1	2757.2	1435.1	3.2162	5.7383	2.5220
8.2	296.737	0.00139129	0.022863	1315.4	2568.2	1326.8	2755.7	1428.8	3.2243	5.7316	2.5072
8.3	297.589	0.00139461	0.022542	1320.0	2567.0	1331.6	2754.1	1422.6	3.2324	5.7249	2.4925
8.4	298.434	0.00139795	0.022229	1324.6	2565.9	1336.3	2752.6	1416.3	3.2403	5.7183	2.4779
8.5	299.271	0.00140128	0.021923	1329.0	2564.7	1340.9	2751.0	1410.1	3.2483	5.7117	2.4634
8.6	300.100	0.00140463	0.021624	1333.5	2563.4	1345.6	2749.4	1403.9	3.2561	5.7051	2.4490
8.7	300.922	0.00140799	0.021332	1338.0	2562.2	1350.2	2747.8	1397.7	3.2639	5.6986	2.4347
8.8	301.737	0.00141135	0.021045	1342.4	2561.0	1354.8	2746.2	1391.5	3.2717	5.6921	2.4204
8.9	302.544	0.00141473	0.020765	1346.7	2559.8	1359.3	2744.6	1385.3	3.2793	5.6856	2.4062
9.0	303.345	0.00141811	0.020490	1351.1	2558.5	1363.9	2742.9	1379.1	3.2870	5.6791	2.3922

Continued ...

Saturated Water and Steam (Pressure-based), Contd.

p MPa	T_{sat} °C	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
9.0	303.345	0.00141811	0.020490	1351.1	2558.5	1363.9	2742.9	1379.1	3.2870	5.6791	2.3922
9.1	304.139	0.00142151	0.020221	1355.5	2557.3	1368.4	2741.3	1372.9	3.2946	5.6727	2.3782
9.2	304.926	0.00142491	0.019958	1359.8	2556.0	1372.9	2739.6	1366.7	3.3021	5.6663	2.3642
9.3	305.707	0.00142833	0.019700	1364.1	2554.7	1377.4	2737.9	1360.5	3.3096	5.6599	2.3504
9.4	306.481	0.00143176	0.019447	1368.3	2553.4	1381.8	2736.2	1354.4	3.3170	5.6536	2.3366
9.5	307.249	0.00143520	0.019199	1372.6	2552.0	1386.2	2734.4	1348.2	3.3244	5.6473	2.3229
9.6	308.010	0.00143865	0.018956	1376.8	2550.7	1390.6	2732.7	1342.0	3.3317	5.6410	2.3092
9.7	308.766	0.00144212	0.018718	1381.0	2549.3	1395.0	2730.9	1335.9	3.3390	5.6347	2.2957
9.8	309.516	0.00144560	0.018484	1385.2	2548.0	1399.4	2729.1	1329.7	3.3463	5.6284	2.2822
9.9	310.259	0.00144909	0.018255	1389.4	2546.6	1403.7	2727.3	1323.6	3.3535	5.6222	2.2687
10.0	310.997	0.00145259	0.018030	1393.6	2545.2	1408.1	2725.5	1317.4	3.3606	5.6160	2.2553
10.2	312.456	0.00145965	0.017592	1401.8	2542.4	1416.7	2721.8	1305.1	3.3749	5.6035	2.2287
10.4	313.893	0.00146676	0.017170	1409.9	2539.4	1425.2	2718.0	1292.8	3.3889	5.5912	2.2023
10.6	315.308	0.00147394	0.016763	1418.1	2536.5	1433.7	2714.2	1280.5	3.4028	5.5789	2.1761
10.8	316.703	0.00148119	0.016370	1426.1	2533.5	1442.1	2710.3	1268.2	3.4166	5.5667	2.1501
11.0	318.079	0.00148851	0.015990	1434.0	2530.4	1450.4	2706.3	1255.9	3.4303	5.5545	2.1242
11.2	319.434	0.00149590	0.015622	1441.9	2527.3	1458.7	2702.3	1243.6	3.4438	5.5423	2.0985
11.4	320.771	0.00150337	0.015266	1449.9	2524.2	1467.0	2698.2	1231.2	3.4572	5.5302	2.0730
11.6	322.090	0.00151093	0.014922	1457.7	2520.9	1475.2	2694.0	1218.8	3.4705	5.5181	2.0476
11.8	323.391	0.00151857	0.014588	1465.4	2517.7	1483.3	2689.8	1206.4	3.4836	5.5060	2.0224
12.0	324.675	0.00152630	0.014264	1473.2	2514.2	1491.5	2685.4	1194.0	3.4967	5.4939	1.9972
12.2	325.942	0.00153413	0.013950	1480.8	2510.8	1499.5	2681.0	1181.5	3.5097	5.4819	1.9722
12.4	327.194	0.00154205	0.013645	1488.5	2507.4	1507.6	2676.6	1169.0	3.5226	5.4698	1.9472
12.6	328.429	0.00155009	0.013349	1496.1	2503.8	1515.6	2672.0	1156.4	3.5354	5.4577	1.9223
12.8	329.649	0.00155823	0.013061	1503.7	2500.2	1523.6	2667.4	1143.8	3.5481	5.4457	1.8975
13.0	330.854	0.00156649	0.012780	1511.1	2496.6	1531.5	2662.7	1131.2	3.5608	5.4336	1.8728
13.2	332.044	0.00157487	0.012508	1518.6	2492.8	1539.4	2657.9	1118.5	3.5734	5.4215	1.8481
13.4	333.220	0.00158338	0.012242	1526.1	2489.0	1547.3	2653.0	1105.7	3.5859	5.4093	1.8234
13.6	334.382	0.00159202	0.011983	1533.5	2485.0	1555.2	2648.0	1092.8	3.5984	5.3972	1.7988
13.8	335.531	0.00160081	0.011731	1541.0	2481.1	1563.1	2643.0	1079.9	3.6108	5.3850	1.7742
14.0	336.666	0.00160974	0.011485	1548.5	2477.1	1571.0	2637.9	1066.9	3.6232	5.3727	1.7495
14.2	337.789	0.00161883	0.011245	1555.8	2472.9	1578.8	2632.6	1053.8	3.6355	5.3604	1.7249
14.4	338.899	0.00162809	0.011011	1563.3	2468.7	1586.7	2627.3	1040.6	3.6478	5.3481	1.7002
14.6	339.996	0.00163752	0.010781	1570.6	2464.5	1594.5	2621.9	1027.4	3.6601	5.3356	1.6756
14.8	341.082	0.00164714	0.010557	1577.9	2460.1	1602.3	2616.3	1014.0	3.6723	5.3231	1.6508
15.0	342.155	0.00165695	0.010338	1585.3	2455.6	1610.2	2610.7	1000.5	3.6846	5.3106	1.6260
15.2	343.217	0.00166697	0.010124	1592.8	2451.1	1618.1	2605.0	986.9	3.6968	5.2979	1.6011
15.4	344.268	0.00167722	0.0099140	1600.1	2446.4	1625.9	2599.1	973.2	3.7090	5.2852	1.5762
15.6	345.308	0.00168770	0.0097083	1607.5	2441.7	1633.8	2593.1	959.3	3.7212	5.2723	1.5511
15.8	346.337	0.00169843	0.0095067	1614.9	2436.8	1641.7	2587.0	945.3	3.7335	5.2594	1.5259
16.0	347.355	0.00170944	0.0093088	1622.3	2431.9	1649.7	2580.8	931.1	3.7457	5.2463	1.5006

Continued ...

Saturated Water and Steam (Pressure-based), Contd.

p MPa	T_{sat} °C	Volume, m ³ /kg		Energy, kJ/kg		Enthalpy, kJ/kg			Entropy, kJ/(kg K)		
		v_f	v_g	u_f	u_g	h_f	h_g	h_{fg}	s_f	s_g	s_{fg}
16.0	347.355	0.00170944	0.0093088	1622.3	2431.9	1649.7	2580.8	931.1	3.7457	5.2463	1.5006
16.2	348.362	0.00172073	0.0091147	1629.8	2426.7	1657.7	2574.4	916.8	3.7580	5.2331	1.4750
16.4	349.360	0.00173233	0.0089240	1637.3	2421.5	1665.7	2567.9	902.2	3.7704	5.2197	1.4494
16.6	350.347	0.00174427	0.0087366	1644.7	2416.3	1673.7	2561.3	887.5	3.7827	5.2062	1.4235
16.8	351.325	0.00175657	0.0085523	1652.4	2410.8	1681.9	2554.5	872.6	3.7952	5.1925	1.3974
17.0	352.293	0.00176926	0.0083709	1659.9	2405.2	1690.0	2547.5	857.5	3.8077	5.1787	1.3710
17.2	353.251	0.00178237	0.0081923	1667.6	2399.5	1698.3	2540.4	842.1	3.8203	5.1646	1.3443
17.4	354.200	0.00179593	0.0080163	1675.4	2393.5	1706.6	2533.0	826.5	3.8330	5.1504	1.3174
17.6	355.140	0.00181000	0.0078426	1683.1	2387.5	1715.0	2525.5	810.5	3.8458	5.1359	1.2901
17.8	356.071	0.00182460	0.0076712	1691.0	2381.3	1723.5	2517.8	794.3	3.8587	5.1211	1.2624
18.0	356.992	0.00183980	0.0075017	1699.0	2374.8	1732.1	2509.8	777.7	3.8718	5.1061	1.2342
18.2	357.906	0.00185564	0.0073341	1707.0	2368.1	1740.8	2501.6	760.8	3.8851	5.0907	1.2056
18.4	358.810	0.00187219	0.0071681	1715.3	2361.3	1749.7	2493.2	743.5	3.8985	5.0750	1.1765
18.6	359.706	0.00188951	0.0070034	1723.6	2354.1	1758.7	2484.4	725.8	3.9121	5.0590	1.1468
18.8	360.594	0.00190767	0.0068399	1731.9	2346.8	1767.8	2475.4	707.6	3.9260	5.0425	1.1165
19.0	361.473	0.00192677	0.0066773	1740.6	2339.1	1777.2	2466.0	688.9	3.9401	5.0256	1.0855
19.2	362.344	0.00194689	0.0065153	1749.3	2331.1	1786.7	2456.2	669.6	3.9545	5.0081	1.0536
19.4	363.208	0.00196814	0.0063535	1758.2	2322.8	1796.4	2446.1	649.6	3.9692	4.9901	1.0208
19.6	364.063	0.00199064	0.0061915	1767.4	2314.0	1806.4	2435.4	629.0	3.9843	4.9713	0.9871
19.8	364.910	0.0020145	0.0060290	1776.8	2304.8	1816.7	2424.2	607.5	3.9997	4.9518	0.9521
20.0	365.749	0.0020400	0.0058652	1786.4	2295.0	1827.2	2412.3	585.1	4.0156	4.9314	0.9158
20.2	366.581	0.0020674	0.0056996	1796.3	2284.7	1838.1	2399.8	561.7	4.0320	4.9100	0.8780
20.4	367.404	0.0020969	0.0055313	1806.7	2273.5	1849.5	2386.3	536.9	4.0491	4.8872	0.8381
20.6	368.220	0.0021291	0.0053590	1817.5	2261.5	1861.4	2371.9	510.5	4.0670	4.8629	0.7959
20.8	369.027	0.0021649	0.0051814	1829.0	2248.3	1874.0	2356.1	482.1	4.0860	4.8367	0.7507
21.0	369.827	0.0022055	0.0049961	1841.3	2233.7	1887.6	2338.6	451.0	4.1064	4.8079	0.7015
21.2	370.619	0.0022531	0.0048000	1854.8	2217.1	1902.6	2318.9	416.3	4.1291	4.7758	0.6467
21.4	371.402	0.0023115	0.0045880	1870.2	2197.9	1919.7	2296.1	376.4	4.1550	4.7390	0.5839
21.6	372.178	0.0023880	0.0043508	1888.8	2174.6	1940.4	2268.6	328.2	4.1864	4.6950	0.5086
21.8	372.946	0.0024983	0.0040680	1912.9	2144.2	1967.4	2232.9	265.5	4.2274	4.6383	0.4109
22.0	373.705	0.0027044	0.0036475	1951.8	2092.9	2011.3	2173.1	161.7	4.2945	4.5446	0.2501
22.064	373.946	0.0031056		2015.8		2084.3		0	4.4070		0

Table 3
Water (Subcooled) / Steam (Superheated)

Water/Steam at $p = 0.01$ MPa ($T_{\text{sat}} = 45.806^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100020	-0.04	-0.03	-0.00015	270	25.060	2766.4	3017.0	9.1756
5	0.00100008	21.02	21.03	0.07625	280	25.522	2781.6	3036.8	9.2118
10	0.00100034	42.02	42.03	0.15109	290	25.984	2797.0	3056.8	9.2475
15	0.00100094	62.98	62.99	0.22446	300	26.446	2812.2	3076.7	9.2827
20	0.00100184	83.91	83.92	0.29648	310	26.907	2827.7	3096.8	9.3173
25	0.00100300	104.83	104.84	0.36722	320	27.369	2843.2	3116.9	9.3515
30	0.00100441	125.73	125.74	0.43675	330	27.831	2858.7	3137.0	9.3852
35	0.00100604	146.63	146.64	0.50513	340	28.293	2874.4	3157.3	9.4185
40	0.00100789	167.53	167.54	0.57240	350	28.755	2889.9	3177.5	9.4513
45	0.00100992	188.43	188.44	0.63861	360	29.216	2905.7	3197.9	9.4837
45.806	0.00101027	191.80	191.81	0.64920	370	29.678	2921.5	3218.3	9.5157
45.806	14.670	2437.2	2583.9	8.14880	380	30.140	2937.4	3238.8	9.5473
50	14.867	2443.3	2592.0	8.1741	390	30.601	2953.3	3259.3	9.5785
55	15.101	2450.6	2601.6	8.2036	400	31.063	2969.3	3279.9	9.6094
60	15.335	2457.8	2611.2	8.2326	410	31.525	2985.4	3300.6	9.6398
65	15.568	2465.0	2620.7	8.2611	420	31.986	3001.5	3321.4	9.6700
70	15.801	2472.3	2630.3	8.2891	430	32.448	3017.7	3342.2	9.6998
75	16.034	2479.5	2639.8	8.3167	440	32.910	3033.9	3363.0	9.7293
80	16.267	2486.6	2649.3	8.3439	450	33.371	3050.3	3384.0	9.7584
85	16.500	2493.9	2658.9	8.3707	460	33.833	3066.7	3405.0	9.7873
90	16.732	2501.1	2668.4	8.3971	470	34.295	3083.2	3426.1	9.8158
95	16.964	2508.3	2677.9	8.4232	480	34.756	3099.6	3447.2	9.8441
100	17.196	2515.5	2687.5	8.4489	490	35.218	3116.2	3468.4	9.8721
105	17.428	2522.7	2697.0	8.4742	500	35.680	3132.9	3489.7	9.8998
110	17.660	2529.9	2706.5	8.4993	520	36.603	3166.5	3532.5	9.9544
115	17.892	2537.2	2716.1	8.5240	540	37.526	3200.2	3575.5	10.008
120	18.124	2544.4	2725.6	8.5484	560	38.449	3234.3	3618.8	10.061
125	18.356	2551.6	2735.2	8.5726	580	39.372	3268.7	3662.4	10.112
130	18.587	2558.8	2744.7	8.5964	600	40.296	3303.3	3706.3	10.163
135	18.819	2566.1	2754.3	8.6200	620	41.219	3338.2	3750.4	10.213
140	19.050	2573.4	2763.9	8.6434	640	42.142	3373.5	3794.9	10.262
145	19.282	2580.6	2773.4	8.6664	660	43.065	3409.0	3839.6	10.311
150	19.513	2587.9	2783.0	8.6892	680	43.988	3444.7	3884.6	10.358
155	19.745	2595.2	2792.6	8.7118	700	44.911	3480.8	3929.9	10.406
160	19.976	2602.5	2802.3	8.7341	720	45.834	3517.2	3975.5	10.452
165	20.207	2609.8	2811.9	8.7562	740	46.758	3553.7	4021.3	10.498
170	20.438	2617.1	2821.5	8.7781	760	47.681	3590.7	4067.5	10.543
175	20.670	2624.5	2831.2	8.7997	780	48.604	3627.9	4113.9	10.587
180	20.901	2631.8	2840.8	8.8212	800	49.527	3665.3	4160.6	10.631
185	21.132	2639.2	2850.5	8.8424	820	50.450	3703.1	4207.6	10.675
190	21.363	2646.6	2860.2	8.8634	840	51.373	3741.2	4254.9	10.717
195	21.594	2654.0	2869.9	8.8843	860	52.296	3779.4	4302.4	10.760
200	21.826	2661.3	2879.6	8.9049	880	53.219	3818.0	4350.2	10.802
210	22.288	2676.2	2899.1	8.9456	900	54.142	3856.9	4398.3	10.843
220	22.750	2691.1	2918.6	8.9856	920	55.065	3896.1	4446.7	10.884
230	23.212	2706.0	2938.1	9.0248	940	55.989	3935.4	4495.3	10.924
240	23.674	2721.1	2957.8	9.0635	960	56.912	3975.1	4544.2	10.964
250	24.136	2736.0	2977.4	9.1015	980	57.835	4015.0	4593.4	11.004
260	24.598	2751.2	2997.2	9.1388	1000	58.758	4055.2	4642.8	11.043
270	25.060	2766.4	3017.0	9.1756					

Water/Steam at $p = 0.02$ MPa ($T_{\text{sat}} = 60.058^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100020	-0.04	-0.02	-0.00015	270	12.526	2766.2	3016.7	8.8553
5	0.00100007	21.02	21.04	0.07625	280	12.757	2781.5	3036.6	8.8916
10	0.00100034	42.02	42.04	0.15108	290	12.989	2796.7	3056.5	8.9273
15	0.00100094	62.98	63.00	0.22446	300	13.220	2812.1	3076.5	8.9625
20	0.00100183	83.91	83.93	0.29648	310	13.451	2827.5	3096.5	8.9972
25	0.00100300	104.82	104.84	0.36722	320	13.682	2843.1	3116.7	9.0314
30	0.00100441	125.73	125.75	0.43675	330	13.913	2858.5	3136.8	9.0651
35	0.00100604	146.63	146.65	0.50513	340	14.144	2874.2	3157.1	9.0983
40	0.00100788	167.52	167.54	0.57240	350	14.375	2889.9	3177.4	9.1312
45	0.00100992	188.42	188.44	0.63861	360	14.606	2905.6	3197.7	9.1636
50	0.00101215	209.33	209.35	0.70381	370	14.837	2921.4	3218.1	9.1956
55	0.00101455	230.24	230.26	0.76802	380	15.068	2937.2	3238.6	9.2272
60	0.00101713	251.16	251.18	0.83129	390	15.299	2953.2	3259.2	9.2584
60.058	0.00101716	251.40	251.42	0.83202	400	15.530	2969.2	3279.8	9.2893
60.058	7.6480	2455.9	2608.9	7.90720	410	15.760	2985.3	3300.5	9.3198
65	7.7648	2463.3	2618.6	7.9360	420	15.991	3001.4	3321.2	9.3499
70	7.8826	2470.6	2628.3	7.9646	430	16.222	3017.6	3342.0	9.3797
75	8.0002	2478.0	2638.0	7.9927	440	16.453	3033.8	3362.9	9.4092
80	8.1176	2485.3	2647.7	8.0202	450	16.684	3050.2	3383.9	9.4384
85	8.2348	2492.7	2657.4	8.0474	460	16.915	3066.6	3404.9	9.4672
90	8.3518	2500.0	2667.0	8.0741	470	17.146	3083.0	3425.9	9.4958
95	8.4687	2507.2	2676.6	8.1004	480	17.377	3099.6	3447.1	9.5241
100	8.5855	2514.5	2686.2	8.1263	490	17.608	3116.1	3468.3	9.5520
105	8.7022	2521.8	2695.8	8.1519	500	17.838	3132.8	3489.6	9.5798
110	8.8187	2529.0	2705.4	8.1771	520	18.300	3166.4	3532.4	9.6344
115	8.9352	2536.3	2715.0	8.2020	540	18.762	3200.2	3575.4	9.6880
120	9.0516	2543.6	2724.6	8.2266	560	19.224	3234.2	3618.7	9.7406
125	9.1679	2550.8	2734.2	8.2509	580	19.685	3268.6	3662.3	9.7923
130	9.2841	2558.2	2743.9	8.2749	600	20.147	3303.3	3706.2	9.8431
135	9.4003	2565.5	2753.5	8.2986	620	20.609	3338.2	3750.4	9.8932
140	9.5164	2572.8	2763.1	8.3220	640	21.070	3373.4	3794.8	9.9424
145	9.6325	2580.1	2772.7	8.3451	660	21.532	3408.9	3839.5	9.9908
150	9.7486	2587.3	2782.3	8.3680	680	21.993	3444.6	3884.5	10.039
155	9.8646	2594.7	2792.0	8.3907	700	22.455	3480.7	3929.8	10.086
160	9.9805	2602.0	2801.6	8.4131	720	22.917	3517.1	3975.4	10.132
165	10.096	2609.4	2811.3	8.4352	740	23.378	3553.7	4021.3	10.178
170	10.212	2616.7	2820.9	8.4572	760	23.840	3590.6	4067.4	10.223
175	10.328	2624.0	2830.6	8.4789	780	24.301	3627.9	4113.9	10.267
180	10.444	2631.4	2840.3	8.5004	800	24.763	3665.3	4160.6	10.311
185	10.560	2638.8	2850.0	8.5216	820	25.225	3703.1	4207.6	10.355
190	10.676	2646.2	2859.7	8.5427	840	25.686	3741.1	4254.8	10.397
195	10.791	2653.6	2869.4	8.5636	860	26.148	3779.4	4302.4	10.440
200	10.907	2661.0	2879.1	8.5843	880	26.609	3818.0	4350.2	10.482
210	11.139	2675.8	2898.6	8.6250	900	27.071	3856.9	4398.3	10.523
220	11.370	2690.8	2918.2	8.6651	920	27.532	3896.1	4446.7	10.564
230	11.601	2705.8	2937.8	8.7044	940	27.994	3935.4	4495.3	10.604
240	11.833	2720.7	2957.4	8.7431	960	28.456	3975.1	4544.2	10.644
250	12.064	2735.8	2977.1	8.7811	980	28.917	4015.1	4593.4	10.684
260	12.295	2751.0	2996.9	8.8185	1000	29.379	4055.2	4642.8	10.723
270	12.526	2766.2	3016.7	8.8553					

Water/Steam at $p = 0.03$ MPa ($T_{\text{sat}} = 69.095^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100019	-0.04	-0.01	-0.00015	270	8.3484	2765.9	3016.4	8.6678
5	0.00100007	21.02	21.05	0.07625	280	8.5026	2781.2	3036.3	8.7041
10	0.00100033	42.02	42.05	0.15108	290	8.6568	2796.5	3056.2	8.7398
15	0.00100093	62.98	63.01	0.22446	300	8.8110	2811.9	3076.2	8.7750
20	0.00100183	83.91	83.94	0.29648	310	8.9651	2827.3	3096.3	8.8097
25	0.00100299	104.82	104.85	0.36722	320	9.1192	2842.8	3116.4	8.8439
30	0.00100440	125.73	125.76	0.43675	330	9.2733	2858.4	3136.6	8.8777
35	0.00100603	146.63	146.66	0.50512	340	9.4274	2874.1	3156.9	8.9110
40	0.00100788	167.52	167.55	0.57239	350	9.5815	2889.8	3177.2	8.9438
45	0.00100992	188.42	188.45	0.63861	360	9.7356	2905.4	3197.5	8.9763
50	0.00101214	209.33	209.36	0.70380	370	9.8896	2921.3	3218.0	9.0083
55	0.00101455	230.24	230.27	0.76802	380	10.044	2937.2	3238.5	9.0399
60	0.00101712	251.16	251.19	0.83129	390	10.198	2953.1	3259.0	9.0711
65	0.00101987	272.09	272.12	0.89365	400	10.352	2969.0	3279.6	9.1020
69.095	0.00102224	289.24	289.27	0.94407	410	10.506	2985.1	3300.3	9.1325
69.095	5.2284	2467.6	2624.5	7.76750	420	10.660	3001.3	3321.1	9.1627
70	5.2428	2469.0	2626.3	7.7727	430	10.814	3017.5	3341.9	9.1925
75	5.3220	2476.5	2636.2	7.8013	440	10.968	3033.8	3362.8	9.2220
80	5.4010	2484.0	2646.0	7.8292	450	11.122	3050.0	3383.7	9.2511
85	5.4797	2491.4	2655.8	7.8567	460	11.276	3066.4	3404.7	9.2800
90	5.5583	2498.8	2665.5	7.8837	470	11.430	3082.9	3425.8	9.3086
95	5.6368	2506.2	2675.3	7.9103	480	11.584	3099.5	3447.0	9.3368
100	5.7151	2513.5	2685.0	7.9365	490	11.737	3116.1	3468.2	9.3648
105	5.7933	2520.9	2694.7	7.9623	500	11.891	3132.8	3489.5	9.3925
110	5.8714	2528.2	2704.3	7.9877	520	12.199	3166.3	3532.3	9.4471
115	5.9495	2535.5	2714.0	8.0128	540	12.507	3200.1	3575.3	9.5007
120	6.0274	2542.9	2723.7	8.0375	560	12.815	3234.2	3618.6	9.5534
125	6.1053	2550.1	2733.3	8.0620	580	13.123	3268.5	3662.2	9.6051
130	6.1830	2557.5	2743.0	8.0861	600	13.431	3303.2	3706.1	9.6559
135	6.2608	2564.8	2752.6	8.1099	620	13.738	3338.2	3750.3	9.7060
140	6.3385	2572.1	2762.3	8.1334	640	14.046	3373.3	3794.7	9.7552
145	6.4161	2579.5	2772.0	8.1566	660	14.354	3408.9	3839.5	9.8036
150	6.4937	2586.8	2781.6	8.1796	680	14.662	3444.6	3884.5	9.8514
155	6.5712	2594.2	2791.3	8.2023	700	14.970	3480.7	3929.8	9.8984
160	6.6487	2601.5	2801.0	8.2248	720	15.277	3517.1	3975.4	9.9448
165	6.7262	2608.9	2810.7	8.2470	740	15.585	3553.6	4021.2	9.9905
170	6.8036	2616.3	2820.4	8.2690	760	15.893	3590.6	4067.4	10.036
175	6.8811	2623.7	2830.1	8.2908	780	16.201	3627.8	4113.8	10.080
180	6.9584	2631.0	2839.8	8.3123	800	16.508	3665.3	4160.5	10.124
185	7.0358	2638.4	2849.5	8.3337	820	16.816	3703.0	4207.5	10.167
190	7.1131	2645.8	2859.2	8.3548	840	17.124	3741.1	4254.8	10.210
195	7.1905	2653.2	2868.9	8.3757	860	17.432	3779.3	4302.3	10.253
200	7.2677	2660.7	2878.7	8.3964	880	17.739	3818.0	4350.2	10.294
210	7.4223	2675.5	2898.2	8.4372	900	18.047	3856.9	4398.3	10.336
220	7.5768	2690.5	2917.8	8.4773	920	18.355	3896.0	4446.6	10.377
230	7.7312	2705.5	2937.4	8.5167	940	18.663	3935.4	4495.3	10.417
240	7.8855	2720.5	2957.1	8.5554	960	18.970	3975.1	4544.2	10.457
250	8.0399	2735.6	2976.8	8.5935	980	19.278	4015.0	4593.3	10.497
260	8.1941	2750.8	2996.6	8.6309	1000	19.586	4055.2	4642.8	10.536
270	8.3484	2765.9	3016.4	8.6678					

Water/Steam at $p = 0.04$ MPa ($T_{\text{sat}} = 75.857^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100019	-0.04	0.00	-0.00015	270	6.2594	2765.7	3016.1	8.5346
5	0.00100006	21.02	21.06	0.07625	280	6.3752	2781.0	3036.0	8.5709
10	0.00100033	42.02	42.06	0.15108	290	6.4909	2796.4	3056.0	8.6067
15	0.00100093	62.98	63.02	0.22446	300	6.6066	2811.7	3076.0	8.6419
20	0.00100182	83.91	83.95	0.29648	310	6.7223	2827.2	3096.1	8.6767
25	0.00100299	104.82	104.86	0.36722	320	6.8380	2842.7	3116.2	8.7109
30	0.00100440	125.73	125.77	0.43674	330	6.9536	2858.3	3136.4	8.7447
35	0.00100603	146.62	146.66	0.50512	340	7.0693	2873.9	3156.7	8.7780
40	0.00100787	167.52	167.56	0.57239	350	7.1849	2889.6	3177.0	8.8108
45	0.00100991	188.42	188.46	0.63860	360	7.3005	2905.4	3197.4	8.8433
50	0.00101214	209.33	209.37	0.70380	370	7.4161	2921.2	3217.8	8.8753
55	0.00101454	230.24	230.28	0.76801	380	7.5316	2937.0	3238.3	8.9069
60	0.00101712	251.16	251.20	0.83128	390	7.6472	2953.0	3258.9	8.9382
65	0.00101986	272.09	272.13	0.89364	400	7.7628	2969.0	3279.5	8.9691
70	0.00102277	293.03	293.07	0.95513	410	7.8783	2985.1	3300.2	8.9996
75	0.00102584	313.99	314.03	1.0158	420	7.9938	3001.1	3320.9	9.0297
75.857	0.00102638	317.58	317.62	1.0261	430	8.1094	3017.4	3341.8	9.0596
75.857	3.9930	2476.4	2636.1	7.6690	440	8.2249	3033.6	3362.6	9.0891
80	4.0425	2482.6	2644.3	7.6925	450	8.3404	3050.0	3383.6	9.1182
85	4.1021	2490.1	2654.2	7.7204	460	8.4559	3066.4	3404.6	9.1471
90	4.1615	2497.6	2664.1	7.7477	470	8.5714	3082.8	3425.7	9.1757
95	4.2208	2505.1	2673.9	7.7746	480	8.6869	3099.4	3446.9	9.2039
100	4.2799	2512.5	2683.7	7.8010	490	8.8024	3116.0	3468.1	9.2319
105	4.3389	2519.9	2693.5	7.8270	500	8.9179	3132.7	3489.4	9.2596
110	4.3978	2527.3	2703.2	7.8527	520	9.1488	3166.2	3532.2	9.3143
115	4.4566	2534.7	2713.0	7.8779	540	9.3798	3200.0	3575.2	9.3679
120	4.5153	2542.1	2722.7	7.9028	560	9.6107	3234.1	3618.5	9.4205
125	4.5739	2549.4	2732.4	7.9274	580	9.8416	3268.5	3662.2	9.4723
130	4.6325	2556.8	2742.1	7.9516	600	10.073	3303.1	3706.0	9.5231
135	4.6910	2564.2	2751.8	7.9755	620	10.303	3338.1	3750.2	9.5731
140	4.7495	2571.5	2761.5	7.9992	640	10.534	3373.3	3794.7	9.6223
145	4.8079	2578.9	2771.2	8.0225	660	10.765	3408.8	3839.4	9.6708
150	4.8662	2586.3	2780.9	8.0456	680	10.996	3444.6	3884.4	9.7185
155	4.9245	2593.6	2790.6	8.0684	700	11.227	3480.6	3929.7	9.7656
160	4.9828	2601.0	2800.3	8.0909	720	11.458	3517.0	3975.3	9.8119
165	5.0411	2608.5	2810.1	8.1132	740	11.689	3553.6	4021.2	9.8577
170	5.0993	2615.8	2819.8	8.1353	760	11.919	3590.5	4067.3	9.9028
175	5.1575	2623.2	2829.5	8.1571	780	12.150	3627.8	4113.8	9.9473
180	5.2156	2630.6	2839.2	8.1787	800	12.381	3665.3	4160.5	9.9912
185	5.2737	2638.1	2849.0	8.2000	820	12.612	3703.0	4207.5	10.035
190	5.3319	2645.4	2858.7	8.2212	840	12.843	3741.1	4254.8	10.077
195	5.3899	2652.9	2868.5	8.2421	860	13.074	3779.3	4302.3	10.120
200	5.4480	2660.3	2878.2	8.2629	880	13.304	3817.9	4350.1	10.162
210	5.5641	2675.2	2897.8	8.3038	900	13.535	3856.8	4398.2	10.203
220	5.6801	2690.2	2917.4	8.3440	920	13.766	3896.0	4446.6	10.244
230	5.7961	2705.2	2937.0	8.3834	940	13.997	3935.3	4495.2	10.284
240	5.9120	2720.2	2956.7	8.4222	960	14.228	3975.0	4544.1	10.324
250	6.0278	2735.4	2976.5	8.4603	980	14.458	4015.0	4593.3	10.364
260	6.1437	2750.6	2996.3	8.4977	1000	14.689	4055.1	4642.7	10.403
270	6.2594	2765.7	3016.1	8.5346					

Water/Steam at $p = 0.05$ MPa ($T_{\text{sat}} = 81.317^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100018	-0.04	0.01	-0.00015	270	5.0061	2765.5	3015.8	8.4313
5	0.00100006	21.02	21.07	0.07625	280	5.0988	2780.9	3035.8	8.4676
10	0.00100032	42.02	42.07	0.15108	290	5.1914	2796.1	3055.7	8.5034
15	0.00100092	62.98	63.03	0.22446	300	5.2840	2811.6	3075.8	8.5386
20	0.00100182	83.91	83.96	0.29647	310	5.3767	2827.0	3095.8	8.5734
25	0.00100298	104.82	104.87	0.36721	320	5.4692	2842.5	3116.0	8.6076
30	0.00100439	125.73	125.78	0.43674	330	5.5618	2858.1	3136.2	8.6414
35	0.00100603	146.62	146.67	0.50511	340	5.6544	2873.8	3156.5	8.6747
40	0.00100787	167.52	167.57	0.57239	350	5.7469	2889.5	3176.8	8.7076
45	0.00100991	188.42	188.47	0.63860	360	5.8394	2905.2	3197.2	8.7401
50	0.00101213	209.32	209.37	0.70379	370	5.9319	2921.0	3217.6	8.7721
55	0.00101454	230.24	230.29	0.76801	380	6.0244	2936.9	3238.1	8.8038
60	0.00101711	251.16	251.21	0.83128	390	6.1169	2952.9	3258.7	8.8350
65	0.00101986	272.09	272.14	0.89364	400	6.2094	2968.8	3279.3	8.8659
70	0.00102276	293.03	293.08	0.95512	410	6.3019	2984.9	3300.0	8.8964
75	0.00102583	313.99	314.04	1.0158	420	6.3943	3001.1	3320.8	8.9266
80	0.00102905	334.96	335.01	1.0756	430	6.4868	3017.3	3341.6	8.9564
81.317	0.00102993	340.49	340.54	1.0912	440	6.5792	3033.5	3362.5	8.9859
81.317	3.2400	2483.2	2645.2	7.5930	450	6.6717	3049.9	3383.5	9.0151
85	3.2754	2488.8	2652.6	7.6138	460	6.7641	3066.3	3404.5	9.0440
90	3.3233	2496.4	2662.6	7.6415	470	6.8565	3082.8	3425.6	9.0726
95	3.3711	2503.9	2672.5	7.6686	480	6.9489	3099.3	3446.7	9.1008
100	3.4187	2511.5	2682.4	7.6953	490	7.0414	3115.9	3468.0	9.1288
105	3.4661	2519.0	2692.3	7.7215	500	7.1338	3132.6	3489.3	9.1566
110	3.5135	2526.4	2702.1	7.7474	520	7.3186	3166.2	3532.1	9.2112
115	3.5608	2533.9	2711.9	7.7728	540	7.5034	3199.9	3575.1	9.2648
120	3.6080	2541.3	2721.7	7.7978	560	7.6881	3234.1	3618.5	9.3175
125	3.6551	2548.7	2731.5	7.8225	580	7.8729	3268.5	3662.1	9.3692
130	3.7021	2556.1	2741.2	7.8469	600	8.0576	3303.1	3706.0	9.4201
135	3.7491	2563.5	2751.0	7.8710	620	8.2424	3338.0	3750.1	9.4701
140	3.7960	2570.9	2760.7	7.8947	640	8.4271	3373.2	3794.6	9.5193
145	3.8429	2578.4	2770.5	7.9181	660	8.6118	3408.7	3839.3	9.5678
150	3.8897	2585.7	2780.2	7.9413	680	8.7965	3444.6	3884.4	9.6155
155	3.9365	2593.2	2790.0	7.9642	700	8.9812	3480.6	3929.7	9.6625
160	3.9833	2600.5	2799.7	7.9868	720	9.1659	3517.0	3975.3	9.7089
165	4.0300	2607.9	2809.4	8.0091	740	9.3506	3553.6	4021.1	9.7546
170	4.0766	2615.4	2819.2	8.0312	760	9.5353	3590.5	4067.3	9.7998
175	4.1233	2622.7	2828.9	8.0531	780	9.7200	3627.7	4113.7	9.8443
180	4.1699	2630.2	2838.7	8.0748	800	9.9047	3665.2	4160.4	9.8882
185	4.2165	2637.6	2848.4	8.0962	820	10.089	3702.9	4207.4	9.9316
190	4.2631	2645.0	2858.2	8.1174	840	10.274	3741.0	4254.7	9.9745
195	4.3096	2652.5	2868.0	8.1384	860	10.459	3779.3	4302.3	10.017
200	4.3562	2660.0	2877.8	8.1592	880	10.643	3818.0	4350.1	10.059
210	4.4492	2674.9	2897.4	8.2001	900	10.828	3856.8	4398.2	10.100
220	4.5421	2689.9	2917.0	8.2404	920	11.013	3896.0	4446.6	10.141
230	4.6350	2704.9	2936.7	8.2799	940	11.197	3935.4	4495.2	10.181
240	4.7278	2720.0	2956.4	8.3187	960	11.382	3975.0	4544.1	10.221
250	4.8206	2735.1	2976.1	8.3568	980	11.567	4014.9	4593.3	10.261
260	4.9134	2750.3	2996.0	8.3943	1000	11.751	4055.2	4642.7	10.300
270	5.0061	2765.5	3015.8	8.4313					

Water/Steam at $p = 0.06$ MPa ($T_{\text{sat}} = 85.926^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100018	-0.04	0.02	-0.00015	270	4.1705	2765.3	3015.5	8.3467
5	0.00100005	21.02	21.08	0.07625	280	4.2478	2780.6	3035.5	8.3831
10	0.00100032	42.02	42.08	0.15108	290	4.3251	2796.0	3055.5	8.4189
15	0.00100092	62.98	63.04	0.22445	300	4.4023	2811.4	3075.5	8.4542
20	0.00100182	83.91	83.97	0.29647	310	4.4795	2826.8	3095.6	8.4889
25	0.00100298	104.82	104.88	0.36721	320	4.5567	2842.4	3115.8	8.5232
30	0.00100439	125.72	125.78	0.43674	330	4.6339	2858.0	3136.0	8.5570
35	0.00100602	146.62	146.68	0.50511	340	4.7111	2873.6	3156.3	8.5904
40	0.00100786	167.52	167.58	0.57238	350	4.7883	2889.3	3176.6	8.6232
45	0.00100990	188.42	188.48	0.63859	360	4.8654	2905.1	3197.0	8.6557
50	0.00101213	209.32	209.38	0.70379	370	4.9425	2920.8	3217.4	8.6878
55	0.00101453	230.23	230.29	0.76800	380	5.0196	2936.8	3238.0	8.7194
60	0.00101711	251.15	251.21	0.83127	390	5.0967	2952.7	3258.5	8.7507
65	0.00101985	272.08	272.14	0.89363	400	5.1738	2968.8	3279.2	8.7816
70	0.00102276	293.03	293.09	0.95512	410	5.2509	2984.8	3299.9	8.8121
75	0.00102583	313.99	314.05	1.0158	420	5.3280	3001.0	3320.7	8.8423
80	0.00102905	334.96	335.02	1.0756	430	5.4051	3017.2	3341.5	8.8721
85	0.00103243	355.96	356.02	1.1346	440	5.4821	3033.5	3362.4	8.9017
85.926	0.00103307	359.85	359.91	1.1454	450	5.5592	3049.7	3383.3	8.9308
85.926	2.7317	2489.0	2652.9	7.5311	460	5.6362	3066.2	3404.4	8.9597
90	2.7645	2495.2	2661.1	7.5540	470	5.7133	3082.7	3425.5	8.9883
95	2.8046	2502.8	2671.1	7.5814	480	5.7903	3099.2	3446.6	9.0166
100	2.8445	2510.4	2681.1	7.6084	490	5.8673	3115.9	3467.9	9.0446
105	2.8843	2518.0	2691.1	7.6348	500	5.9444	3132.5	3489.2	9.0723
110	2.9240	2525.6	2701.0	7.6609	520	6.0984	3166.1	3532.0	9.1270
115	2.9636	2533.1	2710.9	7.6865	540	6.2524	3199.9	3575.0	9.1806
120	3.0031	2540.5	2720.7	7.7117	560	6.4064	3234.0	3618.4	9.2332
125	3.0425	2547.9	2730.5	7.7365	580	6.5604	3268.4	3662.0	9.2850
130	3.0819	2555.4	2740.3	7.7610	600	6.7144	3303.0	3705.9	9.3358
135	3.1212	2562.8	2750.1	7.7852	620	6.8684	3338.0	3750.1	9.3859
140	3.1604	2570.3	2759.9	7.8090	640	7.0223	3373.2	3794.5	9.4351
145	3.1996	2577.7	2769.7	7.8326	660	7.1763	3408.7	3839.3	9.4836
150	3.2387	2585.2	2779.5	7.8558	680	7.3302	3444.5	3884.3	9.5313
155	3.2778	2592.6	2789.3	7.8788	700	7.4841	3480.6	3929.6	9.5784
160	3.3169	2600.0	2799.0	7.9015	720	7.6381	3516.9	3975.2	9.6247
165	3.3559	2607.4	2808.8	7.9239	740	7.7920	3553.6	4021.1	9.6705
170	3.3949	2614.9	2818.6	7.9461	760	7.9459	3590.4	4067.2	9.7156
175	3.4338	2622.4	2828.4	7.9680	780	8.0998	3627.7	4113.7	9.7601
180	3.4728	2629.7	2838.1	7.9897	800	8.2537	3665.2	4160.4	9.8040
185	3.5117	2637.2	2847.9	8.0112	820	8.4076	3702.9	4207.4	9.8474
190	3.5506	2644.7	2857.7	8.0324	840	8.5615	3741.0	4254.7	9.8903
195	3.5894	2652.1	2867.5	8.0535	860	8.7154	3779.3	4302.2	9.9326
200	3.6283	2659.6	2877.3	8.0743	880	8.8693	3817.9	4350.1	9.9745
210	3.7059	2674.5	2896.9	8.1153	900	9.0232	3856.8	4398.2	10.016
220	3.7834	2689.6	2916.6	8.1556	920	9.1771	3895.9	4446.5	10.057
230	3.8609	2704.6	2936.3	8.1952	940	9.3310	3935.3	4495.2	10.097
240	3.9384	2719.7	2956.0	8.2340	960	9.4849	3975.0	4544.1	10.137
250	4.0158	2734.9	2975.8	8.2722	980	9.6388	4014.9	4593.2	10.177
260	4.0932	2750.1	2995.7	8.3098	1000	9.7927	4055.1	4642.7	10.216
270	4.1705	2765.3	3015.5	8.3467					

Water/Steam at $p = 0.07$ MPa ($T_{\text{sat}} = 89.932^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100017	-0.04	0.03	-0.00015	270	3.5736	2765.1	3015.3	8.2752
5	0.00100005	21.02	21.09	0.07625	280	3.6400	2780.4	3035.2	8.3116
10	0.00100031	42.02	42.09	0.15108	290	3.7062	2795.8	3055.2	8.3474
15	0.00100091	62.98	63.05	0.22445	300	3.7725	2811.2	3075.3	8.3827
20	0.00100181	83.91	83.98	0.29647	310	3.8387	2826.7	3095.4	8.4175
25	0.00100298	104.82	104.89	0.36721	320	3.9050	2842.3	3115.6	8.4518
30	0.00100438	125.72	125.79	0.43673	330	3.9712	2857.8	3135.8	8.4856
35	0.00100602	146.62	146.69	0.50511	340	4.0373	2873.5	3156.1	8.5190
40	0.00100786	167.52	167.59	0.57238	350	4.1035	2889.2	3176.4	8.5519
45	0.00100990	188.42	188.49	0.63859	360	4.1697	2904.9	3196.8	8.5844
50	0.00101212	209.32	209.39	0.70378	370	4.2358	2920.8	3217.3	8.6164
55	0.00101453	230.23	230.30	0.76800	380	4.3019	2936.7	3237.8	8.6481
60	0.00101711	251.15	251.22	0.83127	390	4.3680	2952.6	3258.4	8.6794
65	0.00101985	272.08	272.15	0.89363	400	4.4341	2968.6	3279.0	8.7103
70	0.00102276	293.03	293.10	0.95511	410	4.5002	2984.7	3299.7	8.7408
75	0.00102582	313.99	314.06	1.0157	420	4.5663	3000.9	3320.5	8.7710
80	0.00102904	334.96	335.03	1.0756	430	4.6324	3017.0	3341.3	8.8009
85	0.00103242	355.95	356.02	1.1346	440	4.6985	3033.4	3362.3	8.8304
89.932	0.00103590	376.68	376.75	1.1921	450	4.7645	3049.7	3383.2	8.8596
89.932	2.3648	2493.9	2659.4	7.4790	460	4.8306	3066.2	3404.3	8.8885
90	2.3653	2494.0	2659.6	7.4794	470	4.8966	3082.6	3425.4	8.9170
95	2.3999	2501.7	2669.7	7.5072	480	4.9627	3099.1	3446.5	8.9453
100	2.4343	2509.4	2679.8	7.5344	490	5.0287	3115.8	3467.8	8.9733
105	2.4687	2517.0	2689.8	7.5611	500	5.0948	3132.5	3489.1	9.0011
110	2.5029	2524.6	2699.8	7.5874	520	5.2268	3166.0	3531.9	9.0557
115	2.5370	2532.2	2709.8	7.6132	540	5.3589	3199.8	3574.9	9.1094
120	2.5710	2539.7	2719.7	7.6385	560	5.4909	3233.9	3618.3	9.1620
125	2.6049	2547.3	2729.6	7.6635	580	5.6229	3268.3	3661.9	9.2138
130	2.6388	2554.8	2739.5	7.6882	600	5.7549	3303.0	3705.8	9.2646
135	2.6726	2562.2	2749.3	7.7124	620	5.8869	3337.9	3750.0	9.3147
140	2.7064	2569.7	2759.1	7.7364	640	6.0189	3373.2	3794.5	9.3639
145	2.7401	2577.2	2769.0	7.7600	660	6.1509	3408.6	3839.2	9.4124
150	2.7737	2584.6	2778.8	7.7834	680	6.2828	3444.4	3884.2	9.4601
155	2.8073	2592.1	2788.6	7.8064	700	6.4148	3480.5	3929.5	9.5072
160	2.8409	2599.5	2798.4	7.8292	720	6.5467	3516.8	3975.1	9.5535
165	2.8744	2607.0	2808.2	7.8517	740	6.6787	3553.5	4021.0	9.5993
170	2.9079	2614.4	2818.0	7.8739	760	6.8106	3590.5	4067.2	9.6444
175	2.9414	2621.9	2827.8	7.8959	780	6.9426	3627.6	4113.6	9.6889
180	2.9748	2629.4	2837.6	7.9177	800	7.0745	3665.1	4160.3	9.7329
185	3.0082	2636.8	2847.4	7.9392	820	7.2064	3702.9	4207.3	9.7763
190	3.0416	2644.3	2857.2	7.9605	840	7.3384	3740.9	4254.6	9.8191
195	3.0750	2651.8	2867.0	7.9815	860	7.4703	3779.3	4302.2	9.8615
200	3.1083	2659.2	2876.8	8.0024	880	7.6022	3817.8	4350.0	9.9033
210	3.1750	2674.3	2896.5	8.0435	900	7.7341	3856.7	4398.1	9.9447
220	3.2415	2689.3	2916.2	8.0839	920	7.8660	3895.9	4446.5	9.9855
230	3.3080	2704.3	2935.9	8.1235	940	7.9979	3935.2	4495.1	10.026
240	3.3745	2719.5	2955.7	8.1624	960	8.1298	3974.9	4544.0	10.066
250	3.4409	2734.6	2975.5	8.2006	980	8.2617	4014.9	4593.2	10.106
260	3.5073	2749.9	2995.4	8.2382	1000	8.3937	4055.0	4642.6	10.145
270	3.5736	2765.1	3015.3	8.2752					

Water/Steam at $p = 0.08$ MPa ($T_{\text{sat}} = 93.486^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100017	-0.04	0.04	-0.00015	270	3.1260	2764.9	3015.0	8.2131
5	0.00100004	21.02	21.10	0.07625	280	3.1841	2780.2	3034.9	8.2496
10	0.00100031	42.02	42.10	0.15108	290	3.2421	2795.6	3055.0	8.2854
15	0.00100091	62.98	63.06	0.22445	300	3.3001	2811.0	3075.0	8.3208
20	0.00100181	83.91	83.99	0.29647	310	3.3581	2826.5	3095.1	8.3556
25	0.00100297	104.82	104.90	0.36721	320	3.4161	2842.0	3115.3	8.3899
30	0.00100438	125.72	125.80	0.43673	330	3.4741	2857.7	3135.6	8.4237
35	0.00100601	146.62	146.70	0.50510	340	3.5320	2873.3	3155.9	8.4571
40	0.00100785	167.52	167.60	0.57237	350	3.5899	2889.0	3176.2	8.4900
45	0.00100989	188.42	188.50	0.63858	360	3.6478	2904.8	3196.6	8.5225
50	0.00101212	209.32	209.40	0.70378	370	3.7057	2920.6	3217.1	8.5546
55	0.00101452	230.23	230.31	0.76799	380	3.7636	2936.5	3237.6	8.5863
60	0.00101710	251.15	251.23	0.83126	390	3.8215	2952.5	3258.2	8.6176
65	0.00101984	272.08	272.16	0.89362	400	3.8794	2968.5	3278.9	8.6485
70	0.00102275	293.03	293.11	0.95510	410	3.9372	2984.6	3299.6	8.6790
75	0.00102582	313.98	314.06	1.0157	420	3.9951	3000.8	3320.4	8.7092
80	0.00102904	334.96	335.04	1.0756	430	4.0529	3017.0	3341.2	8.7391
85	0.00103242	355.95	356.03	1.1346	440	4.1107	3033.2	3362.1	8.7686
90	0.00103595	376.97	377.05	1.1929	450	4.1686	3049.6	3383.1	8.7978
93.486	0.00103850	391.63	391.71	1.2330	460	4.2264	3066.0	3404.1	8.8267
93.486	2.0871	2498.2	2665.2	7.4339	470	4.2842	3082.5	3425.2	8.8553
95	2.0963	2500.6	2668.3	7.4424	480	4.3420	3099.0	3446.4	8.8836
100	2.1267	2508.4	2678.5	7.4699	490	4.3998	3115.6	3467.6	8.9116
105	2.1569	2516.0	2688.6	7.4969	500	4.4576	3132.3	3488.9	8.9393
110	2.1870	2523.7	2698.7	7.5233	520	4.5732	3165.9	3531.8	8.9940
115	2.2170	2531.3	2708.7	7.5493	540	4.6887	3199.7	3574.8	9.0476
120	2.2469	2538.9	2718.7	7.5749	560	4.8043	3233.9	3618.2	9.1003
125	2.2768	2546.5	2728.6	7.6000	580	4.9198	3268.2	3661.8	9.1521
130	2.3065	2554.1	2738.6	7.6248	600	5.0353	3302.9	3705.7	9.2029
135	2.3362	2561.6	2748.5	7.6492	620	5.1508	3337.8	3749.9	9.2530
140	2.3658	2569.0	2758.3	7.6733	640	5.2663	3373.1	3794.4	9.3022
145	2.3954	2576.6	2768.2	7.6970	660	5.3818	3408.6	3839.1	9.3507
150	2.4249	2584.1	2778.1	7.7204	680	5.4973	3444.4	3884.2	9.3984
155	2.4544	2591.5	2787.9	7.7435	700	5.6128	3480.5	3929.5	9.4455
160	2.4839	2599.0	2797.7	7.7664	720	5.7283	3516.8	3975.1	9.4919
165	2.5133	2606.5	2807.6	7.7889	740	5.8437	3553.5	4021.0	9.5376
170	2.5427	2614.0	2817.4	7.8113	760	5.9592	3590.4	4067.1	9.5827
175	2.5720	2621.4	2827.2	7.8333	780	6.0746	3627.6	4113.6	9.6273
180	2.6013	2629.0	2837.1	7.8551	800	6.1901	3665.1	4160.3	9.6712
185	2.6306	2636.5	2846.9	7.8767	820	6.3055	3702.9	4207.3	9.7146
190	2.6599	2643.9	2856.7	7.8980	840	6.4210	3740.9	4254.6	9.7575
195	2.6891	2651.4	2866.5	7.9191	860	6.5364	3779.2	4302.1	9.7998
200	2.7184	2658.9	2876.4	7.9400	880	6.6518	3817.9	4350.0	9.8416
210	2.7768	2674.0	2896.1	7.9812	900	6.7673	3856.7	4398.1	9.8830
220	2.8351	2689.0	2915.8	8.0216	920	6.8827	3895.9	4446.5	9.9239
230	2.8934	2704.0	2935.5	8.0613	940	6.9981	3935.3	4495.1	9.9643
240	2.9516	2719.2	2955.3	8.1002	960	7.1136	3974.9	4544.0	10.004
250	3.0098	2734.4	2975.2	8.1385	980	7.2290	4014.9	4593.2	10.044
260	3.0679	2749.6	2995.0	8.1761	1000	7.3444	4055.0	4642.6	10.083
270	3.1260	2764.9	3015.0	8.2131					

Water/Steam at $p = 0.09$ MPa ($T_{\text{sat}} = 96.687^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100016	-0.04	0.05	-0.00015	270	2.7779	2764.7	3014.7	8.1584
5	0.00100004	21.02	21.11	0.07625	280	2.8295	2780.0	3034.7	8.1949
10	0.00100030	42.02	42.11	0.15108	290	2.8811	2795.4	3054.7	8.2307
15	0.00100090	62.98	63.07	0.22445	300	2.9328	2810.8	3074.8	8.2661
20	0.00100180	83.91	84.00	0.29647	310	2.9843	2826.3	3094.9	8.3009
25	0.00100297	104.82	104.91	0.36720	320	3.0359	2841.9	3115.1	8.3353
30	0.00100437	125.72	125.81	0.43673	330	3.0875	2857.5	3135.4	8.3691
35	0.00100601	146.62	146.71	0.50510	340	3.1390	2873.2	3155.7	8.4025
40	0.00100785	167.52	167.61	0.57237	350	3.1905	2888.9	3176.0	8.4354
45	0.00100989	188.42	188.51	0.63858	360	3.2420	2904.6	3196.4	8.4679
50	0.00101211	209.32	209.41	0.70377	370	3.2935	2920.5	3216.9	8.5000
55	0.00101452	230.23	230.32	0.76799	380	3.3450	2936.4	3237.5	8.5317
60	0.00101710	251.15	251.24	0.83126	390	3.3964	2952.4	3258.1	8.5630
65	0.00101984	272.08	272.17	0.89362	400	3.4479	2968.4	3278.7	8.5939
70	0.00102275	293.02	293.11	0.95510	410	3.4993	2984.5	3299.4	8.6245
75	0.00102581	313.98	314.07	1.0157	420	3.5508	3000.6	3320.2	8.6547
80	0.00102903	334.96	335.05	1.0756	430	3.6022	3016.9	3341.1	8.6846
85	0.00103241	355.95	356.04	1.1346	440	3.6536	3033.2	3362.0	8.7141
90	0.00103594	376.96	377.05	1.1929	450	3.7050	3049.6	3383.0	8.7433
95	0.00103963	398.00	398.09	1.2504	460	3.7564	3065.9	3404.0	8.7722
96.687	0.00104091	405.11	405.20	1.2696	470	3.8078	3082.4	3425.1	8.8008
96.687	1.8694	2502.1	2670.3	7.3943	480	3.8592	3099.0	3446.3	8.8291
100	1.8874	2507.2	2677.1	7.4126	490	3.9106	3115.5	3467.5	8.8571
105	1.9144	2515.1	2687.4	7.4399	500	3.9620	3132.2	3488.8	8.8849
110	1.9413	2522.8	2697.5	7.4665	520	4.0648	3165.9	3531.7	8.9396
115	1.9681	2530.5	2707.6	7.4927	540	4.1675	3199.6	3574.7	8.9932
120	1.9948	2538.2	2717.7	7.5185	560	4.2702	3233.8	3618.1	9.0459
125	2.0215	2545.8	2727.7	7.5438	580	4.3729	3268.1	3661.7	9.0976
130	2.0480	2553.4	2737.7	7.5687	600	4.4756	3302.9	3705.7	9.1485
135	2.0745	2560.9	2747.6	7.5932	620	4.5783	3337.8	3749.8	9.1986
140	2.1010	2568.4	2757.5	7.6174	640	4.6810	3373.0	3794.3	9.2478
145	2.1273	2575.9	2767.4	7.6412	660	4.7837	3408.6	3839.1	9.2963
150	2.1537	2583.5	2777.3	7.6647	680	4.8863	3444.3	3884.1	9.3440
155	2.1800	2591.0	2787.2	7.6879	700	4.9890	3480.4	3929.4	9.3911
160	2.2062	2598.5	2797.1	7.7108	720	5.0916	3516.8	3975.0	9.4375
165	2.2324	2606.0	2806.9	7.7335	740	5.1943	3553.4	4020.9	9.4832
170	2.2586	2613.5	2816.8	7.7559	760	5.2969	3590.4	4067.1	9.5283
175	2.2847	2621.1	2826.7	7.7780	780	5.3996	3627.5	4113.5	9.5729
180	2.3109	2628.5	2836.5	7.7998	800	5.5022	3665.1	4160.3	9.6168
185	2.3369	2636.1	2846.4	7.8214	820	5.6048	3702.9	4207.3	9.6602
190	2.3630	2643.5	2856.2	7.8428	840	5.7074	3740.8	4254.5	9.7031
195	2.3891	2651.1	2866.1	7.8640	860	5.8101	3779.2	4302.1	9.7454
200	2.4151	2658.5	2875.9	7.8849	880	5.9127	3817.8	4349.9	9.7873
210	2.4671	2673.6	2895.6	7.9262	900	6.0153	3856.6	4398.0	9.8286
220	2.5190	2688.7	2915.4	7.9667	920	6.1179	3895.8	4446.4	9.8695
230	2.5708	2703.8	2935.2	8.0064	940	6.2205	3935.3	4495.1	9.9099
240	2.6227	2719.0	2955.0	8.0454	960	6.3231	3974.9	4544.0	9.9499
250	2.6744	2734.1	2974.8	8.0837	980	6.4257	4014.9	4593.2	9.9895
260	2.7262	2749.3	2994.7	8.1213	1000	6.5283	4055.1	4642.6	10.029
270	2.7779	2764.7	3014.7	8.1584					

Water/Steam at $p = 0.10$ MPa ($T_{\text{sat}} = 99.606^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100016	-0.04	0.06	-0.00015	270	2.4993	2764.5	3014.4	8.1094
5	0.00100003	21.02	21.12	0.07625	280	2.5459	2779.8	3034.4	8.1459
10	0.00100030	42.02	42.12	0.15108	290	2.5924	2795.2	3054.4	8.1818
15	0.00100090	62.98	63.08	0.22445	300	2.6388	2810.6	3074.5	8.2172
20	0.00100180	83.91	84.01	0.29646	310	2.6853	2826.2	3094.7	8.2520
25	0.00100296	104.82	104.92	0.36720	320	2.7317	2841.7	3114.9	8.2864
30	0.00100437	125.72	125.82	0.43673	330	2.7782	2857.3	3135.1	8.3202
35	0.00100600	146.62	146.72	0.50510	340	2.8246	2873.0	3155.5	8.3536
40	0.00100785	167.52	167.62	0.57237	350	2.8710	2888.7	3175.8	8.3866
45	0.00100988	188.41	188.51	0.63858	360	2.9173	2904.6	3196.3	8.4191
50	0.00101211	209.32	209.42	0.70377	370	2.9637	2920.3	3216.7	8.4512
55	0.00101452	230.23	230.33	0.76798	380	3.0100	2936.3	3237.3	8.4829
60	0.00101709	251.15	251.25	0.83125	390	3.0564	2952.3	3257.9	8.5142
65	0.00101984	272.08	272.18	0.89361	400	3.1027	2968.3	3278.6	8.5452
70	0.00102274	293.02	293.12	0.95509	410	3.1490	2984.4	3299.3	8.5757
75	0.00102581	313.98	314.08	1.0157	420	3.1953	3000.6	3320.1	8.6059
80	0.00102903	334.95	335.05	1.0755	430	3.2416	3016.7	3340.9	8.6358
85	0.00103241	355.95	356.05	1.1346	440	3.2879	3033.1	3361.9	8.6653
90	0.00103594	376.96	377.06	1.1928	450	3.3342	3049.4	3382.8	8.6946
95	0.00103962	398.00	398.10	1.2504	460	3.3805	3065.8	3403.9	8.7235
99.606	0.00104315	417.40	417.50	1.3028	470	3.4267	3082.3	3425.0	8.7521
99.606	1.6939	2505.5	2674.9	7.3588	480	3.4730	3098.9	3446.2	8.7804
100	1.6959	2506.2	2675.8	7.3610	490	3.5193	3115.5	3467.4	8.8084
105	1.7204	2514.1	2686.1	7.3885	500	3.5655	3132.1	3488.7	8.8361
110	1.7447	2521.8	2696.3	7.4155	520	3.6580	3165.8	3531.6	8.8908
115	1.7690	2529.6	2706.5	7.4418	540	3.7505	3199.6	3574.7	8.9445
120	1.7932	2537.3	2716.6	7.4678	560	3.8430	3233.7	3618.0	8.9972
125	1.8172	2545.0	2726.7	7.4932	580	3.9354	3268.2	3661.7	9.0489
130	1.8412	2552.6	2736.7	7.5183	600	4.0279	3302.8	3705.6	9.0998
135	1.8652	2560.2	2746.7	7.5429	620	4.1203	3337.8	3749.8	9.1499
140	1.8891	2567.8	2756.7	7.5672	640	4.2127	3373.0	3794.3	9.1991
145	1.9129	2575.4	2766.7	7.5911	660	4.3052	3408.5	3839.0	9.2476
150	1.9367	2582.9	2776.6	7.6148	680	4.3976	3444.2	3884.0	9.2954
155	1.9604	2590.5	2786.5	7.6380	700	4.4900	3480.4	3929.4	9.3424
160	1.9841	2598.0	2796.4	7.6610	720	4.5824	3516.8	3975.0	9.3888
165	2.0077	2605.5	2806.3	7.6838	740	4.6747	3553.4	4020.9	9.4345
170	2.0313	2613.1	2816.2	7.7062	760	4.7671	3590.3	4067.0	9.4797
175	2.0549	2620.6	2826.1	7.7284	780	4.8595	3627.6	4113.5	9.5242
180	2.0785	2628.1	2836.0	7.7503	800	4.9519	3665.0	4160.2	9.5681
185	2.1020	2635.6	2845.8	7.7719	820	5.0443	3702.8	4207.2	9.6115
190	2.1255	2643.1	2855.7	7.7934	840	5.1366	3740.8	4254.5	9.6544
195	2.1490	2650.7	2865.6	7.8146	860	5.2290	3779.2	4302.1	9.6968
200	2.1724	2658.3	2875.5	7.8356	880	5.3213	3817.8	4349.9	9.7386
210	2.2193	2673.3	2895.2	7.8769	900	5.4137	3856.6	4398.0	9.7800
220	2.2661	2688.4	2915.0	7.9174	920	5.5061	3895.8	4446.4	9.8209
230	2.3128	2703.5	2934.8	7.9572	940	5.5984	3935.2	4495.0	9.8613
240	2.3595	2718.7	2954.6	7.9962	960	5.6908	3974.8	4543.9	9.9013
250	2.4062	2733.9	2974.5	8.0346	980	5.7831	4014.8	4593.1	9.9408
260	2.4528	2749.1	2994.4	8.0723	1000	5.8754	4055.1	4642.6	9.9800
270	2.4993	2764.5	3014.4	8.1094					

Water/Steam at $p = 0.11$ MPa ($T_{\text{sat}} = 102.292^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	$\text{kJ}/\text{kg K}$	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	$\text{kJ}/\text{kg K}$
*0	0.00100015	-0.04	0.07	-0.00015	270	2.2714	2764.2	3014.1	8.0650
5	0.00100003	21.02	21.13	0.07625	280	2.3138	2779.6	3034.1	8.1015
10	0.00100029	42.02	42.13	0.15108	290	2.3561	2795.0	3054.2	8.1374
15	0.00100089	62.98	63.09	0.22445	300	2.3984	2810.5	3074.3	8.1729
20	0.00100179	83.91	84.02	0.29646	310	2.4406	2826.0	3094.5	8.2077
25	0.00100296	104.82	104.93	0.36720	320	2.4829	2841.6	3114.7	8.2421
30	0.00100437	125.72	125.83	0.43672	330	2.5251	2857.1	3134.9	8.2760
35	0.00100600	146.62	146.73	0.50509	340	2.5673	2872.9	3155.3	8.3094
40	0.00100784	167.51	167.62	0.57236	350	2.6095	2888.6	3175.6	8.3424
45	0.00100988	188.41	188.52	0.63857	360	2.6517	2904.4	3196.1	8.3749
50	0.00101211	209.32	209.43	0.70376	370	2.6938	2920.3	3216.6	8.4070
55	0.00101451	230.23	230.34	0.76798	380	2.7360	2936.1	3237.1	8.4387
60	0.00101709	251.15	251.26	0.83125	390	2.7781	2952.1	3257.7	8.4701
65	0.00101983	272.08	272.19	0.89360	400	2.8203	2968.2	3278.4	8.5010
70	0.00102274	293.02	293.13	0.95509	410	2.8624	2984.2	3299.1	8.5316
75	0.00102580	313.98	314.09	1.0157	420	2.9045	3000.4	3319.9	8.5618
80	0.00102902	334.95	335.06	1.0755	430	2.9466	3016.7	3340.8	8.5917
85	0.00103240	355.95	356.06	1.1346	440	2.9887	3032.9	3361.7	8.6212
90	0.00103593	376.96	377.07	1.1928	450	3.0308	3049.3	3382.7	8.6504
95	0.00103962	398.00	398.11	1.2504	460	3.0729	3065.8	3403.8	8.6794
100	0.00104346	419.06	419.17	1.3072	470	3.1149	3082.3	3424.9	8.7080
102.292	0.00104527	428.73	428.84	1.3330	480	3.1570	3098.8	3446.1	8.7363
102.292	1.5495	2508.8	2679.2	7.3269	490	3.1991	3115.4	3467.3	8.7643
105	1.5616	2513.0	2684.8	7.3418	500	3.2411	3132.1	3488.6	8.7921
110	1.5839	2521.0	2695.2	7.3690	520	3.3253	3165.7	3531.5	8.8467
115	1.6061	2528.7	2705.4	7.3956	540	3.4093	3199.6	3574.6	8.9004
120	1.6281	2536.5	2715.6	7.4217	560	3.4934	3233.6	3617.9	8.9531
125	1.6501	2544.2	2725.7	7.4473	580	3.5775	3268.1	3661.6	9.0049
130	1.6720	2551.9	2735.8	7.4725	600	3.6615	3302.7	3705.5	9.0558
135	1.6939	2559.6	2745.9	7.4973	620	3.7456	3337.7	3749.7	9.1058
140	1.7157	2567.2	2755.9	7.5217	640	3.8296	3372.9	3794.2	9.1551
145	1.7374	2574.8	2765.9	7.5457	660	3.9136	3408.4	3838.9	9.2036
150	1.7591	2582.4	2775.9	7.5694	680	3.9977	3444.3	3884.0	9.2513
155	1.7807	2589.9	2785.8	7.5928	700	4.0817	3480.3	3929.3	9.2984
160	1.8023	2597.5	2795.8	7.6159	720	4.1657	3516.7	3974.9	9.3448
165	1.8239	2605.1	2805.7	7.6387	740	4.2497	3553.3	4020.8	9.3905
170	1.8454	2612.6	2815.6	7.6612	760	4.3337	3590.3	4067.0	9.4356
175	1.8669	2620.1	2825.5	7.6834	780	4.4177	3627.5	4113.4	9.4802
180	1.8883	2627.7	2835.4	7.7054	800	4.5016	3665.0	4160.2	9.5241
185	1.9098	2635.2	2845.3	7.7271	820	4.5856	3702.8	4207.2	9.5675
190	1.9312	2642.8	2855.2	7.7486	840	4.6696	3740.8	4254.5	9.6104
195	1.9525	2650.3	2865.1	7.7698	860	4.7536	3779.1	4302.0	9.6527
200	1.9739	2657.9	2875.0	7.7908	880	4.8375	3817.8	4349.9	9.6946
210	2.0166	2673.0	2894.8	7.8322	900	4.9215	3856.6	4398.0	9.7360
220	2.0592	2688.1	2914.6	7.8728	920	5.0055	3895.8	4446.4	9.7768
230	2.1017	2703.2	2934.4	7.9126	940	5.0894	3935.2	4495.0	9.8173
240	2.1442	2718.4	2954.3	7.9517	960	5.1734	3974.8	4543.9	9.8573
250	2.1867	2733.7	2974.2	7.9901	980	5.2573	4014.8	4593.1	9.8968
260	2.2291	2748.9	2994.1	8.0279	1000	5.3413	4055.0	4642.5	9.9360
270	2.2714	2764.2	3014.1	8.0650					

Water/Steam at $p = 0.12$ MPa ($T_{\text{sat}} = 104.784^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100015	-0.04	0.08	-0.00015	270	2.0815	2764.0	3013.8	8.0244
5	0.00100002	21.02	21.14	0.07625	280	2.1204	2779.4	3033.8	8.0610
10	0.00100029	42.02	42.14	0.15108	290	2.1592	2794.8	3053.9	8.0970
15	0.00100089	62.97	63.09	0.22445	300	2.1980	2810.2	3074.0	8.1324
20	0.00100179	83.90	84.02	0.29646	310	2.2367	2825.8	3094.2	8.1673
25	0.00100295	104.82	104.94	0.36719	320	2.2755	2841.3	3114.4	8.2017
30	0.00100436	125.72	125.84	0.43672	330	2.3142	2857.0	3134.7	8.2356
35	0.00100599	146.62	146.74	0.50509	340	2.3529	2872.8	3155.1	8.2690
40	0.00100784	167.51	167.63	0.57236	350	2.3916	2888.4	3175.4	8.3020
45	0.00100988	188.41	188.53	0.63857	360	2.4303	2904.3	3195.9	8.3345
50	0.00101210	209.31	209.43	0.70376	370	2.4690	2920.1	3216.4	8.3667
55	0.00101451	230.22	230.34	0.76797	380	2.5076	2936.1	3237.0	8.3984
60	0.00101708	251.14	251.26	0.83124	390	2.5463	2952.0	3257.6	8.4297
65	0.00101983	272.07	272.19	0.89360	400	2.5849	2968.1	3278.3	8.4607
70	0.00102273	293.02	293.14	0.95508	410	2.6235	2984.2	3299.0	8.4913
75	0.00102580	313.98	314.10	1.0157	420	2.6621	3000.3	3319.8	8.5215
80	0.00102902	334.95	335.07	1.0755	430	2.7008	3016.6	3340.7	8.5514
85	0.00103240	355.94	356.06	1.1346	440	2.7394	3032.9	3361.6	8.5809
90	0.00103593	376.96	377.08	1.1928	450	2.7779	3049.3	3382.6	8.6102
95	0.00103961	398.00	398.12	1.2504	460	2.8165	3065.6	3403.6	8.6391
100	0.00104345	419.05	419.18	1.3072	470	2.8551	3082.2	3424.8	8.6677
104.784	0.00104727	439.23	439.36	1.3609	480	2.8937	3098.8	3446.0	8.6960
104.784	1.4284	2511.7	2683.1	7.2977	490	2.9323	3115.3	3467.2	8.7240
105	1.4293	2512.0	2683.5	7.2989	500	2.9708	3132.0	3488.5	8.7518
110	1.4498	2519.9	2693.9	7.3263	520	3.0479	3165.7	3531.4	8.8065
115	1.4703	2527.9	2704.3	7.3531	540	3.1250	3199.5	3574.5	8.8602
120	1.4906	2535.7	2714.6	7.3794	560	3.2021	3233.5	3617.8	8.9129
125	1.5109	2543.5	2724.8	7.4052	580	3.2792	3268.0	3661.5	8.9646
130	1.5310	2551.2	2734.9	7.4305	600	3.3563	3302.6	3705.4	9.0155
135	1.5511	2558.9	2745.0	7.4554	620	3.4333	3337.6	3749.6	9.0656
140	1.5712	2566.6	2755.1	7.4800	640	3.5104	3372.9	3794.1	9.1149
145	1.5912	2574.2	2765.1	7.5041	660	3.5874	3408.4	3838.9	9.1633
150	1.6111	2581.8	2775.1	7.5279	680	3.6644	3444.2	3883.9	9.2111
155	1.6310	2589.4	2785.1	7.5514	700	3.7414	3480.3	3929.3	9.2582
160	1.6508	2597.0	2795.1	7.5745	720	3.8184	3516.7	3974.9	9.3046
165	1.6706	2604.5	2805.0	7.5974	740	3.8954	3553.4	4020.8	9.3503
170	1.6904	2612.2	2815.0	7.6199	760	3.9724	3590.2	4066.9	9.3954
175	1.7102	2619.7	2824.9	7.6422	780	4.0494	3627.5	4113.4	9.4400
180	1.7299	2627.3	2834.9	7.6643	800	4.1264	3664.9	4160.1	9.4839
185	1.7496	2634.8	2844.8	7.6860	820	4.2034	3702.7	4207.1	9.5273
190	1.7692	2642.4	2854.7	7.7076	840	4.2804	3740.8	4254.4	9.5702
195	1.7888	2649.9	2864.6	7.7289	860	4.3574	3779.1	4302.0	9.6126
200	1.8085	2657.5	2874.5	7.7499	880	4.4343	3817.7	4349.8	9.6544
210	1.8476	2672.6	2894.3	7.7914	900	4.5113	3856.5	4397.9	9.6958
220	1.8867	2687.8	2914.2	7.8320	920	4.5883	3895.7	4446.3	9.7367
230	1.9258	2703.0	2934.1	7.8719	940	4.6653	3935.2	4495.0	9.7771
240	1.9648	2718.1	2953.9	7.9111	960	4.7422	3974.8	4543.9	9.8171
250	2.0037	2733.5	2973.9	7.9495	980	4.8192	4014.8	4593.1	9.8567
260	2.0427	2748.7	2993.8	7.9873	1000	4.8961	4055.0	4642.5	9.8958
270	2.0815	2764.0	3013.8	8.0244					

Water/Steam at $p = 0.13$ MPa ($T_{\text{sat}} = 107.109^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
*0	0.00100014	-0.04	0.09	-0.00015	270	1.9208	2763.8	3013.5	7.9871
5	0.00100002	21.02	21.15	0.07625	280	1.9567	2779.2	3033.6	8.0237
10	0.00100028	42.02	42.15	0.15107	290	1.9926	2794.7	3053.7	8.0597
15	0.00100088	62.97	63.10	0.22444	300	2.0284	2810.1	3073.8	8.0951
20	0.00100178	83.90	84.03	0.29646	310	2.0642	2825.7	3094.0	8.1300
25	0.00100295	104.82	104.95	0.36719	320	2.1000	2841.2	3114.2	8.1644
30	0.00100436	125.72	125.85	0.43672	330	2.1358	2856.8	3134.5	8.1984
35	0.00100599	146.62	146.75	0.50509	340	2.1715	2872.6	3154.9	8.2318
40	0.00100783	167.51	167.64	0.57235	350	2.2073	2888.4	3175.3	8.2648
45	0.00100987	188.41	188.54	0.63856	360	2.2430	2904.1	3195.7	8.2974
50	0.00101210	209.31	209.44	0.70375	370	2.2787	2920.0	3216.2	8.3295
55	0.00101450	230.22	230.35	0.76797	380	2.3144	2935.9	3236.8	8.3613
60	0.00101708	251.14	251.27	0.83123	390	2.3501	2951.9	3257.4	8.3926
65	0.00101982	272.07	272.20	0.89359	400	2.3858	2967.9	3278.1	8.4236
70	0.00102273	293.02	293.15	0.95507	410	2.4214	2984.0	3298.8	8.4542
75	0.00102579	313.97	314.10	1.0157	420	2.4571	3000.3	3319.7	8.4844
80	0.00102901	334.95	335.08	1.0755	430	2.4927	3016.4	3340.5	8.5143
85	0.00103239	355.94	356.07	1.1346	440	2.5284	3032.8	3361.5	8.5439
90	0.00103592	376.96	377.09	1.1928	450	2.5640	3049.2	3382.5	8.5731
95	0.00103961	397.98	398.12	1.2504	460	2.5996	3065.6	3403.5	8.6020
100	0.00104345	419.05	419.19	1.3072	470	2.6353	3082.0	3424.6	8.6306
105	0.00104744	440.14	440.28	1.3633	480	2.6709	3098.6	3445.8	8.6590
107.109	0.00104917	449.05	449.19	1.3868	490	2.7065	3115.3	3467.1	8.6870
107.109	1.3253	2514.3	2686.6	7.2709	500	2.7421	3131.9	3488.4	8.7148
110	1.3364	2519.0	2692.7	7.2868	520	2.8133	3165.6	3531.3	8.7695
115	1.3553	2527.0	2703.2	7.3138	540	2.8845	3199.4	3574.4	8.8231
120	1.3742	2534.9	2713.5	7.3403	560	2.9556	3233.6	3617.8	8.8759
125	1.3930	2542.7	2723.8	7.3663	580	3.0268	3267.9	3661.4	8.9276
130	1.4117	2550.5	2734.0	7.3917	600	3.0979	3302.6	3705.3	8.9785
135	1.4303	2558.2	2744.1	7.4168	620	3.1691	3337.6	3749.6	9.0286
140	1.4489	2565.9	2754.3	7.4414	640	3.2402	3372.8	3794.0	9.0779
145	1.4674	2573.5	2764.3	7.4657	660	3.3113	3408.3	3838.8	9.1264
150	1.4859	2581.2	2774.4	7.4896	680	3.3824	3444.2	3883.9	9.1741
155	1.5043	2588.8	2784.4	7.5132	700	3.4535	3480.2	3929.2	9.2212
160	1.5227	2596.4	2794.4	7.5364	720	3.5246	3516.6	3974.8	9.2676
165	1.5410	2604.1	2804.4	7.5593	740	3.5957	3553.3	4020.7	9.3133
170	1.5593	2611.7	2814.4	7.5819	760	3.6668	3590.2	4066.9	9.3585
175	1.5776	2619.2	2824.3	7.6043	780	3.7379	3627.4	4113.3	9.4030
180	1.5958	2626.8	2834.3	7.6264	800	3.8089	3664.9	4160.1	9.4470
185	1.6140	2634.4	2844.2	7.6482	820	3.8800	3702.7	4207.1	9.4904
190	1.6322	2642.0	2854.2	7.6698	840	3.9511	3740.8	4254.4	9.5332
195	1.6503	2649.6	2864.1	7.6911	860	4.0221	3779.0	4301.9	9.5756
200	1.6685	2657.1	2874.0	7.7122	880	4.0932	3817.7	4349.8	9.6174
210	1.7047	2672.3	2893.9	7.7538	900	4.1642	3856.6	4397.9	9.6588
220	1.7408	2687.5	2913.8	7.7945	920	4.2353	3895.7	4446.3	9.6997
230	1.7769	2702.7	2933.7	7.8344	940	4.3064	3935.1	4494.9	9.7401
240	1.8130	2717.9	2953.6	7.8736	960	4.3774	3974.8	4543.9	9.7801
250	1.8490	2733.1	2973.5	7.9121	980	4.4484	4014.7	4593.0	9.8197
260	1.8849	2748.5	2993.5	7.9499	1000	4.5195	4055.0	4642.5	9.8588
270	1.9208	2763.8	3013.5	7.9871					

Water/Steam at $p = 0.14$ MPa ($T_{\text{sat}} = 109.292^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100014	-0.04	0.10	-0.00015	270	1.7831	2763.6	3013.2	7.9525
5	0.00100001	21.02	21.16	0.07625	280	1.8164	2779.0	3033.3	7.9891
10	0.00100028	42.02	42.16	0.15107	290	1.8498	2794.4	3053.4	8.0251
15	0.00100088	62.97	63.11	0.22444	300	1.8831	2809.9	3073.5	8.0606
20	0.00100178	83.90	84.04	0.29645	310	1.9163	2825.4	3093.7	8.0955
25	0.00100294	104.82	104.96	0.36719	320	1.9496	2841.1	3114.0	8.1300
30	0.00100435	125.72	125.86	0.43671	330	1.9828	2856.7	3134.3	8.1639
35	0.00100599	146.61	146.75	0.50508	340	2.0160	2872.5	3154.7	8.1974
40	0.00100783	167.51	167.65	0.57235	350	2.0492	2888.2	3175.1	8.2304
45	0.00100987	188.41	188.55	0.63856	360	2.0824	2904.0	3195.5	8.2630
50	0.00101209	209.31	209.45	0.70375	370	2.1156	2919.8	3216.0	8.2951
55	0.00101450	230.22	230.36	0.76796	380	2.1488	2935.8	3236.6	8.3269
60	0.00101707	251.14	251.28	0.83123	390	2.1819	2951.8	3257.3	8.3582
65	0.00101982	272.07	272.21	0.89359	400	2.2151	2967.8	3277.9	8.3892
70	0.00102272	293.01	293.15	0.95507	410	2.2482	2984.0	3298.7	8.4198
75	0.00102579	313.97	314.11	1.0157	420	2.2813	3000.1	3319.5	8.4500
80	0.00102901	334.95	335.09	1.0755	430	2.3144	3016.4	3340.4	8.4799
85	0.00103239	355.94	356.08	1.1345	440	2.3475	3032.6	3361.3	8.5095
90	0.00103592	376.94	377.09	1.1928	450	2.3806	3049.0	3382.3	8.5388
95	0.00103960	397.98	398.13	1.2504	460	2.4137	3065.5	3403.4	8.5677
100	0.00104344	419.05	419.20	1.3072	470	2.4468	3081.9	3424.5	8.5963
105	0.00104743	440.14	440.29	1.3633	480	2.4799	3098.5	3445.7	8.6246
109.292	0.00105099	458.27	458.42	1.4110	490	2.5130	3115.2	3467.0	8.6527
110	1.2366	2516.9	2690.0	7.2461	500	2.5460	3131.9	3488.3	8.6804
115	1.2391	2518.0	2691.5	7.2500	520	2.6122	3165.5	3531.2	8.7352
120	1.2568	2526.0	2702.0	7.2773	540	2.6783	3199.3	3574.3	8.7889
125	1.2745	2534.0	2712.4	7.3039	560	2.7444	3233.5	3617.7	8.8416
130	1.2920	2541.9	2722.8	7.3301	580	2.8105	3267.8	3661.3	8.8934
135	1.3094	2549.7	2733.0	7.3557	600	2.8765	3302.6	3705.3	8.9443
140	1.3268	2557.5	2743.3	7.3809	620	2.9426	3337.5	3749.5	8.9943
145	1.3441	2565.2	2753.4	7.4057	640	3.0086	3372.8	3794.0	9.0436
150	1.3613	2573.0	2763.6	7.4300	660	3.0747	3408.2	3838.7	9.0921
155	1.3785	2580.6	2773.6	7.4540	680	3.1407	3444.1	3883.8	9.1399
160	1.3957	2588.3	2783.7	7.4777	700	3.2067	3480.2	3929.1	9.1869
165	1.4128	2596.0	2793.8	7.5010	720	3.2728	3516.6	3974.8	9.2333
170	1.4299	2603.6	2803.8	7.5240	740	3.3388	3553.2	4020.6	9.2791
175	1.4469	2611.2	2813.8	7.5467	760	3.4048	3590.1	4066.8	9.3242
180	1.4639	2618.9	2823.8	7.5691	780	3.4708	3627.4	4113.3	9.3688
185	1.4809	2626.4	2833.7	7.5912	800	3.5368	3664.8	4160.0	9.4127
190	1.4978	2634.0	2843.7	7.6131	820	3.6028	3702.6	4207.0	9.4561
195	1.5147	2641.6	2853.7	7.6347	840	3.6688	3740.7	4254.3	9.4990
200	1.5316	2649.2	2863.6	7.6561	860	3.7348	3779.0	4301.9	9.5414
205	1.5485	2656.8	2873.6	7.6773	880	3.8008	3817.6	4349.7	9.5832
210	1.5654	2664.4	2883.6	7.6985	900	3.8668	3856.5	4397.9	9.6246
215	1.5822	2672.0	2893.5	7.7189	920	3.9327	3895.6	4446.2	9.6655
220	1.6000	2680.0	2903.5	7.7393	940	3.9987	3935.1	4494.9	9.7059
225	1.6158	2687.2	2913.4	7.7597	960	4.0647	3974.7	4543.8	9.7459
230	1.6316	2695.0	2923.4	7.7801	980	4.1307	4014.7	4593.0	9.7855
235	1.6493	2702.4	2933.3	7.7996	1000	4.1966	4054.9	4642.4	9.8246
240	1.6670	2710.0	2943.3	7.8190					
245	1.6828	2717.6	2953.2	7.8389					
250	1.7000	2725.0	2963.2	7.8583					
255	1.7163	2732.9	2973.2	7.8774					
260	1.7326	2740.0	2983.2	7.8963					
265	1.7497	2748.2	2993.2	7.9153					
270	1.7668	2756.0	3003.2	7.9342					

Water/Steam at $p = 0.15$ MPa ($T_{\text{sat}} = 111.349^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100013	-0.04	0.11	-0.00014	270	1.6637	2763.3	3012.9	7.9202
5	0.00100001	21.02	21.17	0.07625	280	1.6949	2778.8	3033.0	7.9569
10	0.00100027	42.02	42.17	0.15107	290	1.7260	2794.2	3053.1	7.9929
15	0.00100088	62.97	63.12	0.22444	300	1.7571	2809.7	3073.3	8.0284
20	0.00100177	83.90	84.05	0.29645	310	1.7882	2825.3	3093.5	8.0634
25	0.00100294	104.82	104.97	0.36719	320	1.8192	2840.9	3113.8	8.0978
30	0.00100435	125.72	125.87	0.43671	330	1.8503	2856.6	3134.1	8.1318
35	0.00100598	146.61	146.76	0.50508	340	1.8813	2872.3	3154.5	8.1653
40	0.00100782	167.51	167.66	0.57235	350	1.9123	2888.1	3174.9	8.1983
45	0.00100986	188.41	188.56	0.63855	360	1.9433	2903.8	3195.3	8.2309
50	0.00101209	209.31	209.46	0.70374	370	1.9743	2919.8	3215.9	8.2631
55	0.00101449	230.22	230.37	0.76796	380	2.0052	2935.6	3236.4	8.2948
60	0.00101707	251.14	251.29	0.83122	390	2.0362	2951.7	3257.1	8.3262
65	0.00101981	272.07	272.22	0.89358	400	2.0671	2967.7	3277.8	8.3572
70	0.00102272	293.01	293.16	0.95506	410	2.0981	2983.8	3298.5	8.3878
75	0.00102578	313.97	314.12	1.0157	420	2.1290	3000.0	3319.4	8.4180
80	0.00102901	334.94	335.09	1.0755	430	2.1599	3016.3	3340.3	8.4480
85	0.00103238	355.94	356.09	1.1345	440	2.1908	3032.6	3361.2	8.4775
90	0.00103591	376.94	377.10	1.1928	450	2.2217	3048.9	3382.2	8.5068
95	0.00103960	397.98	398.14	1.2503	460	2.2526	3065.4	3403.3	8.5357
100	0.00104344	419.04	419.20	1.3072	470	2.2835	3081.9	3424.4	8.5644
105	0.00104743	440.14	440.30	1.3633	480	2.3144	3098.4	3445.6	8.5927
110	0.00105158	461.26	461.42	1.4188	490	2.3453	3115.1	3466.9	8.6207
111.349	0.00105273	466.97	467.13	1.4337	500	2.3761	3131.8	3488.2	8.6485
111.349	1.1593	2519.2	2693.1	7.2230	520	2.4379	3165.4	3531.1	8.7032
115	1.1714	2525.1	2700.8	7.2430	540	2.4996	3199.3	3574.2	8.7569
120	1.1880	2533.2	2711.4	7.2699	560	2.5613	3233.4	3617.6	8.8096
125	1.2044	2541.1	2721.8	7.2962	580	2.6230	3267.8	3661.2	8.8614
130	1.2208	2549.0	2732.1	7.3220	600	2.6846	3302.5	3705.2	8.9124
135	1.2370	2556.8	2742.4	7.3473	620	2.7463	3337.5	3749.4	8.9624
140	1.2533	2564.6	2752.6	7.3722	640	2.8080	3372.7	3793.9	9.0117
145	1.2694	2572.4	2762.8	7.3967	660	2.8696	3408.3	3838.7	9.0602
150	1.2855	2580.1	2772.9	7.4208	680	2.9312	3444.0	3883.7	9.1080
155	1.3016	2587.8	2783.0	7.4445	700	2.9929	3480.2	3929.1	9.1550
160	1.3176	2595.5	2793.1	7.4679	720	3.0545	3516.5	3974.7	9.2014
165	1.3335	2603.1	2803.1	7.4910	740	3.1161	3553.2	4020.6	9.2472
170	1.3495	2610.8	2813.2	7.5138	760	3.1777	3590.1	4066.8	9.2923
175	1.3654	2618.4	2823.2	7.5363	780	3.2394	3627.3	4113.2	9.3369
180	1.3813	2626.0	2833.2	7.5585	800	3.3010	3664.9	4160.0	9.3808
185	1.3971	2633.6	2843.2	7.5804	820	3.3626	3702.6	4207.0	9.4243
190	1.4129	2641.3	2853.2	7.6021	840	3.4242	3740.7	4254.3	9.4671
195	1.4287	2648.8	2863.1	7.6235	860	3.4858	3779.0	4301.9	9.5095
200	1.4445	2656.4	2873.1	7.6447	880	3.5473	3817.6	4349.7	9.5513
210	1.4760	2671.6	2893.0	7.6864	900	3.6089	3856.5	4397.8	9.5927
220	1.5074	2686.9	2913.0	7.7272	920	3.6705	3895.6	4446.2	9.6336
230	1.5388	2702.1	2932.9	7.7672	940	3.7321	3935.1	4494.9	9.6740
240	1.5701	2717.4	2952.9	7.8065	960	3.7937	3974.7	4543.8	9.7140
250	1.6013	2732.7	2972.9	7.8451	980	3.8553	4014.7	4593.0	9.7536
260	1.6325	2748.0	2992.9	7.8830	1000	3.9168	4054.9	4642.4	9.7927
270	1.6637	2763.3	3012.9	7.9202					

Water/Steam at $p = 0.16$ MPa ($T_{\text{sat}} = 113.297^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100012	-0.04	0.12	-0.00014	270	1.5593	2763.1	3012.6	7.8901
5	0.00100000	21.02	21.18	0.07625	280	1.5885	2778.5	3032.7	7.9267
10	0.00100027	42.02	42.18	0.15107	290	1.6177	2794.1	3052.9	7.9628
15	0.00100087	62.97	63.13	0.22444	300	1.6469	2809.6	3073.1	7.9983
20	0.00100177	83.90	84.06	0.29645	310	1.6760	2825.1	3093.3	8.0333
25	0.00100293	104.81	104.97	0.36718	320	1.7052	2840.8	3113.6	8.0678
30	0.00100434	125.72	125.88	0.43671	330	1.7343	2856.4	3133.9	8.1018
35	0.00100598	146.61	146.77	0.50508	340	1.7634	2872.1	3154.2	8.1353
40	0.00100782	167.51	167.67	0.57234	350	1.7925	2887.9	3174.7	8.1683
45	0.00100986	188.41	188.57	0.63855	360	1.8215	2903.8	3195.2	8.2009
50	0.00101208	209.31	209.47	0.70374	370	1.8506	2919.6	3215.7	8.2331
55	0.00101449	230.22	230.38	0.76795	380	1.8796	2935.6	3236.3	8.2649
60	0.00101706	251.14	251.30	0.83122	390	1.9087	2951.5	3256.9	8.2962
65	0.00101981	272.07	272.23	0.89358	400	1.9377	2967.6	3277.6	8.3272
70	0.00102271	293.01	293.17	0.95506	410	1.9667	2983.7	3298.4	8.3578
75	0.00102578	313.97	314.13	1.0157	420	1.9957	2999.9	3319.2	8.3881
80	0.00102900	334.94	335.10	1.0755	430	2.0247	3016.1	3340.1	8.4180
85	0.00103238	355.92	356.09	1.1345	440	2.0537	3032.5	3361.1	8.4476
90	0.00103591	376.94	377.11	1.1928	450	2.0826	3048.9	3382.1	8.4769
95	0.00103959	397.98	398.15	1.2503	460	2.1116	3065.3	3403.2	8.5058
100	0.00104343	419.04	419.21	1.3072	470	2.1406	3081.8	3424.3	8.5344
105	0.00104742	440.13	440.30	1.3633	480	2.1695	3098.4	3445.5	8.5628
110	0.00105157	461.26	461.43	1.4188	490	2.1985	3115.0	3466.8	8.5908
113.297	0.00105440	475.21	475.38	1.4551	500	2.2274	3131.7	3488.1	8.6186
113.297	1.0914	2521.4	2696.0	7.2014	520	2.2853	3165.4	3531.0	8.6734
115	1.0967	2524.2	2699.7	7.2108	540	2.3432	3199.2	3574.1	8.7271
120	1.1123	2532.3	2710.3	7.2379	560	2.4011	3233.3	3617.5	8.7798
125	1.1278	2540.3	2720.7	7.2644	580	2.4589	3267.8	3661.2	8.8316
130	1.1432	2548.2	2731.1	7.2904	600	2.5167	3302.4	3705.1	8.8825
135	1.1585	2556.1	2741.5	7.3158	620	2.5745	3337.4	3749.3	8.9326
140	1.1738	2563.9	2751.7	7.3408	640	2.6324	3372.6	3793.8	8.9819
145	1.1890	2571.8	2762.0	7.3654	660	2.6902	3408.2	3838.6	9.0304
150	1.2041	2579.4	2772.1	7.3896	680	2.7480	3444.0	3883.7	9.0781
155	1.2192	2587.2	2782.3	7.4135	700	2.8057	3480.1	3929.0	9.1252
160	1.2343	2594.9	2792.4	7.4369	720	2.8635	3516.4	3974.6	9.1716
165	1.2493	2602.6	2802.5	7.4601	740	2.9213	3553.1	4020.5	9.2174
170	1.2642	2610.2	2812.5	7.4829	760	2.9791	3590.0	4066.7	9.2625
175	1.2792	2617.9	2822.6	7.5055	780	3.0368	3627.3	4113.2	9.3071
180	1.2941	2625.5	2832.6	7.5277	800	3.0946	3664.8	4159.9	9.3510
185	1.3090	2633.2	2842.6	7.5497	820	3.1523	3702.6	4207.0	9.3944
190	1.3238	2640.8	2852.6	7.5714	840	3.2101	3740.7	4254.3	9.4373
195	1.3387	2648.4	2862.6	7.5929	860	3.2679	3778.9	4301.8	9.4797
200	1.3535	2656.0	2872.6	7.6141	880	3.3256	3817.6	4349.7	9.5215
210	1.3831	2671.3	2892.6	7.6559	900	3.3833	3856.5	4397.8	9.5629
220	1.4126	2686.6	2912.6	7.6968	920	3.4411	3895.6	4446.2	9.6038
230	1.4420	2701.8	2932.5	7.7369	940	3.4988	3935.0	4494.8	9.6442
240	1.4714	2717.1	2952.5	7.7762	960	3.5566	3974.7	4543.8	9.6842
250	1.5007	2732.4	2972.5	7.8148	980	3.6143	4014.6	4592.9	9.7238
260	1.5300	2747.8	2992.6	7.8528	1000	3.6720	4054.9	4642.4	9.7629
270	1.5593	2763.1	3012.6	7.8901					

Water/Steam at $p = 0.18$ MPa ($T_{\text{sat}} = 116.911^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100012	-0.04	0.14	-0.00014	270	1.3852	2762.8	3012.1	7.8349
5	0.00099999	21.02	21.20	0.07625	280	1.4112	2778.2	3032.2	7.8716
10	0.00100026	42.02	42.20	0.15107	290	1.4372	2793.7	3052.4	7.9078
15	0.00100086	62.97	63.15	0.22444	300	1.4632	2809.2	3072.6	7.9433
20	0.00100176	83.90	84.08	0.29645	310	1.4891	2824.8	3092.8	7.9784
25	0.00100293	104.81	104.99	0.36718	320	1.5151	2840.4	3113.1	8.0129
30	0.00100433	125.71	125.89	0.43670	330	1.5410	2856.1	3133.5	8.0469
35	0.00100597	146.61	146.79	0.50507	340	1.5669	2871.8	3153.8	8.0804
40	0.00100781	167.51	167.69	0.57233	350	1.5927	2887.6	3174.3	8.1135
45	0.00100985	188.40	188.58	0.63854	360	1.6186	2903.5	3194.8	8.1461
50	0.00101207	209.31	209.49	0.70373	370	1.6445	2919.3	3215.3	8.1783
55	0.00101448	230.22	230.40	0.76794	380	1.6703	2935.2	3235.9	8.2101
60	0.00101706	251.13	251.31	0.83121	390	1.6961	2951.3	3256.6	8.2415
65	0.00101980	272.06	272.24	0.89356	400	1.7219	2967.4	3277.3	8.2725
70	0.00102270	293.01	293.19	0.95504	410	1.7477	2983.5	3298.1	8.3032
75	0.00102577	313.96	314.14	1.0157	420	1.7735	2999.7	3318.9	8.3334
80	0.00102899	334.93	335.12	1.0755	430	1.7993	3015.9	3339.8	8.3634
85	0.00103237	355.92	356.11	1.1345	440	1.8251	3032.3	3360.8	8.3930
90	0.00103590	376.93	377.12	1.1928	450	1.8509	3048.6	3381.8	8.4222
95	0.00103958	397.97	398.16	1.2503	460	1.8766	3065.1	3402.9	8.4512
100	0.00104342	419.04	419.23	1.3071	470	1.9024	3081.7	3424.1	8.4799
105	0.00104741	440.13	440.32	1.3633	480	1.9282	3098.2	3445.3	8.5082
110	0.00105156	461.25	461.44	1.4188	490	1.9539	3114.8	3466.5	8.5363
115	0.00105587	482.41	482.60	1.4737	500	1.9797	3131.6	3487.9	8.5641
116.911	0.00105756	490.51	490.70	1.4945	520	2.0311	3165.2	3530.8	8.6188
116.911	0.97747	2525.5	2701.4	7.1621	540	2.0826	3199.0	3573.9	8.6725
120	0.98612	2530.5	2708.0	7.1790	560	2.1340	3233.2	3617.3	8.7253
125	1.0000	2538.7	2718.7	7.2059	580	2.1855	3267.6	3661.0	8.7771
130	1.0139	2546.7	2729.2	7.2322	600	2.2369	3302.4	3705.0	8.8280
135	1.0276	2554.7	2739.7	7.2580	620	2.2883	3337.3	3749.2	8.8781
140	1.0413	2562.6	2750.0	7.2832	640	2.3397	3372.6	3793.7	8.9274
145	1.0549	2570.5	2760.4	7.3081	660	2.3911	3408.1	3838.5	8.9759
150	1.0684	2578.3	2770.6	7.3325	680	2.4425	3444.0	3883.6	9.0237
155	1.0819	2586.2	2780.9	7.3565	700	2.4938	3480.0	3928.9	9.0708
160	1.0954	2593.8	2791.0	7.3801	720	2.5452	3516.4	3974.5	9.1172
165	1.1088	2601.6	2801.2	7.4034	740	2.5966	3553.0	4020.4	9.1629
170	1.1222	2609.3	2811.3	7.4264	760	2.6479	3590.0	4066.6	9.2081
175	1.1355	2617.0	2821.4	7.4491	780	2.6993	3627.2	4113.1	9.2526
180	1.1488	2624.7	2831.5	7.4714	800	2.7506	3664.7	4159.8	9.2966
185	1.1621	2632.4	2841.6	7.4935	820	2.8020	3702.5	4206.9	9.3400
190	1.1754	2640.0	2851.6	7.5154	840	2.8533	3740.6	4254.2	9.3829
195	1.1886	2647.8	2861.7	7.5369	860	2.9047	3778.9	4301.7	9.4253
200	1.2018	2655.4	2871.7	7.5582	880	2.9560	3817.5	4349.6	9.4671
210	1.2282	2670.6	2891.7	7.6002	900	3.0073	3856.4	4397.7	9.5085
220	1.2545	2686.0	2911.8	7.6412	920	3.0587	3895.5	4446.1	9.5494
230	1.2807	2701.3	2931.8	7.6814	940	3.1100	3935.0	4494.8	9.5898
240	1.3069	2716.6	2951.8	7.7208	960	3.1613	3974.7	4543.7	9.6298
250	1.3330	2732.0	2971.9	7.7595	980	3.2127	4014.6	4592.9	9.6694
260	1.3591	2747.3	2991.9	7.7975	1000	3.2640	4054.8	4642.3	9.7085
270	1.3852	2762.8	3012.1	7.8349					

Water/Steam at $p = 0.20$ MPa ($T_{\text{sat}} = 120.210^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100011	-0.04	0.16	-0.00014	270	1.2459	2762.3	3011.5	7.7855
5	0.00099998	21.02	21.22	0.07625	280	1.2694	2777.7	3031.6	7.8223
10	0.00100025	42.02	42.22	0.15107	290	1.2928	2793.2	3051.8	7.8584
15	0.00100085	62.97	63.17	0.22443	300	1.3162	2808.9	3072.1	7.8941
20	0.00100175	83.90	84.10	0.29644	310	1.3396	2824.4	3092.3	7.9291
25	0.00100292	104.81	105.01	0.36717	320	1.3630	2840.1	3112.7	7.9637
30	0.00100433	125.71	125.91	0.43670	330	1.3863	2855.7	3133.0	7.9977
35	0.00100596	146.61	146.81	0.50506	340	1.4097	2871.5	3153.4	8.0313
40	0.00100780	167.50	167.70	0.57233	350	1.4330	2887.3	3173.9	8.0644
45	0.00100984	188.40	188.60	0.63853	360	1.4563	2903.1	3194.4	8.0971
50	0.00101207	209.30	209.50	0.70372	370	1.4795	2919.1	3215.0	8.1293
55	0.00101447	230.21	230.41	0.76793	380	1.5028	2935.0	3235.6	8.1611
60	0.00101705	251.13	251.33	0.83120	390	1.5261	2951.1	3256.3	8.1925
65	0.00101979	272.06	272.26	0.89355	400	1.5493	2967.1	3277.0	8.2236
70	0.00102270	293.00	293.20	0.95503	410	1.5726	2983.3	3297.8	8.2542
75	0.00102576	313.95	314.16	1.0157	420	1.5958	2999.5	3318.7	8.2845
80	0.00102898	334.92	335.13	1.0755	430	1.6190	3015.8	3339.6	8.3145
85	0.00103236	355.92	356.13	1.1345	440	1.6422	3032.1	3360.5	8.3441
90	0.00103589	376.93	377.14	1.1928	450	1.6655	3048.5	3381.6	8.3734
95	0.00103957	397.97	398.18	1.2503	460	1.6887	3065.0	3402.7	8.4023
100	0.00104341	419.03	419.24	1.3071	470	1.7119	3081.4	3423.8	8.4310
105	0.00104740	440.12	440.33	1.3633	480	1.7351	3098.0	3445.0	8.4594
110	0.00105155	461.25	461.46	1.4188	490	1.7582	3114.7	3466.3	8.4874
115	0.00105586	482.41	482.62	1.4736	500	1.7814	3131.4	3487.7	8.5152
120	0.00106032	503.60	503.81	1.5279	520	1.8278	3165.0	3530.6	8.5700
120.210	0.00106052	504.49	504.70	1.5302	540	1.8741	3198.9	3573.7	8.6237
120.210	0.88568	2529.1	2706.2	7.1269	560	1.9204	3233.0	3617.1	8.6765
125	0.89781	2537.0	2716.6	7.1531	580	1.9667	3267.5	3660.8	8.7283
130	0.91037	2545.2	2727.3	7.1797	600	2.0130	3302.2	3704.8	8.7792
135	0.92284	2553.2	2737.8	7.2058	620	2.0593	3337.1	3749.0	8.8293
140	0.93524	2561.3	2748.3	7.2313	640	2.1056	3372.5	3793.6	8.8786
145	0.94758	2569.2	2758.7	7.2564	660	2.1518	3408.0	3838.4	8.9272
150	0.95986	2577.1	2769.1	7.2810	680	2.1981	3443.8	3883.4	8.9750
155	0.97208	2585.0	2779.4	7.3052	700	2.2443	3479.9	3928.8	9.0220
160	0.98426	2592.8	2789.7	7.3290	720	2.2906	3516.3	3974.4	9.0685
165	0.99640	2600.6	2799.9	7.3525	740	2.3368	3552.9	4020.3	9.1142
170	1.0085	2608.4	2810.1	7.3756	760	2.3830	3589.9	4066.5	9.1594
175	1.0206	2616.1	2820.2	7.3984	780	2.4293	3627.1	4113.0	9.2039
180	1.0326	2623.9	2830.4	7.4209	800	2.4755	3664.7	4159.8	9.2479
185	1.0446	2631.6	2840.5	7.4431	820	2.5217	3702.5	4206.8	9.2913
190	1.0566	2639.3	2850.6	7.4650	840	2.5679	3740.5	4254.1	9.3342
195	1.0685	2647.0	2860.7	7.4867	860	2.6141	3778.9	4301.7	9.3766
200	1.0805	2654.6	2870.7	7.5081	880	2.6603	3817.4	4349.5	9.4184
210	1.1043	2669.9	2890.8	7.5501	900	2.7066	3856.3	4397.6	9.4598
220	1.1280	2685.3	2910.9	7.5913	920	2.7528	3895.4	4446.0	9.5007
230	1.1517	2700.7	2931.0	7.6316	940	2.7990	3934.9	4494.7	9.5412
240	1.1753	2716.0	2951.1	7.6712	960	2.8451	3974.6	4543.6	9.5812
250	1.1989	2731.4	2971.2	7.7100	980	2.8913	4014.5	4592.8	9.6207
260	1.2224	2746.8	2991.3	7.7480	1000	2.9375	4054.8	4642.3	9.6599
270	1.2459	2762.3	3011.5	7.7855					

Water/Steam at $p = 0.22$ MPa ($T_{\text{sat}} = 123.250^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100010	-0.04	0.18	-0.00014	270	1.1320	2761.9	3010.9	7.7407
5	0.00099998	21.02	21.24	0.07625	280	1.1533	2777.4	3031.1	7.7775
10	0.00100024	42.01	42.23	0.15107	290	1.1747	2792.9	3051.3	7.8138
15	0.00100084	62.97	63.19	0.22443	300	1.1960	2808.5	3071.6	7.8494
20	0.00100174	83.90	84.12	0.29644	310	1.2173	2824.1	3091.9	7.8845
25	0.00100291	104.81	105.03	0.36717	320	1.2385	2839.7	3112.2	7.9191
30	0.00100432	125.71	125.93	0.43669	330	1.2598	2855.4	3132.6	7.9532
35	0.00100595	146.61	146.83	0.50506	340	1.2810	2871.2	3153.0	7.9868
40	0.00100779	167.50	167.72	0.57232	350	1.3022	2887.0	3173.5	8.0200
45	0.00100983	188.40	188.62	0.63852	360	1.3234	2902.9	3194.0	8.0526
50	0.00101206	209.30	209.52	0.70371	370	1.3446	2918.8	3214.6	8.0849
55	0.00101446	230.21	230.43	0.76792	380	1.3658	2934.8	3235.3	8.1167
60	0.00101704	251.13	251.35	0.83119	390	1.3870	2950.9	3256.0	8.1482
65	0.00101978	272.06	272.28	0.89354	400	1.4081	2966.9	3276.7	8.1792
70	0.00102269	292.99	293.22	0.95502	410	1.4293	2983.1	3297.5	8.2099
75	0.00102575	313.95	314.18	1.0157	420	1.4504	2999.3	3318.4	8.2402
80	0.00102897	334.92	335.15	1.0755	430	1.4715	3015.6	3339.3	8.2702
85	0.00103235	355.91	356.14	1.1345	440	1.4926	3031.9	3360.3	8.2998
90	0.00103588	376.93	377.16	1.1928	450	1.5138	3048.3	3381.3	8.3291
95	0.00103956	397.96	398.19	1.2503	460	1.5349	3064.7	3402.4	8.3581
100	0.00104340	419.03	419.26	1.3071	470	1.5560	3081.3	3423.6	8.3868
105	0.00104739	440.12	440.35	1.3633	480	1.5771	3097.8	3444.8	8.4151
110	0.00105154	461.24	461.47	1.4188	490	1.5981	3114.5	3466.1	8.4432
115	0.00105585	482.40	482.63	1.4736	500	1.6192	3131.3	3487.5	8.4710
120	0.00106031	503.60	503.83	1.5279	520	1.6614	3164.9	3530.4	8.5258
123.250	0.00106330	517.40	517.63	1.5628	540	1.7035	3198.7	3573.5	8.5796
123.250	0.81007	2532.4	2710.6	7.0951	560	1.7456	3233.0	3617.0	8.6323
125	0.81414	2535.3	2714.4	7.1047	580	1.7877	3267.4	3660.7	8.6842
130	0.82567	2543.7	2725.3	7.1318	600	1.8298	3302.0	3704.6	8.7351
135	0.83712	2551.8	2736.0	7.1582	620	1.8719	3337.1	3748.9	8.7852
140	0.84848	2559.9	2746.6	7.1840	640	1.9140	3372.3	3793.4	8.8345
145	0.85978	2567.9	2757.1	7.2093	660	1.9561	3407.9	3838.2	8.8831
150	0.87102	2576.0	2767.6	7.2341	680	1.9981	3443.7	3883.3	8.9309
155	0.88220	2583.8	2777.9	7.2585	700	2.0402	3479.9	3928.7	8.9780
160	0.89334	2591.8	2788.3	7.2825	720	2.0822	3516.2	3974.3	9.0244
165	0.90444	2599.6	2798.6	7.3062	740	2.1243	3552.9	4020.2	9.0702
170	0.91550	2607.4	2808.8	7.3294	760	2.1663	3589.8	4066.4	9.1153
175	0.92652	2615.2	2819.0	7.3524	780	2.2083	3627.1	4112.9	9.1599
180	0.93751	2622.9	2829.2	7.3750	800	2.2504	3664.6	4159.7	9.2039
185	0.94847	2630.7	2839.4	7.3973	820	2.2924	3702.4	4206.7	9.2473
190	0.95941	2638.4	2849.5	7.4193	840	2.3344	3740.4	4254.0	9.2902
195	0.97032	2646.2	2859.7	7.4411	860	2.3764	3778.8	4301.6	9.3325
200	0.98120	2653.9	2869.8	7.4625	880	2.4184	3817.4	4349.4	9.3744
210	1.0029	2669.4	2890.0	7.5048	900	2.4604	3856.3	4397.6	9.4158
220	1.0246	2684.7	2910.1	7.5461	920	2.5025	3895.4	4446.0	9.4567
230	1.0461	2700.2	2930.3	7.5865	940	2.5445	3934.8	4494.6	9.4971
240	1.0677	2715.5	2950.4	7.6261	960	2.5865	3974.6	4543.6	9.5371
250	1.0891	2730.9	2970.5	7.6650	980	2.6285	4014.5	4592.8	9.5767
260	1.1106	2746.4	2990.7	7.7032	1000	2.6705	4054.7	4642.2	9.6159
270	1.1320	2761.9	3010.9	7.7407					

Water/Steam at $p = 0.24$ MPa ($T_{\text{sat}} = 126.072^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100009	-0.04	0.20	-0.00014	270	1.0370	2761.4	3010.3	7.6997
5	0.00099997	21.02	21.26	0.07625	280	1.0566	2776.9	3030.5	7.7366
10	0.00100023	42.01	42.25	0.15106	290	1.0762	2792.5	3050.8	7.7729
15	0.00100083	62.97	63.21	0.22443	300	1.0958	2808.1	3071.1	7.8086
20	0.00100173	83.90	84.14	0.29643	310	1.1153	2823.7	3091.4	7.8438
25	0.00100290	104.81	105.05	0.36716	320	1.1348	2839.4	3111.8	7.8784
30	0.00100431	125.71	125.95	0.43668	330	1.1543	2855.2	3132.2	7.9125
35	0.00100594	146.60	146.84	0.50505	340	1.1738	2870.9	3152.6	7.9462
40	0.00100778	167.50	167.74	0.57231	350	1.1933	2886.7	3173.1	7.9793
45	0.00100982	188.40	188.64	0.63852	360	1.2128	2902.6	3193.7	8.0121
50	0.00101205	209.30	209.54	0.70370	370	1.2322	2918.6	3214.3	8.0443
55	0.00101445	230.21	230.45	0.76791	380	1.2516	2934.5	3234.9	8.0762
60	0.00101703	251.13	251.37	0.83118	390	1.2710	2950.6	3255.6	8.1077
65	0.00101977	272.05	272.29	0.89353	400	1.2904	2966.7	3276.4	8.1387
70	0.00102268	292.99	293.24	0.95501	410	1.3098	2982.8	3297.2	8.1694
75	0.00102574	313.94	314.19	1.0156	420	1.3292	2999.1	3318.1	8.1998
80	0.00102896	334.92	335.17	1.0755	430	1.3486	3015.3	3339.0	8.2297
85	0.00103234	355.91	356.16	1.1345	440	1.3680	3031.7	3360.0	8.2594
90	0.00103587	376.92	377.17	1.1927	450	1.3873	3048.1	3381.1	8.2887
95	0.00103955	397.96	398.21	1.2503	460	1.4067	3064.6	3402.2	8.3177
100	0.00104339	419.02	419.27	1.3071	470	1.4260	3081.1	3423.3	8.3464
105	0.00104738	440.11	440.36	1.3633	480	1.4454	3097.7	3444.6	8.3748
110	0.00105153	461.24	461.49	1.4187	490	1.4647	3114.4	3465.9	8.4029
115	0.00105584	482.39	482.64	1.4736	500	1.4841	3131.0	3487.2	8.4307
120	0.00106030	503.59	503.84	1.5279	520	1.5227	3164.8	3530.2	8.4855
125	0.00106493	524.82	525.08	1.5816	540	1.5614	3198.6	3573.3	8.5392
126.072	0.00106594	529.38	529.64	1.5930	560	1.6000	3232.8	3616.8	8.5920
126.072	0.74668	2535.4	2714.6	7.0661	580	1.6386	3267.2	3660.5	8.6439
130	0.75507	2542.0	2723.2	7.0876	600	1.6772	3302.0	3704.5	8.6948
135	0.76566	2550.3	2734.1	7.1143	620	1.7158	3336.9	3748.7	8.7449
140	0.77616	2558.5	2744.8	7.1405	640	1.7544	3372.2	3793.3	8.7943
145	0.78660	2566.6	2755.4	7.1660	660	1.7929	3407.8	3838.1	8.8428
150	0.79697	2574.7	2766.0	7.1911	680	1.8315	3443.6	3883.2	8.8906
155	0.80729	2582.8	2776.5	7.2157	700	1.8701	3479.7	3928.5	8.9377
160	0.81757	2590.7	2786.9	7.2399	720	1.9086	3516.1	3974.2	8.9841
165	0.82779	2598.5	2797.2	7.2636	740	1.9472	3552.8	4020.1	9.0299
170	0.83798	2606.5	2807.6	7.2871	760	1.9857	3589.7	4066.3	9.0751
175	0.84814	2614.2	2817.8	7.3101	780	2.0242	3627.0	4112.8	9.1196
180	0.85826	2622.1	2828.1	7.3329	800	2.0628	3664.5	4159.6	9.1636
185	0.86835	2629.9	2838.3	7.3553	820	2.1013	3702.3	4206.6	9.2071
190	0.87841	2637.7	2848.5	7.3774	840	2.1398	3740.3	4253.9	9.2499
195	0.88845	2645.5	2858.7	7.3993	860	2.1783	3778.7	4301.5	9.2923
200	0.89847	2653.2	2868.8	7.4208	880	2.2168	3817.4	4349.4	9.3342
210	0.91843	2668.7	2889.1	7.4632	900	2.2554	3856.2	4397.5	9.3756
220	0.93833	2684.1	2909.3	7.5046	920	2.2939	3895.4	4445.9	9.4165
230	0.95816	2699.5	2929.5	7.5452	940	2.3324	3934.8	4494.6	9.4569
240	0.97794	2715.0	2949.7	7.5849	960	2.3709	3974.5	4543.5	9.4969
250	0.99767	2730.5	2969.9	7.6239	980	2.4094	4014.4	4592.7	9.5365
260	1.0174	2745.9	2990.1	7.6621	1000	2.4479	4054.7	4642.2	9.5757
270	1.0370	2761.4	3010.3	7.6997					

Water/Steam at $p = 0.26$ MPa ($T_{\text{sat}} = 128.708^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100008	-0.04	0.22	-0.00014
5	0.00099996	21.02	21.28	0.07625
10	0.00100022	42.01	42.27	0.15106
15	0.00100082	62.97	63.23	0.22442
20	0.00100172	83.90	84.16	0.29643
25	0.00100289	104.81	105.07	0.36716
30	0.00100430	125.71	125.97	0.43668
35	0.00100593	146.60	146.86	0.50504
40	0.00100777	167.50	167.76	0.57230
45	0.00100981	188.39	188.65	0.63851
50	0.00101204	209.30	209.56	0.70369
55	0.00101444	230.20	230.46	0.76790
60	0.00101702	251.12	251.38	0.83117
65	0.00101976	272.04	272.31	0.89352
70	0.00102267	292.98	293.25	0.95500
75	0.00102573	313.94	314.21	1.0156
80	0.00102895	334.91	335.18	1.0754
85	0.00103233	355.90	356.17	1.1345
90	0.00103586	376.92	377.19	1.1927
95	0.00103954	397.95	398.22	1.2503
100	0.00104338	419.02	419.29	1.3071
105	0.00104737	440.11	440.38	1.3632
110	0.00105152	461.23	461.50	1.4187
115	0.00105583	482.39	482.66	1.4736
120	0.00106029	503.57	503.85	1.5279
125	0.00106492	524.81	525.09	1.5815
128.708	0.00106846	540.59	540.87	1.6210
128.708	0.69273	2538.2	2718.3	7.0394
130	0.69530	2540.4	2721.2	7.0465
135	0.70517	2548.9	2732.2	7.0736
140	0.71495	2557.1	2743.0	7.1001
145	0.72466	2565.4	2753.8	7.1259
150	0.73431	2573.5	2764.4	7.1512
155	0.74390	2581.6	2775.0	7.1760
160	0.75344	2589.6	2785.5	7.2004
165	0.76293	2597.5	2795.9	7.2243
170	0.77239	2605.5	2806.3	7.2479
175	0.78181	2613.3	2816.6	7.2711
180	0.79119	2621.2	2826.9	7.2940
185	0.80055	2629.1	2837.2	7.3165
190	0.80987	2636.8	2847.4	7.3387
195	0.81917	2644.6	2857.6	7.3607
200	0.82845	2652.4	2867.8	7.3823
210	0.84695	2668.0	2888.2	7.4249
220	0.86537	2683.5	2908.5	7.4664
230	0.88372	2698.9	2928.7	7.5071
240	0.90203	2714.5	2949.0	7.5469
250	0.92028	2729.9	2969.2	7.5860
260	0.93849	2745.4	2989.4	7.6243
270	0.95666	2761.0	3009.7	7.6619

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.95666	2761.0	3009.7	7.6619
280	0.97481	2776.5	3030.0	7.6989
290	0.99292	2792.1	3050.3	7.7353
300	1.0110	2807.7	3070.6	7.7710
310	1.0291	2823.3	3090.9	7.8063
320	1.0471	2839.1	3111.3	7.8409
330	1.0651	2854.9	3131.8	7.8751
340	1.0831	2870.6	3152.2	7.9087
350	1.1011	2886.4	3172.7	7.9419
360	1.1191	2902.3	3193.3	7.9747
370	1.1371	2918.3	3213.9	8.0070
380	1.1550	2934.3	3234.6	8.0389
390	1.1729	2950.3	3255.3	8.0704
400	1.1909	2966.5	3276.1	8.1014
410	1.2088	2982.6	3296.9	8.1322
420	1.2267	2998.9	3317.8	8.1625
430	1.2446	3015.1	3338.7	8.1925
440	1.2625	3031.4	3359.7	8.2222
450	1.2804	3047.9	3380.8	8.2515
460	1.2982	3064.4	3401.9	8.2805
470	1.3161	3080.9	3423.1	8.3092
480	1.3340	3097.6	3444.4	8.3376
490	1.3518	3114.2	3465.7	8.3657
500	1.3697	3130.9	3487.0	8.3935
520	1.4054	3164.6	3530.0	8.4483
540	1.4411	3198.5	3573.2	8.5021
560	1.4767	3232.7	3616.6	8.5549
580	1.5124	3267.1	3660.3	8.6068
600	1.5480	3301.8	3704.3	8.6578
620	1.5837	3336.8	3748.6	8.7079
640	1.6193	3372.1	3793.1	8.7572
660	1.6549	3407.7	3838.0	8.8057
680	1.6905	3443.6	3883.1	8.8536
700	1.7261	3479.6	3928.4	8.9007
720	1.7617	3516.1	3974.1	8.9471
740	1.7973	3552.7	4020.0	8.9929
760	1.8329	3589.6	4066.2	9.0381
780	1.8684	3626.9	4112.7	9.0826
800	1.9040	3664.5	4159.5	9.1266
820	1.9396	3702.2	4206.5	9.1700
840	1.9752	3740.2	4253.8	9.2129
860	2.0107	3778.6	4301.4	9.2553
880	2.0463	3817.3	4349.3	9.2972
900	2.0818	3856.1	4397.4	9.3386
920	2.1174	3895.3	4445.8	9.3795
940	2.1529	3934.7	4494.5	9.4199
960	2.1885	3974.4	4543.4	9.4599
980	2.2240	4014.4	4592.6	9.4995
1000	2.2596	4054.6	4642.1	9.5387

Water/Steam at $p = 0.28$ MPa ($T_{\text{sat}} = 131.185^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100007	-0.04	0.24	-0.00014	270	0.88779	2760.5	3009.1	7.6269
5	0.00099995	21.02	21.30	0.07625	280	0.90467	2776.1	3029.4	7.6640
10	0.00100021	42.01	42.29	0.15106	290	0.92151	2791.7	3049.7	7.7004
15	0.00100081	62.97	63.25	0.22442	300	0.93833	2807.4	3070.1	7.7362
20	0.00100171	83.90	84.18	0.29643	310	0.95512	2823.1	3090.5	7.7714
25	0.00100288	104.81	105.09	0.36715	320	0.97190	2838.8	3110.9	7.8062
30	0.00100429	125.71	125.99	0.43667	330	0.98865	2854.5	3131.3	7.8404
35	0.00100592	146.60	146.88	0.50503	340	1.0054	2870.3	3151.8	7.8741
40	0.00100777	167.49	167.77	0.57230	350	1.0221	2886.2	3172.4	7.9073
45	0.00100980	188.39	188.67	0.63850	360	1.0388	2902.0	3192.9	7.9400
50	0.00101203	209.29	209.57	0.70368	370	1.0555	2918.1	3213.6	7.9724
55	0.00101443	230.20	230.48	0.76789	380	1.0722	2934.1	3234.3	8.0043
60	0.00101701	251.12	251.40	0.83115	390	1.0889	2950.1	3255.0	8.0358
65	0.00101975	272.04	272.33	0.89351	400	1.1055	2966.3	3275.8	8.0669
70	0.00102266	292.98	293.27	0.95498	410	1.1222	2982.4	3296.6	8.0976
75	0.00102572	313.93	314.22	1.0156	420	1.1388	2998.6	3317.5	8.1280
80	0.00102894	334.91	335.20	1.0754	430	1.1554	3015.0	3338.5	8.1580
85	0.00103232	355.90	356.19	1.1344	440	1.1721	3031.3	3359.5	8.1877
90	0.00103585	376.91	377.20	1.1927	450	1.1887	3047.7	3380.5	8.2170
95	0.00103953	397.95	398.24	1.2502	460	1.2053	3064.2	3401.7	8.2460
100	0.00104337	419.01	419.30	1.3071	470	1.2219	3080.8	3422.9	8.2748
105	0.00104736	440.10	440.39	1.3632	480	1.2385	3097.3	3444.1	8.3032
110	0.00105151	461.22	461.51	1.4187	490	1.2551	3114.0	3465.4	8.3313
115	0.00105581	482.37	482.67	1.4736	500	1.2717	3130.7	3486.8	8.3591
120	0.00106028	503.57	503.87	1.5278	520	1.3048	3164.5	3529.8	8.4140
125	0.00106491	524.81	525.11	1.5815	540	1.3380	3198.4	3573.0	8.4677
130	0.00106970	546.09	546.39	1.6346	560	1.3711	3232.5	3616.4	8.5206
131.185	0.00107086	551.14	551.44	1.6471	580	1.4042	3267.0	3660.2	8.5724
131.185	0.64624	2540.8	2721.7	7.0146	600	1.4373	3301.8	3704.2	8.6234
135	0.65330	2547.3	2730.2	7.0356	620	1.4704	3336.8	3748.5	8.6736
140	0.66247	2555.7	2741.2	7.0624	640	1.5035	3372.0	3793.0	8.7229
145	0.67156	2564.1	2752.1	7.0885	660	1.5366	3407.6	3837.8	8.7714
150	0.68059	2572.2	2762.8	7.1140	680	1.5697	3443.4	3882.9	8.8193
155	0.68955	2580.4	2773.5	7.1390	700	1.6027	3479.5	3928.3	8.8664
160	0.69846	2588.4	2784.0	7.1636	720	1.6358	3516.0	3974.0	8.9128
165	0.70733	2596.4	2794.5	7.1877	740	1.6688	3552.6	4019.9	8.9586
170	0.71616	2604.5	2805.0	7.2114	760	1.7019	3589.6	4066.1	9.0038
175	0.72494	2612.4	2815.4	7.2348	780	1.7349	3626.8	4112.6	9.0484
180	0.73370	2620.4	2825.8	7.2578	800	1.7680	3664.4	4159.4	9.0923
185	0.74242	2628.2	2836.1	7.2804	820	1.8010	3702.1	4206.4	9.1358
190	0.75112	2636.1	2846.4	7.3028	840	1.8340	3740.3	4253.8	9.1787
195	0.75979	2643.9	2856.6	7.3248	860	1.8670	3778.5	4301.3	9.2211
200	0.76844	2651.7	2866.9	7.3465	880	1.9001	3817.2	4349.2	9.2629
210	0.78567	2667.3	2887.3	7.3893	900	1.9331	3856.1	4397.4	9.3043
220	0.80282	2682.8	2907.6	7.4310	920	1.9661	3895.3	4445.8	9.3452
230	0.81992	2698.4	2928.0	7.4717	940	1.9991	3934.7	4494.4	9.3857
240	0.83695	2714.0	2948.3	7.5117	960	2.0321	3974.4	4543.4	9.4257
250	0.85394	2729.4	2968.5	7.5508	980	2.0651	4014.4	4592.6	9.4653
260	0.87088	2745.0	2988.8	7.5892	1000	2.0981	4054.5	4642.0	9.5044
270	0.88779	2760.5	3009.1	7.6269					

Water/Steam at $p = 0.30$ MPa ($T_{\text{sat}} = 133.522^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100006	-0.04	0.26	-0.00013
5	0.00099994	21.02	21.32	0.07625
10	0.00100020	42.01	42.31	0.15106
15	0.00100081	62.97	63.27	0.22442
20	0.00100170	83.89	84.19	0.29642
25	0.00100287	104.80	105.10	0.36715
30	0.00100428	125.70	126.00	0.43666
35	0.00100591	146.60	146.90	0.50503
40	0.00100776	167.49	167.79	0.57229
45	0.00100980	188.39	188.69	0.63849
50	0.00101202	209.29	209.59	0.70368
55	0.00101443	230.20	230.50	0.76788
60	0.00101700	251.11	251.42	0.83114
65	0.00101974	272.03	272.34	0.89350
70	0.00102265	292.98	293.29	0.95497
75	0.00102571	313.93	314.24	1.0156
80	0.00102893	334.90	335.21	1.0754
85	0.00103231	355.89	356.20	1.1344
90	0.00103584	376.91	377.22	1.1927
95	0.00103952	397.94	398.25	1.2502
100	0.00104336	419.01	419.32	1.3071
105	0.00104735	440.10	440.41	1.3632
110	0.00105150	461.21	461.53	1.4187
115	0.00105580	482.37	482.69	1.4736
120	0.00106027	503.56	503.88	1.5278
125	0.00106490	524.80	525.12	1.5815
130	0.00106969	546.08	546.40	1.6346
133.522	0.00107317	561.11	561.43	1.6717
133.522	0.60576	2543.2	2724.9	6.9916
135	0.60833	2545.7	2728.2	6.9998
140	0.61697	2554.3	2739.4	7.0269
145	0.62553	2562.6	2750.3	7.0533
150	0.63401	2571.0	2761.2	7.0791
155	0.64244	2579.2	2771.9	7.1044
160	0.65081	2587.4	2782.6	7.1291
165	0.65913	2595.5	2793.2	7.1534
170	0.66742	2603.5	2803.7	7.1773
175	0.67566	2611.5	2814.2	7.2008
180	0.68387	2619.4	2824.6	7.2239
185	0.69205	2627.4	2835.0	7.2467
190	0.70020	2635.2	2845.3	7.2691
195	0.70832	2643.1	2855.6	7.2913
200	0.71642	2651.0	2865.9	7.3131
210	0.73256	2666.6	2886.4	7.3560
220	0.74862	2682.2	2906.8	7.3978
230	0.76461	2697.8	2927.2	7.4387
240	0.78055	2713.3	2947.5	7.4788
250	0.79644	2729.0	2967.9	7.5180
260	0.81229	2744.5	2988.2	7.5565
270	0.82810	2760.1	3008.5	7.5943

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.82810	2760.1	3008.5	7.5943
280	0.84388	2775.6	3028.8	7.6314
290	0.85962	2791.3	3049.2	7.6678
300	0.87534	2807.0	3069.6	7.7037
310	0.89104	2822.7	3090.0	7.7390
320	0.90672	2838.4	3110.4	7.7738
330	0.92237	2854.2	3130.9	7.8080
340	0.93801	2870.0	3151.4	7.8417
350	0.95363	2885.9	3172.0	7.8750
360	0.96924	2901.8	3192.6	7.9078
370	0.98483	2917.8	3213.2	7.9401
380	1.0004	2933.8	3233.9	7.9721
390	1.0160	2949.9	3254.7	8.0036
400	1.0315	2966.1	3275.5	8.0347
410	1.0471	2982.2	3296.3	8.0655
420	1.0626	2998.4	3317.2	8.0959
430	1.0782	3014.7	3338.2	8.1259
440	1.0937	3031.1	3359.2	8.1556
450	1.1092	3047.5	3380.3	8.1849
460	1.1247	3064.0	3401.4	8.2140
470	1.1402	3080.5	3422.6	8.2427
480	1.1557	3097.2	3443.9	8.2711
490	1.1712	3113.8	3465.2	8.2992
500	1.1867	3130.6	3486.6	8.3271
520	1.2177	3164.3	3529.6	8.3819
540	1.2486	3198.2	3572.8	8.4357
560	1.2796	3232.4	3616.3	8.4886
580	1.3105	3266.9	3660.0	8.5404
600	1.3414	3301.6	3704.0	8.5914
620	1.3723	3336.6	3748.3	8.6416
640	1.4032	3371.9	3792.9	8.6909
660	1.4341	3407.5	3837.7	8.7395
680	1.4649	3443.3	3882.8	8.7873
700	1.4958	3479.5	3928.2	8.8344
720	1.5266	3515.9	3973.9	8.8809
740	1.5575	3552.6	4019.8	8.9267
760	1.5884	3589.5	4066.0	8.9719
780	1.6192	3626.7	4112.5	9.0164
800	1.6500	3664.3	4159.3	9.0604
820	1.6809	3702.0	4206.3	9.1039
840	1.7117	3740.2	4253.7	9.1468
860	1.7425	3778.5	4301.3	9.1892
880	1.7733	3817.1	4349.1	9.2310
900	1.8042	3856.0	4397.3	9.2724
920	1.8350	3895.2	4445.7	9.3133
940	1.8658	3934.7	4494.4	9.3538
960	1.8966	3974.3	4543.3	9.3938
980	1.9274	4014.3	4592.5	9.4334
1000	1.9582	4054.5	4642.0	9.4726

Water/Steam at $p = 0.35$ MPa ($T_{\text{sat}} = 138.857^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100003	-0.04	0.31	-0.00013	270	0.70872	2758.9	3007.0	7.5211
5	0.00099991	21.02	21.37	0.07625	280	0.72230	2774.6	3027.4	7.5583
10	0.00100018	42.01	42.36	0.15106	290	0.73585	2790.4	3047.9	7.5949
15	0.00100078	62.96	63.31	0.22441	300	0.74937	2806.0	3068.3	7.6309
20	0.00100168	83.89	84.24	0.29641	310	0.76287	2821.8	3088.8	7.6664
25	0.00100285	104.80	105.15	0.36714	320	0.77635	2837.6	3109.3	7.7012
30	0.00100426	125.70	126.05	0.43665	330	0.78981	2853.4	3129.8	7.7355
35	0.00100589	146.59	146.94	0.50501	340	0.80325	2869.3	3150.4	7.7693
40	0.00100773	167.49	167.84	0.57227	350	0.81668	2885.2	3171.0	7.8027
45	0.00100977	188.38	188.73	0.63847	360	0.83009	2901.1	3191.6	7.8355
50	0.00101200	209.28	209.63	0.70365	370	0.84348	2917.1	3212.3	7.8680
55	0.00101440	230.18	230.54	0.76786	380	0.85687	2933.2	3233.1	7.9000
60	0.00101698	251.10	251.46	0.83112	390	0.87024	2949.3	3253.9	7.9315
65	0.00101972	272.03	272.39	0.89347	400	0.88360	2965.4	3274.7	7.9627
70	0.00102263	292.97	293.33	0.95494	410	0.89695	2981.7	3295.6	7.9935
75	0.00102569	313.92	314.28	1.0156	420	0.91030	2997.9	3316.5	8.0239
80	0.00102891	334.89	335.25	1.0754	430	0.92363	3014.2	3337.5	8.0540
85	0.00103229	355.88	356.24	1.1344	440	0.93696	3030.7	3358.6	8.0837
90	0.00103581	376.90	377.26	1.1927	450	0.95028	3047.1	3379.7	8.1131
95	0.00103950	397.93	398.29	1.2502	460	0.96360	3063.5	3400.8	8.1422
100	0.00104333	418.98	419.35	1.3070	470	0.97690	3080.1	3422.0	8.1709
105	0.00104732	440.07	440.44	1.3632	480	0.99021	3096.7	3443.3	8.1994
110	0.00105147	461.20	461.57	1.4187	490	1.0035	3113.5	3464.7	8.2275
115	0.00105578	482.35	482.72	1.4735	500	1.0168	3130.2	3486.1	8.2554
120	0.00106024	503.55	503.92	1.5278	520	1.0434	3163.9	3529.1	8.3103
125	0.00106487	524.79	525.16	1.5814	540	1.0699	3197.8	3572.3	8.3642
130	0.00106966	546.07	546.44	1.6346	560	1.0965	3232.0	3615.8	8.4170
135	0.00107463	567.39	567.77	1.6872	580	1.1230	3266.6	3659.6	8.4689
138.857	0.00107857	583.88	584.26	1.7274	600	1.1495	3301.3	3703.6	8.5200
138.857	0.52418	2548.5	2732.0	6.9401	620	1.1760	3336.3	3747.9	8.5701
140	0.52591	2550.5	2734.6	6.9465	640	1.2025	3371.6	3792.5	8.6195
145	0.53341	2559.2	2745.9	6.9738	660	1.2290	3407.3	3837.4	8.6681
150	0.54083	2567.8	2757.1	7.0003	680	1.2555	3443.1	3882.5	8.7159
155	0.54818	2576.2	2768.1	7.0261	700	1.2819	3479.2	3927.9	8.7631
160	0.55547	2584.5	2778.9	7.0514	720	1.3084	3515.7	3973.6	8.8095
165	0.56272	2592.7	2789.7	7.0761	740	1.3348	3552.3	4019.5	8.8553
170	0.56991	2600.9	2800.4	7.1004	760	1.3613	3589.3	4065.8	8.9005
175	0.57707	2609.1	2811.1	7.1243	780	1.3877	3626.6	4112.3	8.9451
180	0.58419	2617.1	2821.6	7.1477	800	1.4142	3664.1	4159.1	8.9891
185	0.59128	2625.2	2832.1	7.1708	820	1.4406	3701.9	4206.1	9.0326
190	0.59834	2633.2	2842.6	7.1935	840	1.4671	3740.0	4253.5	9.0755
195	0.60537	2641.1	2853.0	7.2159	860	1.4935	3778.4	4301.1	9.1179
200	0.61238	2649.1	2863.4	7.2380	880	1.5199	3817.0	4349.0	9.1598
210	0.62633	2664.9	2884.1	7.2813	900	1.5463	3855.9	4397.1	9.2012
220	0.64020	2680.6	2904.7	7.3235	920	1.5728	3895.0	4445.5	9.2421
230	0.65400	2696.3	2925.2	7.3647	940	1.5992	3934.5	4494.2	9.2825
240	0.66775	2712.0	2945.7	7.4050	960	1.6256	3974.2	4543.2	9.3226
250	0.68145	2727.7	2966.2	7.4444	980	1.6520	4014.2	4592.4	9.3621
260	0.69510	2743.3	2986.6	7.4831	1000	1.6784	4054.4	4641.8	9.4013
270	0.70872	2758.9	3007.0	7.5211					

Water/Steam at $p = 0.40$ MPa ($T_{\text{sat}} = 143.608^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00100001	-0.03	0.37	-0.00013	270	0.61917	2757.8	3005.5	7.4574
5	0.00099989	21.02	21.42	0.07625	280	0.63111	2773.6	3026.0	7.4948
10	0.00100015	42.01	42.41	0.15105	290	0.64301	2789.4	3046.6	7.5316
15	0.00100076	62.96	63.36	0.22440	300	0.65489	2805.1	3067.1	7.5677
20	0.00100166	83.89	84.29	0.29640	310	0.66674	2820.9	3087.6	7.6032
25	0.00100283	104.80	105.20	0.36712	320	0.67858	2836.8	3108.2	7.6382
30	0.00100424	125.69	126.09	0.43663	330	0.69039	2852.6	3128.8	7.6726
35	0.00100587	146.59	146.99	0.50499	340	0.70218	2868.5	3149.4	7.7065
40	0.00100771	167.48	167.88	0.57225	350	0.71396	2884.4	3170.0	7.7399
45	0.00100975	188.38	188.78	0.63845	360	0.72572	2900.4	3190.7	7.7728
50	0.00101198	209.28	209.68	0.70363	370	0.73747	2916.5	3211.5	7.8053
55	0.00101438	230.17	230.58	0.76783	380	0.74921	2932.5	3232.2	7.8374
60	0.00101696	251.09	251.50	0.83109	390	0.76093	2948.6	3253.0	7.8690
65	0.00101970	272.02	272.43	0.89344	400	0.77264	2964.8	3273.9	7.9002
70	0.00102260	292.96	293.37	0.95491	410	0.78435	2981.1	3294.8	7.9311
75	0.00102567	313.91	314.32	1.0155	420	0.79605	2997.4	3315.8	7.9615
80	0.00102889	334.88	335.29	1.0753	430	0.80773	3013.7	3336.8	7.9917
85	0.00103226	355.87	356.28	1.1344	440	0.81941	3030.1	3357.9	8.0214
90	0.00103579	376.88	377.29	1.1926	450	0.83109	3046.6	3379.0	8.0508
95	0.00103947	397.91	398.33	1.2502	460	0.84275	3063.1	3400.2	8.0799
100	0.00104331	418.97	419.39	1.3070	470	0.85441	3079.6	3421.4	8.1087
105	0.00104730	440.06	440.48	1.3631	480	0.86607	3096.4	3442.8	8.1372
110	0.00105144	461.18	461.60	1.4186	490	0.87771	3113.0	3464.1	8.1654
115	0.00105575	482.34	482.76	1.4735	500	0.88936	3129.8	3485.5	8.1933
120	0.00106021	503.53	503.95	1.5277	520	0.91263	3163.5	3528.6	8.2482
125	0.00106484	524.76	525.19	1.5814	540	0.93589	3197.5	3571.9	8.3021
130	0.00106963	546.04	546.47	1.6345	560	0.95913	3231.7	3615.4	8.3550
135	0.00107459	567.37	567.80	1.6871	580	0.98236	3266.3	3659.2	8.4069
140	0.00107973	588.76	589.19	1.7392	600	1.0056	3301.0	3703.2	8.4580
143.608	0.00108355	604.22	604.65	1.7765	620	1.0288	3336.1	3747.6	8.5082
143.608	0.46238	2553.1	2738.1	6.8955	640	1.0520	3371.4	3792.2	8.5576
145	0.46425	2555.6	2741.3	6.9033	660	1.0752	3406.9	3837.0	8.6062
150	0.47088	2564.4	2752.8	6.9306	680	1.0983	3442.9	3882.2	8.6540
155	0.47744	2573.1	2764.1	6.9571	700	1.1215	3479.0	3927.6	8.7012
160	0.48393	2581.6	2775.2	6.9829	720	1.1447	3515.4	3973.3	8.7477
165	0.49037	2590.1	2786.2	7.0081	740	1.1678	3552.2	4019.3	8.7935
170	0.49676	2598.4	2797.1	7.0329	760	1.1910	3589.1	4065.5	8.8387
175	0.50310	2606.7	2807.9	7.0571	780	1.2142	3626.3	4112.0	8.8833
180	0.50941	2614.8	2818.6	7.0809	800	1.2373	3663.9	4158.8	8.9273
185	0.51569	2623.0	2829.3	7.1043	820	1.2604	3701.7	4205.9	8.9708
190	0.52193	2631.1	2839.9	7.1273	840	1.2836	3739.9	4253.3	9.0137
195	0.52814	2639.1	2850.4	7.1500	860	1.3067	3778.2	4300.9	9.0561
200	0.53433	2647.2	2860.9	7.1723	880	1.3298	3816.9	4348.8	9.0980
210	0.54665	2663.1	2881.8	7.2160	900	1.3530	3855.7	4396.9	9.1394
220	0.55888	2679.0	2902.6	7.2586	920	1.3761	3894.9	4445.3	9.1803
230	0.57104	2694.9	2923.3	7.3001	940	1.3992	3934.3	4494.0	9.2208
240	0.58314	2710.6	2943.9	7.3407	960	1.4223	3974.1	4543.0	9.2608
250	0.59520	2726.4	2964.5	7.3804	980	1.4455	4014.0	4592.2	9.3004
260	0.60720	2742.1	2985.0	7.4193	1000	1.4686	4054.3	4641.7	9.3396
270	0.61917	2757.8	3005.5	7.4574					

Water/Steam at $p = 0.45$ MPa ($T_{\text{sat}} = 147.903^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099998	-0.03	0.42	-0.00012	270	0.54953	2756.7	3004.0	7.4010
5	0.00099986	21.02	21.47	0.07625	280	0.56018	2772.5	3024.6	7.4385
10	0.00100013	42.01	42.46	0.15105	290	0.57081	2788.3	3045.2	7.4754
15	0.00100074	62.96	63.41	0.22440	300	0.58140	2804.2	3065.8	7.5117
20	0.00100164	83.89	84.34	0.29639	310	0.59198	2820.0	3086.4	7.5473
25	0.00100280	104.79	105.24	0.36711	320	0.60253	2835.9	3107.0	7.5824
30	0.00100421	125.69	126.14	0.43662	330	0.61306	2851.8	3127.7	7.6169
35	0.00100585	146.58	147.03	0.50498	340	0.62357	2867.8	3148.4	7.6509
40	0.00100769	167.48	167.93	0.57223	350	0.63407	2883.8	3169.1	7.6844
45	0.00100973	188.37	188.82	0.63843	360	0.64455	2899.8	3189.8	7.7174
50	0.00101195	209.26	209.72	0.70361	370	0.65501	2915.8	3210.6	7.7499
55	0.00101436	230.17	230.63	0.76781	380	0.66547	2931.9	3231.4	7.7820
60	0.00101693	251.08	251.54	0.83106	390	0.67591	2948.0	3252.2	7.8137
65	0.00101968	272.01	272.47	0.89341	400	0.68634	2964.2	3273.1	7.8450
70	0.00102258	292.95	293.41	0.95488	410	0.69677	2980.6	3294.1	7.8759
75	0.00102564	313.90	314.36	1.0155	420	0.70718	2996.9	3315.1	7.9064
80	0.00102886	334.87	335.33	1.0753	430	0.71759	3013.2	3336.1	7.9366
85	0.00103224	355.86	356.32	1.1343	440	0.72799	3029.6	3357.2	7.9664
90	0.00103577	376.86	377.33	1.1926	450	0.73838	3046.1	3378.4	7.9958
95	0.00103945	397.90	398.37	1.2501	460	0.74876	3062.7	3399.6	8.0250
100	0.00104328	418.96	419.43	1.3069	470	0.75914	3079.3	3420.9	8.0538
105	0.00104727	440.05	440.52	1.3631	480	0.76951	3095.9	3442.2	8.0823
110	0.00105142	461.17	461.64	1.4186	490	0.77988	3112.7	3463.6	8.1105
115	0.00105572	482.31	482.79	1.4734	500	0.79024	3129.4	3485.0	8.1384
120	0.00106018	503.51	503.99	1.5277	520	0.81095	3163.2	3528.1	8.1934
125	0.00106481	524.74	525.22	1.5814	540	0.83164	3197.2	3571.4	8.2473
130	0.00106960	546.03	546.51	1.6345	560	0.85232	3231.4	3614.9	8.3002
135	0.00107456	567.36	567.84	1.6871	580	0.87298	3266.0	3658.8	8.3522
140	0.00107970	588.73	589.22	1.7391	600	0.89364	3300.8	3702.9	8.4033
145	0.00108502	610.17	610.66	1.7907	620	0.91428	3335.8	3747.2	8.4535
147.903	0.00108819	622.65	623.14	1.8205	640	0.93491	3371.1	3791.8	8.5029
150	0.41390	2557.1	2743.4	6.8560	660	0.95554	3406.7	3836.7	8.5515
155	0.41642	2560.9	2748.3	6.8678	680	0.97615	3442.6	3881.9	8.5994
160	0.42237	2569.8	2759.9	6.8950	700	0.99676	3478.8	3927.3	8.6466
165	0.42825	2578.6	2771.3	6.9215	720	1.0174	3515.2	3973.0	8.6931
170	0.43406	2587.3	2782.6	6.9473	740	1.0380	3551.9	4019.0	8.7389
175	0.43983	2595.8	2793.7	6.9725	760	1.0586	3588.9	4065.3	8.7842
180	0.44555	2604.2	2804.7	6.9971	780	1.0791	3626.2	4111.8	8.8288
185	0.45123	2612.4	2815.5	7.0213	800	1.0997	3663.7	4158.6	8.8728
190	0.45687	2620.8	2826.4	7.0450	820	1.1203	3701.6	4205.7	8.9163
195	0.46248	2629.0	2837.1	7.0683	840	1.1409	3739.6	4253.0	8.9592
200	0.46806	2637.2	2847.8	7.0913	860	1.1614	3778.1	4300.7	9.0016
205	0.47362	2645.3	2858.4	7.1138	880	1.1820	3816.7	4348.6	9.0435
210	0.48466	2661.4	2879.5	7.1580	900	1.2026	3855.5	4396.7	9.0849
215	0.49561	2677.5	2900.5	7.2009	920	1.2231	3894.8	4445.2	9.1258
220	0.50650	2693.4	2921.3	7.2428	940	1.2437	3934.2	4493.9	9.1663
225	0.51733	2709.3	2942.1	7.2836	960	1.2643	3973.9	4542.8	9.2064
230	0.52811	2725.2	2962.8	7.3235	980	1.2848	4013.9	4592.1	9.2460
235	0.53884	2740.9	2983.4	7.3626	1000	1.3054	4054.1	4641.5	9.2851
240	0.54953	2756.7	3004.0	7.4010					

Water/Steam at $p = 0.50$ MPa ($T_{\text{sat}} = 151.831^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099995	-0.03	0.47	-0.00012
5	0.00099984	21.02	21.52	0.07625
10	0.00100011	42.01	42.51	0.15104
15	0.00100071	62.96	63.46	0.22439
20	0.00100161	83.88	84.38	0.29638
25	0.00100278	104.79	105.29	0.36710
30	0.00100419	125.69	126.19	0.43660
35	0.00100582	146.58	147.08	0.50496
40	0.00100767	167.47	167.97	0.57221
45	0.00100971	188.36	188.86	0.63840
50	0.00101193	209.25	209.76	0.70358
55	0.00101434	230.16	230.67	0.76778
60	0.00101691	251.07	251.58	0.83104
65	0.00101965	272.00	272.51	0.89338
70	0.00102256	292.94	293.45	0.95485
75	0.00102562	313.89	314.40	1.0155
80	0.00102884	334.86	335.37	1.0753
85	0.00103221	355.84	356.36	1.1343
90	0.00103574	376.85	377.37	1.1926
95	0.00103942	397.89	398.41	1.2501
100	0.00104326	418.95	419.47	1.3069
105	0.00104725	440.03	440.55	1.3630
110	0.00105139	461.14	461.67	1.4185
115	0.00105569	482.30	482.83	1.4734
120	0.00106016	503.49	504.02	1.5276
125	0.00106478	524.73	525.26	1.5813
130	0.00106957	546.01	546.54	1.6344
135	0.00107453	567.33	567.87	1.6870
140	0.00107967	588.71	589.25	1.7391
145	0.00108499	610.15	610.69	1.7907
150	0.00109049	631.64	632.19	1.8418
151.831	0.00109255	639.54	640.09	1.8604
151.831	0.37481	2560.7	2748.1	6.8207
155	0.37827	2566.6	2755.7	6.8384
160	0.38366	2575.6	2767.4	6.8656
165	0.38899	2584.4	2778.9	6.8919
170	0.39426	2593.1	2790.2	6.9176
175	0.39948	2601.7	2801.4	6.9427
180	0.40466	2610.1	2812.4	6.9673
185	0.40980	2618.5	2823.4	6.9913
190	0.41491	2626.8	2834.3	7.0150
195	0.41998	2635.1	2845.1	7.0382
200	0.42503	2643.3	2855.8	7.0610
210	0.43506	2659.7	2877.2	7.1056
220	0.44500	2675.8	2898.3	7.1489
230	0.45487	2691.9	2919.3	7.1911
240	0.46467	2707.9	2940.2	7.2322
250	0.47443	2723.8	2961.0	7.2724
260	0.48414	2739.7	2981.8	7.3117
270	0.49380	2755.6	3002.5	7.3502

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.49380	2755.6	3002.5	7.3502
280	0.50344	2771.5	3023.2	7.3880
290	0.51304	2787.4	3043.9	7.4250
300	0.52261	2803.3	3064.6	7.4614
310	0.53216	2819.1	3085.2	7.4972
320	0.54169	2835.1	3105.9	7.5323
330	0.55119	2851.0	3126.6	7.5669
340	0.56068	2867.0	3147.3	7.6010
350	0.57015	2883.0	3168.1	7.6346
360	0.57961	2899.1	3188.9	7.6677
370	0.58905	2915.2	3209.7	7.7003
380	0.59848	2931.3	3230.5	7.7325
390	0.60790	2947.4	3251.4	7.7642
400	0.61730	2963.7	3272.3	7.7955
410	0.62670	2979.9	3293.3	7.8265
420	0.63609	2996.4	3314.4	7.8570
430	0.64547	3012.7	3335.4	7.8872
440	0.65484	3029.2	3356.6	7.9170
450	0.66421	3045.6	3377.7	7.9465
460	0.67357	3062.2	3399.0	7.9757
470	0.68292	3078.8	3420.3	8.0045
480	0.69227	3095.5	3441.6	8.0331
490	0.70161	3112.2	3463.0	8.0613
500	0.71094	3129.0	3484.5	8.0892
520	0.72960	3162.8	3527.6	8.1443
540	0.74824	3196.8	3570.9	8.1983
560	0.76687	3231.1	3614.5	8.2512
580	0.78548	3265.7	3658.4	8.3032
600	0.80409	3300.5	3702.5	8.3543
620	0.82268	3335.5	3746.8	8.4046
640	0.84126	3370.9	3791.5	8.4540
660	0.85983	3406.5	3836.4	8.5027
680	0.87840	3442.4	3881.6	8.5506
700	0.89696	3478.5	3927.0	8.5977
720	0.91551	3514.9	3972.7	8.6443
740	0.93405	3551.7	4018.7	8.6901
760	0.95259	3588.7	4065.0	8.7353
780	0.97113	3626.0	4111.6	8.7800
800	0.98966	3663.6	4158.4	8.8240
820	1.0082	3701.4	4205.5	8.8675
840	1.0267	3739.4	4252.8	8.9104
860	1.0452	3777.9	4300.5	8.9528
880	1.0637	3816.5	4348.4	8.9947
900	1.0823	3855.5	4396.6	9.0362
920	1.1008	3894.6	4445.0	9.0771
940	1.1193	3934.1	4493.7	9.1176
960	1.1378	3973.8	4542.7	9.1576
980	1.1563	4013.8	4591.9	9.1972
1000	1.1748	4054.0	4641.4	9.2364

Water/Steam at $p = 0.55$ MPa ($T_{\text{sat}} = 155.456^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099993	-0.03	0.52	-0.00012
5	0.00099981	21.02	21.57	0.07624
10	0.00100008	42.01	42.56	0.15104
15	0.00100069	62.96	63.51	0.22438
20	0.00100159	83.88	84.43	0.29637
25	0.00100276	104.79	105.34	0.36708
30	0.00100417	125.68	126.23	0.43659
35	0.00100580	146.57	147.12	0.50494
40	0.00100764	167.46	168.01	0.57219
45	0.00100968	188.35	188.91	0.63838
50	0.00101191	209.25	209.81	0.70356
55	0.00101431	230.15	230.71	0.76776
60	0.00101689	251.07	251.63	0.83101
65	0.00101963	271.99	272.55	0.89336
70	0.00102253	292.93	293.49	0.95482
75	0.00102560	313.88	314.44	1.0154
80	0.00102882	334.84	335.41	1.0752
85	0.00103219	355.83	356.40	1.1343
90	0.00103572	376.84	377.41	1.1925
95	0.00103940	397.87	398.44	1.2500
100	0.00104323	418.93	419.50	1.3069
105	0.00104722	440.01	440.59	1.3630
110	0.00105136	461.13	461.71	1.4185
115	0.00105567	482.29	482.87	1.4733
120	0.00106013	503.48	504.06	1.5276
125	0.00106475	524.70	525.29	1.5813
130	0.00106954	545.98	546.57	1.6344
135	0.00107450	567.31	567.90	1.6870
140	0.00107964	588.69	589.28	1.7390
145	0.00108495	610.12	610.72	1.7906
150	0.00109045	631.62	632.22	1.8417
155	0.00109615	653.19	653.79	1.8924
155.456	0.00109668	655.16	655.76	1.8970
155.456	0.34260	2563.9	2752.3	6.7886
160	0.34715	2572.4	2763.3	6.8140
165	0.35208	2581.5	2775.1	6.8410
170	0.35695	2590.3	2786.6	6.8673
175	0.36177	2599.0	2798.0	6.8928
180	0.36654	2607.7	2809.3	6.9178
185	0.37127	2616.2	2820.4	6.9422
190	0.37597	2624.6	2831.4	6.9662
195	0.38063	2633.1	2842.4	6.9897
200	0.38527	2641.3	2853.2	7.0128
210	0.39447	2657.8	2874.8	7.0579
220	0.40358	2674.1	2896.1	7.1016
230	0.41261	2690.4	2917.3	7.1441
240	0.42159	2706.4	2938.3	7.1855
250	0.43051	2722.5	2959.3	7.2259
260	0.43938	2738.5	2980.2	7.2655
270	0.44821	2754.5	3001.0	7.3041

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.44821	2754.5	3001.0	7.3041
280	0.45701	2770.4	3021.8	7.3421
290	0.46577	2786.3	3042.5	7.3793
300	0.47451	2802.3	3063.3	7.4158
310	0.48322	2818.2	3084.0	7.4517
320	0.49191	2834.2	3104.8	7.4869
330	0.50057	2850.2	3125.5	7.5216
340	0.50922	2866.2	3146.3	7.5558
350	0.51786	2882.3	3167.1	7.5894
360	0.52647	2898.3	3187.9	7.6226
370	0.53508	2914.5	3208.8	7.6553
380	0.54367	2930.7	3229.7	7.6875
390	0.55225	2946.9	3250.6	7.7193
400	0.56082	2963.1	3271.6	7.7507
410	0.56937	2979.4	3292.6	7.7817
420	0.57792	2995.7	3313.6	7.8123
430	0.58647	3012.1	3334.7	7.8425
440	0.59500	3028.6	3355.9	7.8724
450	0.60353	3045.2	3377.1	7.9019
460	0.61205	3061.8	3398.4	7.9311
470	0.62056	3078.4	3419.7	7.9600
480	0.62907	3095.0	3441.0	7.9885
490	0.63757	3111.8	3462.5	8.0168
500	0.64607	3128.6	3483.9	8.0447
520	0.66305	3162.4	3527.1	8.0998
540	0.68001	3196.4	3570.4	8.1538
560	0.69696	3230.8	3614.1	8.2068
580	0.71389	3265.3	3657.9	8.2589
600	0.73082	3300.1	3702.1	8.3100
620	0.74773	3335.2	3746.5	8.3603
640	0.76463	3370.6	3791.1	8.4097
660	0.78153	3406.3	3836.1	8.4584
680	0.79842	3442.2	3881.3	8.5063
700	0.81530	3478.3	3926.7	8.5535
720	0.83217	3514.8	3972.5	8.6000
740	0.84904	3551.5	4018.5	8.6459
760	0.86590	3588.6	4064.8	8.6912
780	0.88276	3625.8	4111.3	8.7358
800	0.89961	3663.4	4158.2	8.7798
820	0.91646	3701.2	4205.3	8.8233
840	0.93330	3739.3	4252.6	8.8663
860	0.95015	3777.7	4300.3	8.9087
880	0.96698	3816.4	4348.2	8.9506
900	0.98382	3855.3	4396.4	8.9920
920	1.0007	3894.4	4444.8	9.0330
940	1.0175	3933.9	4493.5	9.0735
960	1.0343	3973.6	4542.5	9.1135
980	1.0511	4013.7	4591.8	9.1531
1000	1.0680	4053.9	4641.3	9.1923

Water/Steam at $p = 0.60$ MPa ($T_{\text{sat}} = 158.826^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099990	-0.03	0.57	-0.00011
5	0.00099979	21.02	21.62	0.07624
10	0.00100006	42.01	42.61	0.15103
15	0.00100067	62.95	63.55	0.22437
20	0.00100157	83.88	84.48	0.29636
25	0.00100273	104.78	105.38	0.36707
30	0.00100415	125.68	126.28	0.43657
35	0.00100578	146.57	147.17	0.50492
40	0.00100762	167.46	168.06	0.57217
45	0.00100966	188.34	188.95	0.63836
50	0.00101189	209.24	209.85	0.70354
55	0.00101429	230.14	230.75	0.76773
60	0.00101687	251.06	251.67	0.83098
65	0.00101961	271.98	272.59	0.89333
70	0.00102251	292.92	293.53	0.95479
75	0.00102557	313.86	314.48	1.0154
80	0.00102879	334.83	335.45	1.0752
85	0.00103217	355.82	356.44	1.1342
90	0.00103569	376.83	377.45	1.1925
95	0.00103937	397.86	398.48	1.2500
100	0.00104321	418.91	419.54	1.3068
105	0.00104719	440.00	440.63	1.3630
110	0.00105134	461.12	461.75	1.4184
115	0.00105564	482.27	482.90	1.4733
120	0.00106010	503.45	504.09	1.5275
125	0.00106472	524.69	525.33	1.5812
130	0.00106951	545.97	546.61	1.6343
135	0.00107447	567.29	567.93	1.6869
140	0.00107961	588.67	589.32	1.7390
145	0.00108492	610.11	610.76	1.7905
150	0.00109042	631.61	632.26	1.8417
155	0.00109611	653.16	653.82	1.8923
158.826	0.00110060	669.72	670.38	1.9308
158.826	0.31558	2566.8	2756.1	6.7592
160	0.31668	2569.0	2759.0	6.7659
165	0.32129	2578.3	2771.1	6.7937
170	0.32583	2587.5	2783.0	6.8206
175	0.33032	2596.4	2794.6	6.8466
180	0.33475	2605.1	2806.0	6.8720
185	0.33915	2613.8	2817.3	6.8968
190	0.34350	2622.4	2828.5	6.9211
195	0.34783	2630.9	2839.6	6.9449
200	0.35212	2639.3	2850.6	6.9683
210	0.36063	2656.0	2872.4	7.0139
220	0.36905	2672.5	2893.9	7.0580
230	0.37740	2688.9	2915.3	7.1008
240	0.38568	2705.1	2936.5	7.1426
250	0.39390	2721.3	2957.6	7.1832
260	0.40208	2737.3	2978.5	7.2230
270	0.41021	2753.4	2999.5	7.2619

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.41021	2753.4	2999.5	7.2619
280	0.41831	2769.3	3020.3	7.3000
290	0.42638	2785.4	3041.2	7.3373
300	0.43442	2801.3	3062.0	7.3740
310	0.44243	2817.3	3082.8	7.4100
320	0.45042	2833.3	3103.6	7.4453
330	0.45839	2849.4	3124.4	7.4801
340	0.46634	2865.5	3145.3	7.5144
350	0.47427	2881.5	3166.1	7.5481
360	0.48219	2897.7	3187.0	7.5813
370	0.49010	2913.8	3207.9	7.6141
380	0.49799	2930.0	3228.8	7.6464
390	0.50587	2946.3	3249.8	7.6782
400	0.51374	2962.6	3270.8	7.7097
410	0.52160	2978.8	3291.8	7.7407
420	0.52945	2995.2	3312.9	7.7713
430	0.53729	3011.6	3334.0	7.8016
440	0.54513	3028.1	3355.2	7.8315
450	0.55296	3044.7	3376.5	7.8611
460	0.56078	3061.2	3397.7	7.8903
470	0.56859	3077.9	3419.1	7.9192
480	0.57640	3094.7	3440.5	7.9478
490	0.58420	3111.4	3461.9	7.9761
500	0.59200	3128.2	3483.4	8.0041
520	0.60758	3162.1	3526.6	8.0592
540	0.62315	3196.1	3570.0	8.1132
560	0.63870	3230.4	3613.6	8.1663
580	0.65424	3265.0	3657.5	8.2183
600	0.66976	3299.8	3701.7	8.2695
620	0.68528	3334.9	3746.1	8.3198
640	0.70078	3370.3	3790.8	8.3693
660	0.71628	3405.9	3835.7	8.4180
680	0.73176	3441.8	3880.9	8.4659
700	0.74725	3478.0	3926.4	8.5131
720	0.76272	3514.6	3972.2	8.5597
740	0.77819	3551.3	4018.2	8.6056
760	0.79365	3588.3	4064.5	8.6508
780	0.80911	3625.6	4111.1	8.6954
800	0.82457	3663.2	4157.9	8.7395
820	0.84002	3701.0	4205.0	8.7830
840	0.85547	3739.1	4252.4	8.8260
860	0.87091	3777.6	4300.1	8.8684
880	0.88635	3816.2	4348.0	8.9103
900	0.90178	3855.1	4396.2	8.9518
920	0.91722	3894.4	4444.7	8.9927
940	0.93265	3933.8	4493.4	9.0332
960	0.94808	3973.6	4542.4	9.0733
980	0.96351	4013.5	4591.6	9.1129
1000	0.97893	4053.7	4641.1	9.1521

Water/Steam at $p = 0.65$ MPa ($T_{\text{sat}} = 161.980^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099988	-0.03	0.62	-0.00011	270	0.37806	2752.2	2997.9	7.2228
5	0.00099976	21.02	21.67	0.07624	280	0.38557	2768.3	3018.9	7.2611
10	0.00100004	42.00	42.65	0.15103	290	0.39305	2784.3	3039.8	7.2986
15	0.00100064	62.95	63.60	0.22437	300	0.40049	2800.4	3060.7	7.3353
20	0.00100154	83.87	84.52	0.29635	310	0.40792	2816.5	3081.6	7.3715
25	0.00100271	104.78	105.43	0.36706	320	0.41532	2832.5	3102.5	7.4070
30	0.00100412	125.67	126.32	0.43656	330	0.42270	2848.6	3123.4	7.4419
35	0.00100576	146.56	147.21	0.50491	340	0.43006	2864.7	3144.2	7.4762
40	0.00100760	167.45	168.10	0.57215	350	0.43740	2880.8	3165.1	7.5100
45	0.00100964	188.33	188.99	0.63834	360	0.44473	2897.0	3186.1	7.5433
50	0.00101186	209.23	209.89	0.70351	370	0.45204	2913.2	3207.0	7.5761
55	0.00101427	230.14	230.80	0.76771	380	0.45934	2929.4	3228.0	7.6085
60	0.00101684	251.05	251.71	0.83096	390	0.46663	2945.7	3249.0	7.6404
65	0.00101958	271.97	272.63	0.89330	400	0.47391	2962.0	3270.0	7.6719
70	0.00102249	292.91	293.57	0.95476	410	0.48118	2978.3	3291.1	7.7029
75	0.00102555	313.85	314.52	1.0154	420	0.48844	2994.7	3312.2	7.7336
80	0.00102877	334.82	335.49	1.0752	430	0.49569	3011.2	3333.4	7.7639
85	0.00103214	355.81	356.48	1.1342	440	0.50293	3027.7	3354.6	7.7939
90	0.00103567	376.82	377.49	1.1924	450	0.51017	3044.2	3375.8	7.8235
95	0.00103935	397.84	398.52	1.2500	460	0.51740	3060.8	3397.1	7.8527
100	0.00104318	418.90	419.58	1.3068	470	0.52462	3077.5	3418.5	7.8817
105	0.00104717	439.99	440.67	1.3629	480	0.53184	3094.2	3439.9	7.9103
110	0.00105131	461.10	461.78	1.4184	490	0.53905	3110.9	3461.3	7.9386
115	0.00105561	482.25	482.94	1.4733	500	0.54625	3127.8	3482.9	7.9666
120	0.00106007	503.44	504.13	1.5275	520	0.56065	3161.7	3526.1	8.0218
125	0.00106469	524.67	525.36	1.5812	540	0.57503	3195.7	3569.5	8.0759
130	0.00106948	545.94	546.64	1.6343	560	0.58940	3230.1	3613.2	8.1289
135	0.00107444	567.27	567.97	1.6869	580	0.60376	3264.7	3657.1	8.1810
140	0.00107957	588.65	589.35	1.7389	600	0.61810	3299.5	3701.3	8.2322
145	0.00108489	610.08	610.79	1.7905	620	0.63243	3334.6	3745.7	8.2825
150	0.00109039	631.58	632.29	1.8416	640	0.64675	3370.0	3790.4	8.3320
155	0.00109608	653.14	653.85	1.8923	660	0.66106	3405.7	3835.4	8.3808
160	0.00110197	674.77	675.49	1.9425	680	0.67537	3441.6	3880.6	8.4287
161.980	0.00110436	683.36	684.08	1.9623	700	0.68967	3477.8	3926.1	8.4760
161.980	0.29259	2569.4	2759.6	6.7322	720	0.70396	3514.3	3971.9	8.5225
165	0.29521	2575.2	2767.1	6.7494	740	0.71824	3551.0	4017.9	8.5684
170	0.29948	2584.5	2779.2	6.7769	760	0.73252	3588.2	4064.3	8.6137
175	0.30369	2593.7	2791.1	6.8035	780	0.74680	3625.4	4110.8	8.6583
180	0.30784	2602.6	2802.7	6.8293	800	0.76107	3663.0	4157.7	8.7024
185	0.31195	2611.4	2814.2	6.8546	820	0.77534	3700.8	4204.8	8.7459
190	0.31602	2620.2	2825.6	6.8792	840	0.78960	3739.0	4252.2	8.7889
195	0.32006	2628.8	2836.8	6.9033	860	0.80386	3777.4	4299.9	8.8313
200	0.32406	2637.4	2848.0	6.9270	880	0.81812	3816.0	4347.8	8.8732
210	0.33199	2654.2	2870.0	6.9731	900	0.83237	3855.0	4396.0	8.9147
220	0.33983	2670.8	2891.7	7.0176	920	0.84662	3894.2	4444.5	8.9556
230	0.34759	2687.3	2913.2	7.0608	940	0.86087	3933.6	4493.2	8.9962
240	0.35528	2703.7	2934.6	7.1028	960	0.87512	3973.4	4542.2	9.0362
250	0.36292	2719.9	2955.8	7.1437	980	0.88936	4013.4	4591.5	9.0758
260	0.37051	2736.1	2976.9	7.1837	1000	0.90360	4053.7	4641.0	9.1150
270	0.37806	2752.2	2997.9	7.2228					

Water/Steam at $p = 0.70$ MPa ($T_{\text{sat}} = 164.946^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099985	-0.03	0.67	-0.00011	270	0.35050	2751.0	2996.4	7.1865
5	0.00099974	21.02	21.72	0.07624	280	0.35750	2767.3	3017.5	7.2249
10	0.00100001	42.00	42.70	0.15102	290	0.36447	2783.4	3038.5	7.2625
15	0.00100062	62.95	63.65	0.22436	300	0.37142	2799.4	3059.4	7.2995
20	0.00100152	83.87	84.57	0.29634	310	0.37833	2815.6	3080.4	7.3357
25	0.00100269	104.77	105.47	0.36704	320	0.38523	2831.6	3101.3	7.3713
30	0.00100410	125.67	126.37	0.43654	330	0.39210	2847.8	3122.3	7.4063
35	0.00100574	146.56	147.26	0.50489	340	0.39895	2863.9	3143.2	7.4407
40	0.00100758	167.44	168.15	0.57213	350	0.40579	2880.1	3164.2	7.4746
45	0.00100962	188.33	189.04	0.63832	360	0.41261	2896.3	3185.1	7.5080
50	0.00101184	209.22	209.93	0.70349	370	0.41942	2912.5	3206.1	7.5409
55	0.00101425	230.13	230.84	0.76768	380	0.42621	2928.8	3227.1	7.5733
60	0.00101682	251.04	251.75	0.83093	390	0.43299	2945.0	3248.1	7.6053
65	0.00101956	271.97	272.68	0.89327	400	0.43977	2961.4	3269.2	7.6368
70	0.00102246	292.89	293.61	0.95473	410	0.44653	2977.7	3290.3	7.6679
75	0.00102553	313.84	314.56	1.0153	420	0.45328	2994.2	3311.5	7.6986
80	0.00102874	334.81	335.53	1.0751	430	0.46003	3010.7	3332.7	7.7290
85	0.00103212	355.80	356.52	1.1342	440	0.46676	3027.2	3353.9	7.7590
90	0.00103564	376.81	377.53	1.1924	450	0.47349	3043.8	3375.2	7.7886
95	0.00103932	397.83	398.56	1.2499	460	0.48021	3060.4	3396.5	7.8179
100	0.00104316	418.89	419.62	1.3067	470	0.48693	3077.0	3417.9	7.8469
105	0.00104714	439.97	440.70	1.3629	480	0.49364	3093.8	3439.3	7.8755
110	0.00105128	461.08	461.82	1.4184	490	0.50034	3110.6	3460.8	7.9038
115	0.00105558	482.23	482.97	1.4732	500	0.50704	3127.4	3482.3	7.9319
120	0.00106004	503.42	504.16	1.5275	520	0.52043	3161.3	3525.6	7.9871
125	0.00106467	524.65	525.40	1.5811	540	0.53379	3195.3	3569.0	8.0412
130	0.00106945	545.92	546.67	1.6342	560	0.54715	3229.8	3612.8	8.0943
135	0.00107441	567.25	568.00	1.6868	580	0.56049	3264.4	3656.7	8.1465
140	0.00107954	588.62	589.38	1.7389	600	0.57381	3299.2	3700.9	8.1977
145	0.00108485	610.06	610.82	1.7904	620	0.58713	3334.4	3745.4	8.2480
150	0.00109035	631.56	632.32	1.8416	640	0.60044	3369.8	3790.1	8.2976
155	0.00109604	653.11	653.88	1.8922	660	0.61374	3405.5	3835.1	8.3463
160	0.00110193	674.75	675.52	1.9425	680	0.62703	3441.4	3880.3	8.3943
164.946	0.00110796	696.22	697.00	1.9918	700	0.64031	3477.6	3925.8	8.4415
164.946	0.27277	2571.9	2762.8	6.7071	720	0.65359	3514.1	3971.6	8.4881
165	0.27282	2571.9	2762.9	6.7074	740	0.66686	3550.9	4017.7	8.5340
170	0.27687	2581.6	2775.4	6.7357	760	0.68013	3587.9	4064.0	8.5793
175	0.28084	2590.9	2787.5	6.7629	780	0.69339	3625.2	4110.6	8.6239
180	0.28476	2600.1	2799.4	6.7893	800	0.70664	3662.9	4157.5	8.6680
185	0.28863	2609.1	2811.1	6.8149	820	0.71990	3700.7	4204.6	8.7115
190	0.29245	2617.9	2822.6	6.8399	840	0.73315	3738.8	4252.0	8.7545
195	0.29624	2626.6	2834.0	6.8644	860	0.74639	3777.2	4299.7	8.7970
200	0.30000	2635.3	2845.3	6.8884	880	0.75963	3815.9	4347.6	8.8389
210	0.30744	2652.3	2867.5	6.9349	900	0.77287	3854.8	4395.8	8.8804
220	0.31478	2669.2	2889.5	6.9799	920	0.78611	3894.0	4444.3	8.9213
230	0.32204	2685.8	2911.2	7.0234	940	0.79934	3933.5	4493.0	8.9618
240	0.32923	2702.2	2932.7	7.0658	960	0.81257	3973.2	4542.0	9.0019
250	0.33637	2718.5	2954.0	7.1070	980	0.82580	4013.2	4591.3	9.0415
260	0.34345	2734.8	2975.2	7.1472	1000	0.83903	4053.5	4640.8	9.0807
270	0.35050	2751.0	2996.4	7.1865					

Water/Steam at $p = 0.75$ MPa ($T_{\text{sat}} = 167.749^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099983	-0.03	0.72	-0.00010	270	0.32661	2749.8	2994.8	7.1525
5	0.00099971	21.02	21.77	0.07624	280	0.33317	2766.1	3016.0	7.1911
10	0.00099999	42.00	42.75	0.15102	290	0.33971	2782.3	3037.1	7.2289
15	0.00100060	62.95	63.70	0.22435	300	0.34621	2798.5	3058.2	7.2659
20	0.00100150	83.87	84.62	0.29633	310	0.35269	2814.7	3079.2	7.3023
25	0.00100267	104.77	105.52	0.36703	320	0.35915	2830.8	3100.2	7.3380
30	0.00100408	125.66	126.41	0.43653	330	0.36558	2847.0	3121.2	7.3731
35	0.00100571	146.55	147.30	0.50487	340	0.37200	2863.2	3142.2	7.4076
40	0.00100756	167.43	168.19	0.57211	350	0.37839	2879.4	3163.2	7.4416
45	0.00100959	188.32	189.08	0.63830	360	0.38478	2895.6	3184.2	7.4750
50	0.00101182	209.22	209.98	0.70347	370	0.39115	2911.8	3205.2	7.5080
55	0.00101422	230.12	230.88	0.76766	380	0.39750	2928.1	3226.2	7.5405
60	0.00101680	251.03	251.79	0.83090	390	0.40384	2944.4	3247.3	7.5725
65	0.00101954	271.96	272.72	0.89324	400	0.41018	2960.8	3268.4	7.6041
70	0.00102244	292.88	293.65	0.95470	410	0.41650	2977.2	3289.6	7.6353
75	0.00102550	313.83	314.60	1.0153	420	0.42281	2993.6	3310.7	7.6660
80	0.00102872	334.80	335.57	1.0751	430	0.42912	3010.2	3332.0	7.6964
85	0.00103209	355.79	356.56	1.1341	440	0.43541	3026.6	3353.2	7.7264
90	0.00103562	376.79	377.57	1.1924	450	0.44170	3043.2	3374.5	7.7561
95	0.00103930	397.82	398.60	1.2499	460	0.44799	3059.9	3395.9	7.7854
100	0.00104313	418.87	419.65	1.3067	470	0.45426	3076.6	3417.3	7.8144
105	0.00104712	439.95	440.74	1.3628	480	0.46053	3093.3	3438.7	7.8431
110	0.00105126	461.07	461.86	1.4183	490	0.46680	3110.1	3460.2	7.8715
115	0.00105556	482.22	483.01	1.4732	500	0.47306	3127.0	3481.8	7.8995
120	0.00106002	503.40	504.20	1.5274	520	0.48556	3160.9	3525.1	7.9548
125	0.00106464	524.63	525.43	1.5811	540	0.49805	3195.1	3568.6	8.0090
130	0.00106942	545.91	546.71	1.6342	560	0.51053	3229.4	3612.3	8.0621
135	0.00107438	567.22	568.03	1.6868	580	0.52299	3264.1	3656.3	8.1143
140	0.00107951	588.60	589.41	1.7388	600	0.53543	3298.9	3700.5	8.1655
145	0.00108482	610.04	610.85	1.7904	620	0.54787	3334.1	3745.0	8.2159
150	0.00109032	631.53	632.35	1.8415	640	0.56030	3369.6	3789.8	8.2654
155	0.00109601	653.09	653.91	1.8922	660	0.57272	3405.3	3834.8	8.3142
160	0.00110189	674.72	675.55	1.9424	680	0.58513	3441.2	3880.0	8.3622
165	0.00110799	696.43	697.26	1.9922	700	0.59754	3477.3	3925.5	8.4094
167.749	0.00111143	708.41	709.24	2.0195	720	0.60994	3513.8	3971.3	8.4560
167.749	0.25551	2574.0	2765.6	6.6836	740	0.62233	3550.7	4017.4	8.5019
170	0.25724	2578.5	2771.4	6.6966	760	0.63472	3587.8	4063.8	8.5472
175	0.26102	2588.0	2783.8	6.7245	780	0.64710	3625.1	4110.4	8.5919
180	0.26474	2597.3	2795.9	6.7514	800	0.65948	3662.6	4157.2	8.6360
185	0.26840	2606.5	2807.8	6.7775	820	0.67185	3700.5	4204.4	8.6795
190	0.27202	2615.5	2819.5	6.8029	840	0.68422	3738.6	4251.8	8.7225
195	0.27560	2624.4	2831.1	6.8277	860	0.69659	3777.1	4299.5	8.7650
200	0.27914	2633.1	2842.5	6.8520	880	0.70895	3815.7	4347.4	8.8069
210	0.28615	2650.4	2865.0	6.8991	900	0.72131	3854.7	4395.7	8.8484
220	0.29306	2667.4	2887.2	6.9445	920	0.73367	3893.8	4444.1	8.8894
230	0.29989	2684.2	2909.1	6.9884	940	0.74602	3933.4	4492.9	8.9299
240	0.30665	2700.7	2930.7	7.0311	960	0.75837	3973.1	4541.9	8.9699
250	0.31335	2717.2	2952.2	7.0725	980	0.77072	4013.2	4591.2	9.0096
260	0.32000	2733.6	2973.6	7.1130	1000	0.78307	4053.4	4640.7	9.0488
270	0.32661	2749.8	2994.8	7.1525					

Water/Steam at $p = 0.80$ MPa ($T_{\text{sat}} = 170.406^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099980	-0.03	0.77	-0.00010	270	0.30570	2748.7	2993.3	7.1205
5	0.00099969	21.02	21.82	0.07624	280	0.31189	2765.0	3014.5	7.1593
10	0.00099996	42.00	42.80	0.15101	290	0.31804	2781.3	3035.7	7.1973
15	0.00100057	62.95	63.75	0.22434	300	0.32416	2797.6	3056.9	7.2345
20	0.00100148	83.86	84.66	0.29632	310	0.33026	2813.8	3078.0	7.2710
25	0.00100264	104.77	105.57	0.36702	320	0.33633	2829.9	3099.0	7.3068
30	0.00100406	125.66	126.46	0.43651	330	0.34238	2846.2	3120.1	7.3420
35	0.00100569	146.55	147.35	0.50485	340	0.34841	2862.4	3141.1	7.3766
40	0.00100753	167.43	168.24	0.57209	350	0.35442	2878.7	3162.2	7.4106
45	0.00100957	188.32	189.13	0.63828	360	0.36042	2894.9	3183.2	7.4441
50	0.00101180	209.21	210.02	0.70344	370	0.36641	2911.2	3204.3	7.4772
55	0.00101420	230.11	230.92	0.76763	380	0.37238	2927.5	3225.4	7.5097
60	0.00101678	251.03	251.84	0.83088	390	0.37834	2943.8	3246.5	7.5418
65	0.00101952	271.94	272.76	0.89321	400	0.38428	2960.2	3267.6	7.5734
70	0.00102242	292.87	293.69	0.95467	410	0.39022	2976.6	3288.8	7.6046
75	0.00102548	313.82	314.64	1.0153	420	0.39615	2993.1	3310.0	7.6355
80	0.00102870	334.79	335.61	1.0751	430	0.40207	3009.6	3331.3	7.6659
85	0.00103207	355.77	356.60	1.1341	440	0.40798	3026.2	3352.6	7.6960
90	0.00103559	376.77	377.60	1.1923	450	0.41389	3042.8	3373.9	7.7257
95	0.00103927	397.80	398.63	1.2499	460	0.41979	3059.5	3395.3	7.7550
100	0.00104310	418.86	419.69	1.3067	470	0.42568	3076.2	3416.7	7.7840
105	0.00104709	439.94	440.78	1.3628	480	0.43157	3092.9	3438.2	7.8127
110	0.00105123	461.05	461.89	1.4183	490	0.43745	3109.7	3459.7	7.8411
115	0.00105553	482.20	483.04	1.4731	500	0.44332	3126.6	3481.3	7.8692
120	0.00105999	503.38	504.23	1.5274	520	0.45506	3160.6	3524.6	7.9245
125	0.00106461	524.62	525.47	1.5810	540	0.46678	3194.7	3568.1	7.9787
130	0.00106939	545.88	546.74	1.6341	560	0.47848	3229.1	3611.9	8.0319
135	0.00107435	567.21	568.07	1.6867	580	0.49017	3263.8	3655.9	8.0841
140	0.00107948	588.59	589.45	1.7388	600	0.50185	3298.6	3700.1	8.1354
145	0.00108479	610.01	610.88	1.7903	620	0.51352	3333.8	3744.6	8.1858
150	0.00109028	631.51	632.38	1.8414	640	0.52518	3369.3	3789.4	8.2353
155	0.00109597	653.06	653.94	1.8921	660	0.53683	3404.9	3834.4	8.2841
160	0.00110186	674.70	675.58	1.9423	680	0.54847	3440.9	3879.7	8.3321
165	0.00110795	696.40	697.29	1.9922	700	0.56011	3477.2	3925.3	8.3794
170	0.00111426	718.20	719.09	2.0416	720	0.57174	3513.7	3971.1	8.4260
170.406	0.00111478	719.97	720.86	2.0457	740	0.58336	3550.5	4017.2	8.4720
170.406	0.24034	2576.0	2768.3	6.6616	760	0.59498	3587.5	4063.5	8.5173
175	0.24366	2585.1	2780.0	6.6879	780	0.60659	3624.8	4110.1	8.5619
180	0.24720	2594.6	2792.4	6.7154	800	0.61820	3662.4	4157.0	8.6061
185	0.25068	2604.1	2804.6	6.7420	820	0.62981	3700.4	4204.2	8.6496
190	0.25412	2613.2	2816.5	6.7679	840	0.64141	3738.5	4251.6	8.6926
195	0.25752	2622.2	2828.2	6.7930	860	0.65300	3776.9	4299.3	8.7351
200	0.26088	2631.0	2839.7	6.8176	880	0.66460	3815.5	4347.2	8.7770
210	0.26752	2648.5	2862.5	6.8653	900	0.67619	3854.5	4395.5	8.8185
220	0.27405	2665.7	2884.9	6.9111	920	0.68778	3893.8	4444.0	8.8595
230	0.28050	2682.6	2907.0	6.9554	940	0.69936	3933.2	4492.7	8.9000
240	0.28688	2699.3	2928.8	6.9984	960	0.71095	3972.9	4541.7	8.9400
250	0.29320	2715.8	2950.4	7.0401	980	0.72253	4013.0	4591.0	8.9797
260	0.29947	2732.3	2971.9	7.0808	1000	0.73411	4053.2	4640.5	9.0189
270	0.30570	2748.7	2993.3	7.1205					

Water/Steam at $p = 0.9$ MPa ($T_{\text{sat}} = 175.350^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099975	-0.03	0.87	-0.00009	270	0.27085	2746.3	2990.1	7.0618
5	0.00099964	21.01	21.91	0.07624	280	0.27640	2762.8	3011.6	7.1009
10	0.00099992	42.00	42.90	0.15101	290	0.28192	2779.3	3033.0	7.1392
15	0.00100053	62.94	63.84	0.22433	300	0.28740	2795.6	3054.3	7.1767
20	0.00100143	83.86	84.76	0.29630	310	0.29286	2811.9	3075.5	7.2134
25	0.00100260	104.76	105.66	0.36699	320	0.29829	2828.2	3096.7	7.2495
30	0.00100401	125.65	126.55	0.43648	330	0.30370	2844.6	3117.9	7.2849
35	0.00100565	146.53	147.44	0.50482	340	0.30909	2860.8	3139.0	7.3197
40	0.00100749	167.41	168.32	0.57205	350	0.31447	2877.2	3160.2	7.3539
45	0.00100953	188.30	189.21	0.63823	360	0.31983	2893.5	3181.3	7.3876
50	0.00101175	209.20	210.11	0.70340	370	0.32517	2909.8	3202.5	7.4207
55	0.00101416	230.10	231.01	0.76758	380	0.33050	2926.3	3223.7	7.4534
60	0.00101673	251.00	251.92	0.83082	390	0.33582	2942.6	3244.8	7.4856
65	0.00101947	271.92	272.84	0.89316	400	0.34113	2959.1	3266.1	7.5173
70	0.00102237	292.86	293.78	0.95461	410	0.34643	2975.5	3287.3	7.5486
75	0.00102543	313.80	314.72	1.0152	420	0.35172	2992.1	3308.6	7.5795
80	0.00102865	334.76	335.69	1.0750	430	0.35700	3008.6	3329.9	7.6101
85	0.00103202	355.75	356.68	1.1340	440	0.36227	3025.2	3351.2	7.6402
90	0.00103555	376.75	377.68	1.1923	450	0.36753	3041.8	3372.6	7.6700
95	0.00103922	397.77	398.71	1.2498	460	0.37279	3058.5	3394.0	7.6994
100	0.00104305	418.83	419.77	1.3066	470	0.37804	3075.3	3415.5	7.7285
105	0.00104704	439.91	440.85	1.3627	480	0.38329	3092.0	3437.0	7.7572
110	0.00105118	461.02	461.97	1.4182	490	0.38853	3108.9	3458.6	7.7857
115	0.00105547	482.17	483.12	1.4730	500	0.39376	3125.8	3480.2	7.8138
120	0.00105993	503.35	504.30	1.5273	520	0.40422	3159.8	3523.6	7.8692
125	0.00106455	524.57	525.53	1.5809	540	0.41465	3194.0	3567.2	7.9235
130	0.00106933	545.85	546.81	1.6340	560	0.42508	3228.4	3611.0	7.9768
135	0.00107429	567.16	568.13	1.6866	580	0.43549	3263.2	3655.1	8.0290
140	0.00107942	588.54	589.51	1.7387	600	0.44588	3298.1	3699.4	8.0803
145	0.00108472	609.96	610.94	1.7902	620	0.45627	3333.3	3743.9	8.1308
150	0.00109022	631.46	632.44	1.8413	640	0.46665	3368.7	3788.7	8.1804
155	0.00109590	653.01	654.00	1.8920	660	0.47702	3404.5	3833.8	8.2292
160	0.00110179	674.65	675.64	1.9422	680	0.48738	3440.5	3879.1	8.2773
165	0.00110788	696.35	697.35	1.9921	700	0.49773	3476.7	3924.7	8.3246
170	0.00111418	718.14	719.14	2.0415	720	0.50808	3513.2	3970.5	8.3712
175	0.00112072	740.01	741.02	2.0906	740	0.51842	3550.0	4016.6	8.4172
175.350	0.00112118	741.55	742.56	2.0940	760	0.52876	3587.1	4063.0	8.4625
175.350	0.21489	2579.6	2773.0	6.6213	780	0.53909	3624.4	4109.6	8.5072
180	0.21792	2589.1	2785.2	6.6482	800	0.54941	3662.1	4156.6	8.5514
185	0.22112	2598.8	2797.8	6.6759	820	0.55974	3699.9	4203.7	8.5949
190	0.22426	2608.3	2810.1	6.7027	840	0.57005	3738.2	4251.2	8.6379
195	0.22736	2617.6	2822.2	6.7286	860	0.58037	3776.6	4298.9	8.6804
200	0.23042	2626.7	2834.1	6.7539	880	0.59068	3815.3	4346.9	8.7224
210	0.23644	2644.6	2857.4	6.8027	900	0.60099	3854.2	4395.1	8.7639
220	0.24236	2662.2	2880.3	6.8495	920	0.61130	3893.4	4443.6	8.8049
230	0.24818	2679.3	2902.7	6.8946	940	0.62160	3933.0	4492.4	8.8454
240	0.25393	2696.4	2924.9	6.9382	960	0.63190	3972.7	4541.4	8.8855
250	0.25962	2713.1	2946.8	6.9805	980	0.64220	4012.7	4590.7	8.9251
260	0.26526	2729.8	2968.5	7.0216	1000	0.65250	4053.0	4640.2	8.9643
270	0.27085	2746.3	2990.1	7.0618					

Water/Steam at $p = 1.0$ MPa ($T_{\text{sat}} = 179.878^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099970	-0.02	0.98	-0.00009
5	0.00099959	21.01	22.01	0.07624
10	0.00099987	41.99	42.99	0.15100
15	0.00100048	62.94	63.94	0.22431
20	0.00100138	83.85	84.85	0.29628
25	0.00100255	104.75	105.75	0.36697
30	0.00100397	125.64	126.64	0.43645
35	0.00100560	146.52	147.53	0.50478
40	0.00100744	167.40	168.41	0.57202
45	0.00100948	188.29	189.30	0.63819
50	0.00101171	209.18	210.19	0.70335
55	0.00101411	230.08	231.09	0.76753
60	0.00101669	250.98	252.00	0.83077
65	0.00101943	271.90	272.92	0.89310
70	0.00102233	292.84	293.86	0.95455
75	0.00102539	313.78	314.81	1.0152
80	0.00102860	334.74	335.77	1.0750
85	0.00103197	355.72	356.75	1.1340
90	0.00103550	376.72	377.76	1.1922
95	0.00103917	397.75	398.79	1.2497
100	0.00104300	418.80	419.84	1.3065
105	0.00104699	439.87	440.92	1.3626
110	0.00105112	460.99	462.04	1.4181
115	0.00105542	482.13	483.19	1.4729
120	0.00105987	503.32	504.38	1.5272
125	0.00106449	524.54	525.60	1.5808
130	0.00106927	545.81	546.88	1.6339
135	0.00107423	567.13	568.20	1.6865
140	0.00107935	588.50	589.58	1.7386
145	0.00108466	609.93	611.01	1.7901
150	0.00109015	631.41	632.50	1.8412
155	0.00109583	652.96	654.06	1.8919
160	0.00110171	674.60	675.70	1.9421
165	0.00110780	696.30	697.41	1.9919
170	0.00111410	718.09	719.20	2.0414
175	0.00112063	739.96	741.08	2.0905
179.878	0.00112723	761.39	762.52	2.1381
179.878	0.19436	2582.7	2777.1	6.5850
180	0.19444	2583.0	2777.4	6.5857
185	0.19742	2593.3	2790.7	6.6148
190	0.20034	2603.2	2803.5	6.6427
195	0.20320	2612.8	2816.0	6.6695
200	0.20602	2622.3	2828.3	6.6955
210	0.21156	2640.6	2852.2	6.7456
220	0.21698	2658.5	2875.5	6.7934
230	0.22231	2676.1	2898.4	6.8393
240	0.22756	2693.3	2920.9	6.8836
250	0.23275	2710.4	2943.1	6.9265
260	0.23788	2727.2	2965.1	6.9681
270	0.24296	2743.9	2986.9	7.0087

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.24296	2743.9	2986.9	7.0087
280	0.24801	2760.6	3008.6	7.0482
290	0.25301	2777.2	3030.2	7.0868
300	0.25799	2793.6	3051.6	7.1246
310	0.26294	2810.1	3073.0	7.1616
320	0.26786	2826.5	3094.4	7.1979
330	0.27276	2842.9	3115.7	7.2335
340	0.27764	2859.3	3136.9	7.2685
350	0.28250	2875.7	3158.2	7.3029
360	0.28735	2892.0	3179.4	7.3367
370	0.29218	2908.5	3200.7	7.3700
380	0.29700	2924.9	3221.9	7.4028
390	0.30181	2941.4	3243.2	7.4351
400	0.30661	2957.9	3264.5	7.4669
410	0.31139	2974.4	3285.8	7.4984
420	0.31617	2990.9	3307.1	7.5294
430	0.32094	3007.6	3328.5	7.5600
440	0.32569	3024.2	3349.9	7.5902
450	0.33045	3040.9	3371.3	7.6200
460	0.33519	3057.6	3392.8	7.6495
470	0.33993	3074.4	3414.3	7.6786
480	0.34466	3091.1	3435.8	7.7075
490	0.34939	3108.0	3457.4	7.7360
500	0.35411	3125.0	3479.1	7.7641
520	0.36354	3159.1	3522.6	7.8196
540	0.37295	3193.3	3566.2	7.8740
560	0.38235	3227.8	3610.1	7.9273
580	0.39174	3262.5	3654.2	7.9796
600	0.40111	3297.5	3698.6	8.0310
620	0.41047	3332.7	3743.2	8.0815
640	0.41982	3368.2	3788.0	8.1312
660	0.42916	3403.9	3833.1	8.1800
680	0.43850	3440.0	3878.5	8.2281
700	0.44783	3476.3	3924.1	8.2755
720	0.45715	3512.9	3970.0	8.3221
740	0.46647	3549.6	4016.1	8.3681
760	0.47578	3586.7	4062.5	8.4135
780	0.48508	3624.1	4109.2	8.4582
800	0.49438	3661.7	4156.1	8.5024
820	0.50368	3699.6	4203.3	8.5460
840	0.51297	3737.8	4250.8	8.5890
860	0.52226	3776.2	4298.5	8.6315
880	0.53155	3814.9	4346.5	8.6735
900	0.54083	3854.0	4394.8	8.7150
920	0.55011	3893.2	4443.3	8.7560
940	0.55939	3932.7	4492.1	8.7965
960	0.56867	3972.4	4541.1	8.8366
980	0.57794	4012.5	4590.4	8.8763
1000	0.58721	4052.7	4639.9	8.9155

Water/Steam at $p = 1.1$ MPa ($T_{\text{sat}} = 184.062^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099965	-0.02	1.08	-0.00008	270	0.22014	2741.5	2983.7	6.9602
5	0.00099954	21.01	22.11	0.07623	280	0.22477	2758.4	3005.6	7.0001
10	0.00099982	41.99	43.09	0.15099	290	0.22936	2775.1	3027.4	7.0391
15	0.00100043	62.93	64.03	0.22430	300	0.23392	2791.7	3049.0	7.0772
20	0.00100134	83.85	84.95	0.29626	310	0.23845	2808.2	3070.5	7.1144
25	0.00100251	104.74	105.84	0.36694	320	0.24296	2824.7	3092.0	7.1509
30	0.00100392	125.63	126.73	0.43642	330	0.24744	2841.2	3113.4	7.1868
35	0.00100556	146.51	147.62	0.50475	340	0.25190	2857.7	3134.8	7.2219
40	0.00100740	167.39	168.50	0.57198	350	0.25635	2874.2	3156.2	7.2565
45	0.00100944	188.28	189.39	0.63815	360	0.26078	2890.6	3177.5	7.2905
50	0.00101166	209.17	210.28	0.70330	370	0.26519	2907.2	3198.9	7.3239
55	0.00101407	230.06	231.18	0.76748	380	0.26959	2923.7	3220.2	7.3568
60	0.00101664	250.97	252.09	0.83072	390	0.27398	2940.1	3241.5	7.3892
65	0.00101938	271.89	273.01	0.89305	400	0.27836	2956.7	3262.9	7.4212
70	0.00102228	292.82	293.94	0.95449	410	0.28272	2973.3	3284.3	7.4527
75	0.00102534	313.76	314.89	1.0151	420	0.28708	2989.8	3305.6	7.4838
80	0.00102856	334.72	335.85	1.0749	430	0.29143	3006.5	3327.1	7.5145
85	0.00103192	355.69	356.83	1.1339	440	0.29577	3023.2	3348.5	7.5448
90	0.00103545	376.70	377.84	1.1921	450	0.30010	3039.9	3370.0	7.5747
95	0.00103912	397.72	398.86	1.2496	460	0.30443	3056.6	3391.5	7.6042
100	0.00104295	418.77	419.92	1.3064	470	0.30875	3073.5	3413.1	7.6335
105	0.00104693	439.85	441.00	1.3626	480	0.31306	3090.3	3434.7	7.6623
110	0.00105107	460.95	462.11	1.4180	490	0.31737	3107.2	3456.3	7.6909
115	0.00105537	482.10	483.26	1.4729	500	0.32167	3124.2	3478.0	7.7191
120	0.00105982	503.28	504.45	1.5271	520	0.33026	3158.2	3521.5	7.7747
125	0.00106443	524.50	525.67	1.5807	540	0.33884	3192.6	3565.3	7.8291
130	0.00106922	545.77	546.95	1.6338	560	0.34740	3227.1	3609.2	7.8825
135	0.00107417	567.09	568.27	1.6864	580	0.35594	3261.9	3653.4	7.9349
140	0.00107929	588.45	589.64	1.7384	600	0.36447	3296.9	3697.8	7.9864
145	0.00108459	609.88	611.07	1.7900	620	0.37300	3332.1	3742.4	8.0369
150	0.00109008	631.36	632.56	1.8411	640	0.38151	3367.6	3787.3	8.0866
155	0.00109576	652.91	654.12	1.8918	660	0.39001	3403.5	3832.5	8.1355
160	0.00110164	674.54	675.75	1.9420	680	0.39851	3439.4	3877.8	8.1836
165	0.00110773	696.24	697.46	1.9918	700	0.40700	3475.8	3923.5	8.2310
170	0.00111403	718.02	719.25	2.0413	720	0.41548	3512.4	3969.4	8.2777
175	0.00112055	739.90	741.13	2.0904	740	0.42396	3549.2	4015.6	8.3237
180	0.00112731	761.86	763.10	2.1391	760	0.43243	3586.3	4062.0	8.3691
184.062	0.00113299	779.78	781.03	2.1785	780	0.44090	3623.7	4108.7	8.4139
184.062	0.17745	2585.4	2780.6	6.5520	800	0.44936	3661.3	4155.6	8.4581
185	0.17797	2587.4	2783.2	6.5576	820	0.45781	3699.3	4202.9	8.5017
190	0.18072	2597.8	2796.6	6.5868	840	0.46627	3737.4	4250.3	8.5447
195	0.18340	2607.9	2809.6	6.6146	860	0.47472	3775.9	4298.1	8.5872
200	0.18603	2617.7	2822.3	6.6415	880	0.48317	3814.6	4346.1	8.6292
210	0.19118	2636.5	2846.8	6.6929	900	0.49161	3853.6	4394.4	8.6707
220	0.19620	2654.9	2870.7	6.7417	920	0.50005	3892.8	4442.9	8.7117
230	0.20113	2672.8	2894.0	6.7885	940	0.50849	3932.4	4491.7	8.7523
240	0.20597	2690.2	2916.8	6.8335	960	0.51693	3972.2	4540.8	8.7924
250	0.21075	2707.6	2939.4	6.8770	980	0.52536	4012.2	4590.1	8.8321
260	0.21547	2724.7	2961.7	6.9192	1000	0.53379	4052.5	4639.7	8.8713
270	0.22014	2741.5	2983.7	6.9602					

Water/Steam at $p = 1.2$ MPa ($T_{\text{sat}} = 187.957^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099960	-0.02	1.18	-0.00008
5	0.00099949	21.01	22.21	0.07623
10	0.00099977	41.99	43.19	0.15098
15	0.00100039	62.93	64.13	0.22428
20	0.00100129	83.84	85.04	0.29623
25	0.00100246	104.74	105.94	0.36692
30	0.00100388	125.62	126.82	0.43639
35	0.00100551	146.50	147.71	0.50471
40	0.00100736	167.38	168.59	0.57194
45	0.00100939	188.27	189.48	0.63811
50	0.00101162	209.16	210.37	0.70326
55	0.00101402	230.04	231.26	0.76743
60	0.00101660	250.95	252.17	0.83067
65	0.00101933	271.87	273.09	0.89299
70	0.00102223	292.79	294.02	0.95444
75	0.00102529	313.74	314.97	1.0150
80	0.00102851	334.70	335.93	1.0748
85	0.00103188	355.67	356.91	1.1338
90	0.00103540	376.67	377.91	1.1921
95	0.00103907	397.69	398.94	1.2496
100	0.00104290	418.74	419.99	1.3064
105	0.00104688	439.81	441.07	1.3625
110	0.00105102	460.92	462.18	1.4179
115	0.00105531	482.06	483.33	1.4728
120	0.00105976	503.25	504.52	1.5270
125	0.00106438	524.46	525.74	1.5806
130	0.00106916	545.73	547.01	1.6337
135	0.00107410	567.04	568.33	1.6863
140	0.00107923	588.41	589.71	1.7383
145	0.00108453	609.83	611.13	1.7899
150	0.00109001	631.32	632.63	1.8410
155	0.00109569	652.87	654.18	1.8916
160	0.00110157	674.49	675.81	1.9419
165	0.00110765	696.19	697.52	1.9917
170	0.00111395	717.97	719.31	2.0411
175	0.00112047	739.84	741.18	2.0902
180	0.00112723	761.80	763.15	2.1390
185	0.00113424	783.87	785.23	2.1874
187.957	0.00113850	796.96	798.33	2.2159
187.957	0.16326	2587.8	2783.7	6.5217
190	0.16432	2592.2	2789.4	6.5340
195	0.16686	2602.8	2803.0	6.5631
200	0.16934	2612.9	2816.1	6.5909
210	0.17417	2632.3	2841.3	6.6437
220	0.17887	2651.1	2865.7	6.6937
230	0.18346	2669.3	2889.5	6.7414
240	0.18797	2687.1	2912.7	6.7872
250	0.19241	2704.7	2935.6	6.8313
260	0.19679	2722.1	2958.2	6.8740
270	0.20111	2739.2	2980.5	6.9155

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.20111	2739.2	2980.5	6.9155
280	0.20540	2756.1	3002.6	6.9558
290	0.20964	2772.9	3024.5	6.9951
300	0.21386	2789.7	3046.3	7.0335
310	0.21804	2806.4	3068.0	7.0710
320	0.22220	2823.0	3089.6	7.1078
330	0.22634	2839.6	3111.2	7.1438
340	0.23045	2856.2	3132.7	7.1792
350	0.23455	2872.7	3154.2	7.2139
360	0.23863	2889.2	3175.6	7.2480
370	0.24270	2905.8	3197.0	7.2816
380	0.24675	2922.3	3218.4	7.3147
390	0.25079	2939.0	3239.9	7.3472
400	0.25482	2955.5	3261.3	7.3793
410	0.25883	2972.1	3282.7	7.4109
420	0.26284	2988.8	3304.2	7.4421
430	0.26684	3005.5	3325.7	7.4728
440	0.27083	3022.2	3347.2	7.5032
450	0.27482	3038.9	3368.7	7.5332
460	0.27879	3055.8	3390.3	7.5628
470	0.28276	3072.6	3411.9	7.5921
480	0.28673	3089.4	3433.5	7.6210
490	0.29069	3106.4	3455.2	7.6496
500	0.29464	3123.3	3476.9	7.6779
520	0.30253	3157.5	3520.5	7.7336
540	0.31041	3191.8	3564.3	7.7881
560	0.31826	3226.4	3608.3	7.8416
580	0.32611	3261.3	3652.6	7.8940
600	0.33394	3296.3	3697.0	7.9455
620	0.34177	3331.6	3741.7	7.9961
640	0.34958	3367.1	3786.6	8.0459
660	0.35739	3402.9	3831.8	8.0948
680	0.36518	3439.0	3877.2	8.1430
700	0.37297	3475.3	3922.9	8.1904
720	0.38076	3511.9	3968.8	8.2371
740	0.38853	3548.8	4015.0	8.2832
760	0.39631	3585.9	4061.5	8.3286
780	0.40407	3623.3	4108.2	8.3734
800	0.41184	3661.0	4155.2	8.4176
820	0.41959	3698.9	4202.4	8.4612
840	0.42735	3737.1	4249.9	8.5042
860	0.43510	3775.6	4297.7	8.5468
880	0.44285	3814.3	4345.7	8.5888
900	0.45059	3853.3	4394.0	8.6303
920	0.45834	3892.6	4442.6	8.6713
940	0.46608	3932.1	4491.4	8.7119
960	0.47381	3971.9	4540.5	8.7520
980	0.48155	4011.9	4589.8	8.7917
1000	0.48928	4052.3	4639.4	8.8310

Water/Steam at $p = 1.3$ MPa ($T_{\text{sat}} = 191.605^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099955	-0.02	1.28	-0.00007	270	0.18501	2736.7	2977.2	6.8739
5	0.00099945	21.01	22.31	0.07623	280	0.18900	2753.8	2999.5	6.9146
10	0.00099973	41.99	43.29	0.15097	290	0.19296	2770.8	3021.6	6.9543
15	0.00100034	62.92	64.22	0.22427	300	0.19688	2787.7	3043.6	6.9930
20	0.00100125	83.83	85.13	0.29621	310	0.20077	2804.5	3065.5	7.0308
25	0.00100242	104.73	106.03	0.36689	320	0.20464	2821.3	3087.3	7.0678
30	0.00100383	125.62	126.92	0.43636	330	0.20848	2837.9	3108.9	7.1041
35	0.00100547	146.49	147.80	0.50468	340	0.21230	2854.6	3130.6	7.1396
40	0.00100731	167.37	168.68	0.57190	350	0.21610	2871.2	3152.1	7.1745
45	0.00100935	188.25	189.56	0.63806	360	0.21989	2887.8	3173.7	7.2088
50	0.00101157	209.13	210.45	0.70321	370	0.22366	2904.4	3195.2	7.2425
55	0.00101398	230.03	231.35	0.76738	380	0.22742	2921.1	3216.7	7.2757
60	0.00101655	250.94	252.26	0.83061	390	0.23116	2937.7	3238.2	7.3084
65	0.00101929	271.84	273.17	0.89293	400	0.23490	2954.3	3259.7	7.3406
70	0.00102219	292.77	294.10	0.95438	410	0.23862	2971.0	3281.2	7.3723
75	0.00102525	313.72	315.05	1.0150	420	0.24233	2987.7	3302.7	7.4036
80	0.00102846	334.67	336.01	1.0748	430	0.24604	3004.4	3324.3	7.4344
85	0.00103183	355.65	356.99	1.1337	440	0.24973	3021.2	3345.8	7.4649
90	0.00103535	376.64	377.99	1.1920	450	0.25342	3038.0	3367.4	7.4949
95	0.00103902	397.67	399.02	1.2495	460	0.25710	3054.8	3389.0	7.5246
100	0.00104285	418.71	420.07	1.3063	470	0.26077	3071.7	3410.7	7.5539
105	0.00104683	439.79	441.15	1.3624	480	0.26444	3088.6	3432.4	7.5829
110	0.00105096	460.89	462.26	1.4178	490	0.26811	3105.6	3454.1	7.6116
115	0.00105526	482.03	483.40	1.4727	500	0.27176	3122.6	3475.9	7.6399
120	0.00105971	503.21	504.59	1.5269	520	0.27906	3156.7	3519.5	7.6957
125	0.00106432	524.43	525.81	1.5806	540	0.28635	3191.1	3563.4	7.7503
130	0.00106910	545.69	547.08	1.6336	560	0.29362	3225.8	3607.5	7.8038
135	0.00107404	567.00	568.40	1.6862	580	0.30087	3260.6	3651.7	7.8563
140	0.00107916	588.37	589.77	1.7382	600	0.30811	3295.7	3696.2	7.9079
145	0.00108446	609.79	611.20	1.7898	620	0.31534	3331.1	3741.0	7.9586
150	0.00108995	631.27	632.69	1.8409	640	0.32257	3366.6	3785.9	8.0083
155	0.00109562	652.82	654.24	1.8915	660	0.32978	3402.4	3831.1	8.0573
160	0.00110150	674.44	675.87	1.9417	680	0.33698	3438.5	3876.6	8.1055
165	0.00110757	696.13	697.57	1.9916	700	0.34418	3474.9	3922.3	8.1530
170	0.00111387	717.91	719.36	2.0410	720	0.35137	3511.5	3968.3	8.1997
175	0.00112039	739.77	741.23	2.0901	740	0.35856	3548.4	4014.5	8.2458
180	0.00112714	761.73	763.20	2.1388	760	0.36574	3585.5	4061.0	8.2912
185	0.00113415	783.80	785.27	2.1873	780	0.37292	3622.9	4107.7	8.3361
190	0.00114141	805.97	807.45	2.2354	800	0.38009	3660.6	4154.7	8.3803
191.605	0.00114380	813.11	814.60	2.2508	820	0.38725	3698.6	4202.0	8.4239
191.605	0.15119	2590.0	2786.5	6.4936	840	0.39442	3736.8	4249.5	8.4670
195	0.15283	2597.3	2796.0	6.5141	860	0.40158	3775.2	4297.3	8.5095
200	0.15519	2607.9	2809.6	6.5431	880	0.40873	3814.1	4345.4	8.5516
210	0.15976	2628.0	2835.7	6.5975	900	0.41589	3853.0	4393.7	8.5931
220	0.16418	2647.3	2860.7	6.6487	920	0.42304	3892.2	4442.2	8.6342
230	0.16850	2665.8	2884.9	6.6973	940	0.43018	3931.9	4491.1	8.6747
240	0.17273	2684.0	2908.5	6.7439	960	0.43733	3971.6	4540.1	8.7149
250	0.17688	2701.9	2931.8	6.7887	980	0.44447	4011.7	4589.5	8.7546
260	0.18097	2719.3	2954.6	6.8320	1000	0.45161	4052.0	4639.1	8.7938
270	0.18501	2736.7	2977.2	6.8739					

Water/Steam at $p = 1.4$ MPa ($T_{\text{sat}} = 195.039^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099950	-0.02	1.38	-0.00006
5	0.00099940	21.01	22.41	0.07623
10	0.00099968	41.98	43.38	0.15096
15	0.00100029	62.92	64.32	0.22425
20	0.00100120	83.83	85.23	0.29619
25	0.00100237	104.72	106.12	0.36686
30	0.00100379	125.60	127.01	0.43633
35	0.00100542	146.48	147.89	0.50464
40	0.00100727	167.36	168.77	0.57186
45	0.00100931	188.24	189.65	0.63802
50	0.00101153	209.12	210.54	0.70317
55	0.00101393	230.01	231.43	0.76733
60	0.00101650	250.92	252.34	0.83056
65	0.00101924	271.83	273.26	0.89288
70	0.00102214	292.75	294.18	0.95432
75	0.00102520	313.69	315.13	1.0149
80	0.00102841	334.65	336.09	1.0747
85	0.00103178	355.63	357.07	1.1337
90	0.00103530	376.62	378.07	1.1919
95	0.00103897	397.64	399.09	1.2494
100	0.00104280	418.68	420.14	1.3062
105	0.00104678	439.75	441.22	1.3623
110	0.00105091	460.86	462.33	1.4178
115	0.00105520	481.99	483.47	1.4726
120	0.00105965	503.18	504.66	1.5268
125	0.00106426	524.39	525.88	1.5805
130	0.00106904	545.65	547.15	1.6335
135	0.00107398	566.97	568.47	1.6861
140	0.00107910	588.32	589.83	1.7381
145	0.00108440	609.74	611.26	1.7897
150	0.00108988	631.22	632.75	1.8408
155	0.00109555	652.77	654.30	1.8914
160	0.00110142	674.39	675.93	1.9416
165	0.00110750	696.08	697.63	1.9914
170	0.00111379	717.86	719.42	2.0409
175	0.00112031	739.72	741.29	2.0900
180	0.00112706	761.67	763.25	2.1387
185	0.00113406	783.73	785.32	2.1871
190	0.00114132	805.90	807.50	2.2353
195	0.00114886	828.18	829.79	2.2831
195.039	0.00114892	828.36	829.97	2.2835
195.039	0.14078	2591.7	2788.8	6.4675
200	0.14303	2602.8	2803.0	6.4975
210	0.14738	2623.6	2829.9	6.5538
220	0.15158	2643.3	2855.5	6.6062
230	0.15566	2662.3	2880.2	6.6559
240	0.15965	2680.8	2904.3	6.7033
250	0.16356	2698.9	2927.9	6.7488
260	0.16741	2716.6	2951.0	6.7926
270	0.17120	2734.1	2973.8	6.8350

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.17120	2734.1	2973.8	6.8350
280	0.17495	2751.5	2996.4	6.8762
290	0.17865	2768.7	3018.8	6.9162
300	0.18232	2785.7	3040.9	6.9552
310	0.18597	2802.5	3062.9	6.9933
320	0.18958	2819.5	3084.9	7.0306
330	0.19317	2836.3	3106.7	7.0671
340	0.19674	2853.0	3128.4	7.1028
350	0.20029	2869.7	3150.1	7.1379
360	0.20383	2886.3	3171.7	7.1723
370	0.20734	2903.0	3193.3	7.2062
380	0.21085	2919.7	3214.9	7.2395
390	0.21434	2936.4	3236.5	7.2723
400	0.21782	2953.2	3258.1	7.3046
410	0.22129	2969.9	3279.7	7.3364
420	0.22475	2986.6	3301.2	7.3678
430	0.22820	3003.3	3322.8	7.3987
440	0.23164	3020.2	3344.5	7.4292
450	0.23508	3037.0	3366.1	7.4594
460	0.23851	3053.9	3387.8	7.4891
470	0.24193	3070.8	3409.5	7.5185
480	0.24534	3087.7	3431.2	7.5476
490	0.24875	3104.8	3453.0	7.5763
500	0.25216	3121.8	3474.8	7.6047
520	0.25895	3156.0	3518.5	7.6605
540	0.26573	3190.4	3562.4	7.7152
560	0.27249	3225.1	3606.6	7.7688
580	0.27923	3260.0	3650.9	7.8214
600	0.28597	3295.0	3695.4	7.8730
620	0.29269	3330.4	3740.2	7.9237
640	0.29941	3366.0	3785.2	7.9736
660	0.30612	3401.9	3830.5	8.0226
680	0.31281	3438.1	3876.0	8.0708
700	0.31951	3474.4	3921.7	8.1183
720	0.32619	3511.0	3967.7	8.1651
740	0.33287	3548.0	4014.0	8.2112
760	0.33954	3585.1	4060.5	8.2567
780	0.34621	3622.5	4107.2	8.3015
800	0.35287	3660.3	4154.3	8.3457
820	0.35953	3698.3	4201.6	8.3894
840	0.36619	3736.4	4249.1	8.4325
860	0.37284	3774.9	4296.9	8.4751
880	0.37949	3813.7	4345.0	8.5171
900	0.38614	3852.7	4393.3	8.5587
920	0.39278	3892.0	4441.9	8.5997
940	0.39942	3931.5	4490.7	8.6403
960	0.40606	3971.3	4539.8	8.6805
980	0.41270	4011.4	4589.2	8.7202
1000	0.41933	4051.7	4638.8	8.7594

Water/Steam at $p = 1.5$ MPa ($T_{\text{sat}} = 198.287^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099945	-0.02	1.48	-0.00006	270	0.15923	2731.7	2970.5	6.7984
5	0.00099935	21.01	22.51	0.07623	280	0.16276	2749.2	2993.3	6.8400
10	0.00099963	41.98	43.48	0.15095	290	0.16625	2766.4	3015.8	6.8804
15	0.00100025	62.91	64.41	0.22424	300	0.16971	2783.6	3038.2	6.9198
20	0.00100115	83.82	85.32	0.29617	310	0.17313	2800.7	3060.4	6.9582
25	0.00100233	104.71	106.21	0.36684	320	0.17653	2817.6	3082.4	6.9957
30	0.00100374	125.59	127.10	0.43630	330	0.17990	2834.5	3104.4	7.0324
35	0.00100538	146.47	147.98	0.50461	340	0.18325	2851.3	3126.2	7.0683
40	0.00100722	167.35	168.86	0.57182	350	0.18659	2868.1	3148.0	7.1036
45	0.00100926	188.23	189.74	0.63798	360	0.18990	2884.9	3169.8	7.1382
50	0.00101149	209.10	210.62	0.70312	370	0.19320	2901.7	3191.5	7.1722
55	0.00101389	230.00	231.52	0.76728	380	0.19649	2918.5	3213.2	7.2057
60	0.00101646	250.90	252.42	0.83051	390	0.19976	2935.2	3234.8	7.2386
65	0.00101920	271.81	273.34	0.89282	400	0.20302	2952.0	3256.5	7.2710
70	0.00102210	292.74	294.27	0.95426	410	0.20627	2968.7	3278.1	7.3029
75	0.00102515	313.67	315.21	1.0148	420	0.20951	2985.5	3299.8	7.3343
80	0.00102837	334.63	336.17	1.0746	430	0.21274	3002.3	3321.4	7.3654
85	0.00103173	355.60	357.15	1.1336	440	0.21597	3019.1	3343.1	7.3960
90	0.00103525	376.60	378.15	1.1918	450	0.21918	3036.0	3364.8	7.4262
95	0.00103892	397.61	399.17	1.2493	460	0.22239	3052.9	3386.5	7.4560
100	0.00104275	418.66	420.22	1.3061	470	0.22559	3069.9	3408.3	7.4855
105	0.00104673	439.72	441.29	1.3622	480	0.22879	3086.8	3430.0	7.5146
110	0.00105086	460.82	462.40	1.4177	490	0.23198	3103.8	3451.8	7.5433
115	0.00105515	481.97	483.55	1.4725	500	0.23516	3121.0	3473.7	7.5718
120	0.00105959	503.14	504.73	1.5267	520	0.24152	3155.2	3517.5	7.6277
125	0.00106420	524.35	525.95	1.5804	540	0.24785	3189.7	3561.5	7.6825
130	0.00106898	545.62	547.22	1.6334	560	0.25418	3224.4	3605.7	7.7362
135	0.00107392	566.92	568.53	1.6860	580	0.26048	3259.4	3650.1	7.7888
140	0.00107904	588.28	589.90	1.7380	600	0.26678	3294.5	3694.7	7.8405
145	0.00108433	609.70	611.33	1.7896	620	0.27307	3329.9	3739.5	7.8912
150	0.00108981	631.18	632.81	1.8407	640	0.27934	3365.5	3784.5	7.9411
155	0.00109548	652.72	654.36	1.8913	660	0.28561	3401.4	3829.8	7.9902
160	0.00110135	674.34	675.99	1.9415	680	0.29187	3437.6	3875.4	8.0385
165	0.00110742	696.03	697.69	1.9913	700	0.29812	3473.9	3921.1	8.0860
170	0.00111371	717.80	719.47	2.0407	720	0.30436	3510.7	3967.2	8.1328
175	0.00112023	739.66	741.34	2.0898	740	0.31060	3547.5	4013.4	8.1789
180	0.00112697	761.61	763.30	2.1386	760	0.31684	3584.7	4060.0	8.2244
185	0.00113397	783.67	785.37	2.1870	780	0.32306	3622.2	4106.8	8.2693
190	0.00114123	805.83	807.54	2.2351	800	0.32929	3659.9	4153.8	8.3135
195	0.00114876	828.11	829.83	2.2830	820	0.33551	3697.8	4201.1	8.3572
198.287	0.00115387	842.83	844.56	2.3143	840	0.34173	3736.1	4248.7	8.4003
198.287	0.13171	2593.4	2791.0	6.4430	860	0.34794	3774.6	4296.5	8.4429
200	0.13245	2597.3	2796.0	6.4536	880	0.35415	3813.4	4344.6	8.4850
210	0.13664	2618.9	2823.9	6.5120	900	0.36036	3852.4	4392.9	8.5266
220	0.14065	2639.2	2850.2	6.5659	920	0.36656	3891.7	4441.5	8.5676
230	0.14453	2658.7	2875.5	6.6166	940	0.37276	3931.3	4490.4	8.6082
240	0.14831	2677.5	2900.0	6.6649	960	0.37896	3971.1	4539.5	8.6484
250	0.15201	2695.9	2923.9	6.7111	980	0.38516	4011.2	4588.9	8.6881
260	0.15565	2713.9	2947.4	6.7555	1000	0.39135	4051.5	4638.5	8.7274
270	0.15923	2731.7	2970.5	6.7984					

Water/Steam at $p = 1.6 \text{ MPa}$ ($T_{\text{sat}} = 201.370^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099940	-0.01	1.59	-0.00005
5	0.00099930	21.01	22.61	0.07622
10	0.00099958	41.98	43.58	0.15094
15	0.00100020	62.91	64.51	0.22422
20	0.00100111	83.82	85.42	0.29615
25	0.00100228	104.71	106.31	0.36681
30	0.00100370	125.58	127.19	0.43627
35	0.00100533	146.46	148.07	0.50458
40	0.00100718	167.33	168.94	0.57178
45	0.00100922	188.21	189.82	0.63794
50	0.00101144	209.09	210.71	0.70307
55	0.00101384	229.98	231.60	0.76723
60	0.00101641	250.88	252.51	0.83045
65	0.00101915	271.79	273.42	0.89276
70	0.00102205	292.71	294.35	0.95420
75	0.00102511	313.65	315.29	1.0148
80	0.00102832	334.60	336.25	1.0746
85	0.00103168	355.58	357.23	1.1335
90	0.00103520	376.56	378.22	1.1918
95	0.00103887	397.58	399.24	1.2493
100	0.00104270	418.62	420.29	1.3060
105	0.00104667	439.70	441.37	1.3621
110	0.00105080	460.80	462.48	1.4176
115	0.00105509	481.93	483.62	1.4724
120	0.00105954	503.10	504.80	1.5266
125	0.00106415	524.32	526.02	1.5803
130	0.00106892	545.57	547.28	1.6334
135	0.00107386	566.88	568.60	1.6859
140	0.00107898	588.23	589.96	1.7379
145	0.00108427	609.66	611.39	1.7895
150	0.00108975	631.13	632.87	1.8405
155	0.00109541	652.67	654.42	1.8912
160	0.00110128	674.29	676.05	1.9414
165	0.00110735	695.97	697.74	1.9912
170	0.00111364	717.74	719.52	2.0406
175	0.00112014	739.60	741.39	2.0897
180	0.00112689	761.55	763.35	2.1384
185	0.00113388	783.61	785.42	2.1868
190	0.00114113	805.76	807.59	2.2350
195	0.00114866	828.04	829.88	2.2828
200	0.00115648	850.44	852.29	2.3305
201.370	0.00115868	856.61	858.46	2.3435
201.370	0.12374	2594.8	2792.8	6.4199
210	0.12722	2614.1	2817.7	6.4720
220	0.13106	2635.1	2844.8	6.5274
230	0.13477	2655.0	2870.6	6.5792
240	0.13838	2674.2	2895.6	6.6284
250	0.14190	2692.9	2919.9	6.6753
260	0.14535	2711.1	2943.7	6.7204
270	0.14875	2729.1	2967.1	6.7638

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.14875	2729.1	2967.1	6.7638
280	0.15209	2746.8	2990.1	6.8059
290	0.15539	2764.3	3012.9	6.8467
300	0.15866	2781.5	3035.4	6.8863
310	0.16190	2798.8	3057.8	6.9250
320	0.16511	2815.8	3080.0	6.9628
330	0.16829	2832.8	3102.1	6.9997
340	0.17145	2849.8	3124.1	7.0359
350	0.17459	2866.7	3146.0	7.0713
360	0.17772	2883.4	3167.8	7.1061
370	0.18083	2900.3	3189.6	7.1403
380	0.18392	2917.1	3211.4	7.1738
390	0.18700	2933.9	3233.1	7.2069
400	0.19007	2950.8	3254.9	7.2394
410	0.19313	2967.6	3276.6	7.2714
420	0.19618	2984.4	3298.3	7.3030
430	0.19922	3001.2	3320.0	7.3341
440	0.20225	3018.1	3341.7	7.3648
450	0.20527	3035.1	3363.5	7.3950
460	0.20829	3052.0	3385.3	7.4249
470	0.21130	3068.9	3407.0	7.4545
480	0.21430	3086.0	3428.9	7.4836
490	0.21730	3103.0	3450.7	7.5124
500	0.22029	3120.1	3472.6	7.5409
520	0.22626	3154.5	3516.5	7.5970
540	0.23222	3189.0	3560.6	7.6518
560	0.23815	3223.8	3604.8	7.7056
580	0.24408	3258.7	3649.2	7.7583
600	0.24999	3293.9	3693.9	7.8100
620	0.25589	3329.3	3738.7	7.8608
640	0.26178	3365.0	3783.8	7.9108
660	0.26766	3400.9	3829.2	7.9599
680	0.27354	3437.0	3874.7	8.0082
700	0.27940	3473.5	3920.5	8.0557
720	0.28526	3510.2	3966.6	8.1026
740	0.29112	3547.1	4012.9	8.1487
760	0.29697	3584.3	4059.5	8.1943
780	0.30281	3621.8	4106.3	8.2391
800	0.30865	3659.5	4153.3	8.2834
820	0.31449	3697.5	4200.7	8.3271
840	0.32032	3735.8	4248.3	8.3702
860	0.32615	3774.3	4296.1	8.4128
880	0.33197	3813.0	4344.2	8.4549
900	0.33780	3852.1	4392.6	8.4965
920	0.34361	3891.4	4441.2	8.5376
940	0.34943	3931.0	4490.1	8.5782
960	0.35525	3970.8	4539.2	8.6184
980	0.36106	4010.9	4588.6	8.6581
1000	0.36687	4051.2	4638.2	8.6974

Water/Steam at $p = 1.8 \text{ MPa}$ ($T_{\text{sat}} = 207.112^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099929	-0.01	1.79	-0.00004	270	0.13126	2723.8	2960.1	6.6996
5	0.00099920	21.01	22.81	0.07622	280	0.13430	2742.0	2983.7	6.7426
10	0.00099949	41.97	43.77	0.15092	290	0.13729	2759.8	3006.9	6.7842
15	0.00100011	62.90	64.70	0.22419	300	0.14025	2777.4	3029.9	6.8246
20	0.00100102	83.80	85.60	0.29611	310	0.14317	2794.9	3052.6	6.8639
25	0.00100219	104.69	106.49	0.36676	320	0.14606	2812.2	3075.1	6.9022
30	0.00100361	125.56	127.37	0.43621	330	0.14893	2829.4	3097.5	6.9396
35	0.00100525	146.44	148.25	0.50451	340	0.15177	2846.5	3119.7	6.9761
40	0.00100709	167.31	169.12	0.57171	350	0.15460	2863.5	3141.8	7.0120
45	0.00100913	188.18	190.00	0.63785	360	0.15741	2880.6	3163.9	7.0471
50	0.00101135	209.06	210.88	0.70298	370	0.16020	2897.5	3185.9	7.0815
55	0.00101375	229.95	231.77	0.76713	380	0.16297	2914.5	3207.8	7.1154
60	0.00101632	250.84	252.67	0.83035	390	0.16573	2931.4	3229.7	7.1487
65	0.00101906	271.76	273.59	0.89265	400	0.16849	2948.3	3251.6	7.1814
70	0.00102196	292.67	294.51	0.95408	410	0.17122	2965.3	3273.5	7.2136
75	0.00102501	313.60	315.45	1.0147	420	0.17395	2982.2	3295.3	7.2454
80	0.00102822	334.56	336.41	1.0744	430	0.17667	2999.2	3317.2	7.2767
85	0.00103159	355.52	357.38	1.1334	440	0.17939	3016.1	3339.0	7.3075
90	0.00103510	376.52	378.38	1.1916	450	0.18209	3033.1	3360.9	7.3380
95	0.00103877	397.53	399.40	1.2491	460	0.18479	3050.1	3382.7	7.3680
100	0.00104260	418.56	420.44	1.3059	470	0.18748	3067.1	3404.6	7.3976
105	0.00104657	439.64	441.52	1.3620	480	0.19016	3084.2	3426.5	7.4269
110	0.00105070	460.73	462.62	1.4174	490	0.19284	3101.4	3448.5	7.4559
115	0.00105498	481.86	483.76	1.4722	500	0.19551	3118.5	3470.4	7.4845
120	0.00105943	503.03	504.94	1.5265	520	0.20084	3153.0	3514.5	7.5407
125	0.00106403	524.24	526.16	1.5801	540	0.20615	3187.6	3558.7	7.5957
130	0.00106880	545.50	547.42	1.6332	560	0.21145	3222.4	3603.0	7.6496
135	0.00107374	566.80	568.73	1.6857	580	0.21673	3257.5	3647.6	7.7025
140	0.00107885	588.15	590.09	1.7377	600	0.22200	3292.7	3692.3	7.7543
145	0.00108414	609.57	611.52	1.7893	620	0.22726	3328.2	3737.3	7.8052
150	0.00108961	631.04	633.00	1.8403	640	0.23251	3363.9	3782.4	7.8552
155	0.00109527	652.57	654.54	1.8909	660	0.23775	3399.9	3827.8	7.9044
160	0.00110113	674.18	676.16	1.9411	680	0.24299	3436.1	3873.5	7.9528
165	0.00110720	695.87	697.86	1.9909	700	0.24821	3472.6	3919.4	8.0004
170	0.00111348	717.63	719.63	2.0404	720	0.25343	3509.3	3965.5	8.0473
175	0.00111998	739.48	741.50	2.0894	740	0.25865	3546.2	4011.8	8.0936
180	0.00112672	761.43	763.46	2.1382	760	0.26386	3583.5	4058.4	8.1391
185	0.00113370	783.47	785.51	2.1866	780	0.26906	3621.0	4105.3	8.1840
190	0.00114095	805.63	807.68	2.2347	800	0.27426	3658.7	4152.4	8.2284
195	0.00114847	827.89	829.96	2.2825	820	0.27945	3696.8	4199.8	8.2721
200	0.00115628	850.29	852.37	2.3301	840	0.28464	3735.0	4247.4	8.3153
207.112	0.00116792	882.37	884.47	2.3975	860	0.28983	3773.6	4295.3	8.3579
207.112	0.11037	2597.2	2795.9	6.3775	880	0.29502	3812.5	4343.5	8.4000
210	0.11145	2604.1	2804.7	6.3958	900	0.30020	3851.5	4391.9	8.4416
220	0.11505	2626.4	2833.5	6.4548	920	0.30537	3890.8	4440.5	8.4828
230	0.11848	2647.3	2860.6	6.5092	940	0.31055	3930.4	4489.4	8.5234
240	0.12180	2667.4	2886.6	6.5602	960	0.31572	3970.3	4538.6	8.5636
250	0.12502	2686.7	2911.7	6.6087	980	0.32089	4010.4	4588.0	8.6033
260	0.12817	2705.5	2936.2	6.6551	1000	0.32606	4050.7	4637.6	8.6426
270	0.13126	2723.8	2960.1	6.6996					

Water/Steam at $p = 2.0$ MPa ($T_{\text{sat}} = 212.377^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099919	-0.01	1.99	-0.00003
5	0.00099910	21.01	23.01	0.07622
10	0.00099939	41.97	43.97	0.15091
15	0.00100001	62.89	64.89	0.22416
20	0.00100093	83.79	85.79	0.29607
25	0.00100210	104.68	106.68	0.36671
30	0.00100352	125.54	127.55	0.43615
35	0.00100516	146.42	148.43	0.50444
40	0.00100700	167.29	169.30	0.57163
45	0.00100904	188.15	190.17	0.63776
50	0.00101126	209.04	211.06	0.70289
55	0.00101366	229.91	231.94	0.76704
60	0.00101623	250.81	252.84	0.83024
65	0.00101897	271.71	273.75	0.89254
70	0.00102187	292.64	294.68	0.95396
75	0.00102492	313.56	315.61	1.0145
80	0.00102813	334.51	336.57	1.0743
85	0.00103149	355.48	357.54	1.1333
90	0.00103501	376.46	378.53	1.1915
95	0.00103867	397.47	399.55	1.2490
100	0.00104249	418.51	420.59	1.3057
105	0.00104647	439.57	441.66	1.3618
110	0.00105059	460.67	462.77	1.4173
115	0.00105487	481.79	483.90	1.4721
120	0.00105931	502.96	505.08	1.5263
125	0.00106392	524.16	526.29	1.5799
130	0.00106868	545.41	547.55	1.6330
135	0.00107362	566.71	568.86	1.6855
140	0.00107872	588.06	590.22	1.7375
145	0.00108401	609.47	611.64	1.7890
150	0.00108948	630.94	633.12	1.8401
155	0.00109513	652.48	654.67	1.8907
160	0.00110099	674.08	676.28	1.9409
165	0.00110705	695.76	697.97	1.9907
170	0.00111332	717.51	719.74	2.0401
175	0.00111982	739.36	741.60	2.0892
180	0.00112655	761.31	763.56	2.1379
185	0.00113353	783.34	785.61	2.1863
190	0.00114076	805.49	807.77	2.2344
195	0.00114827	827.75	830.05	2.2822
200	0.00115607	850.14	852.45	2.3298
210	0.00117262	895.31	897.66	2.4244
212.377	0.00117675	906.15	908.50	2.4468
212.377	0.0995850	2599.1	2798.3	6.3390
220	0.10218	2617.2	2821.6	6.3867
230	0.10541	2639.4	2850.2	6.4440
240	0.10850	2660.2	2877.2	6.4973
250	0.11150	2680.2	2903.2	6.5475
260	0.11441	2699.7	2928.5	6.5952
270	0.11726	2718.6	2953.1	6.6409

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.11726	2718.6	2953.1	6.6409
280	0.12005	2737.0	2977.1	6.6849
290	0.12280	2755.2	3000.8	6.7273
300	0.12551	2773.2	3024.2	6.7684
310	0.12818	2790.9	3047.3	6.8083
320	0.13082	2808.5	3070.1	6.8472
330	0.13344	2825.9	3092.8	6.8851
340	0.13603	2843.2	3115.3	6.9221
350	0.13860	2860.5	3137.7	6.9583
360	0.14115	2877.6	3159.9	6.9937
370	0.14369	2894.7	3182.1	7.0285
380	0.14621	2911.8	3204.2	7.0627
390	0.14872	2928.9	3226.3	7.0962
400	0.15121	2945.9	3248.3	7.1292
410	0.15370	2962.9	3270.3	7.1616
420	0.15617	2980.0	3292.3	7.1935
430	0.15864	2997.0	3314.3	7.2250
440	0.16109	3014.1	3336.3	7.2560
450	0.16354	3031.1	3358.2	7.2866
460	0.16598	3048.2	3380.2	7.3168
470	0.16842	3065.4	3402.2	7.3466
480	0.17085	3082.5	3424.2	7.3760
490	0.17327	3099.7	3446.2	7.4050
500	0.17568	3116.8	3468.2	7.4337
520	0.18050	3151.4	3512.4	7.4901
540	0.18530	3186.1	3556.7	7.5453
560	0.19009	3221.0	3601.2	7.5994
580	0.19486	3256.2	3645.9	7.6523
600	0.19961	3291.5	3690.7	7.7043
620	0.20436	3327.1	3735.8	7.7553
640	0.20910	3362.8	3781.0	7.8054
660	0.21383	3398.8	3826.5	7.8547
680	0.21855	3435.1	3872.2	7.9032
700	0.22326	3471.7	3918.2	7.9509
720	0.22797	3508.4	3964.3	7.9978
740	0.23267	3545.5	4010.8	8.0441
760	0.23737	3582.7	4057.4	8.0897
780	0.24206	3620.2	4104.3	8.1347
800	0.24674	3658.0	4151.5	8.1790
820	0.25142	3696.1	4198.9	8.2228
840	0.25610	3734.4	4246.6	8.2660
860	0.26078	3772.9	4294.5	8.3087
880	0.26545	3811.8	4342.7	8.3509
900	0.27012	3850.9	4391.1	8.3925
920	0.27478	3890.2	4439.8	8.4336
940	0.27944	3929.8	4488.7	8.4743
960	0.28411	3969.7	4537.9	8.5145
980	0.28876	4009.9	4587.4	8.5543
1000	0.29342	4050.2	4637.0	8.5936

Water/Steam at $p = 2.2$ MPa ($T_{\text{sat}} = 217.249^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099909	0.00	2.20	-0.00001	270	0.10579	2713.1	2945.8	6.5866
5	0.00099900	21.01	23.21	0.07621	280	0.10838	2732.1	2970.5	6.6316
10	0.00099930	41.96	44.16	0.15089	290	0.11093	2750.6	2994.6	6.6749
15	0.00099992	62.88	65.08	0.22413	300	0.11344	2768.8	3018.4	6.7167
20	0.00100083	83.78	85.98	0.29603	310	0.11591	2786.9	3041.9	6.7573
25	0.00100201	104.66	106.86	0.36666	320	0.11834	2804.8	3065.1	6.7967
30	0.00100343	125.53	127.74	0.43608	330	0.12075	2822.4	3088.0	6.8351
35	0.00100507	146.39	148.60	0.50437	340	0.12314	2839.9	3110.8	6.8726
40	0.00100691	167.26	169.48	0.57155	350	0.12551	2857.3	3133.4	6.9092
45	0.00100895	188.13	190.35	0.63768	360	0.12785	2874.6	3155.9	6.9450
50	0.00101117	209.01	211.23	0.70280	370	0.13018	2891.9	3178.3	6.9801
55	0.00101357	229.88	232.11	0.76694	380	0.13249	2909.1	3200.6	7.0145
60	0.00101614	250.77	253.01	0.83013	390	0.13479	2926.4	3222.9	7.0483
65	0.00101888	271.68	273.92	0.89243	400	0.13708	2943.5	3245.1	7.0815
70	0.00102177	292.59	294.84	0.95384	410	0.13936	2960.6	3267.2	7.1142
75	0.00102483	313.52	315.77	1.0144	420	0.14162	2977.7	3289.3	7.1463
80	0.00102804	334.47	336.73	1.0742	430	0.14388	2994.9	3311.4	7.1780
85	0.00103140	355.43	357.70	1.1331	440	0.14613	3012.0	3333.5	7.2091
90	0.00103491	376.41	378.69	1.1913	450	0.14837	3029.2	3355.6	7.2399
95	0.00103857	397.42	399.70	1.2488	460	0.15060	3046.3	3377.6	7.2702
100	0.00104239	418.45	420.74	1.3056	470	0.15282	3063.5	3399.7	7.3001
105	0.00104636	439.51	441.81	1.3617	480	0.15504	3080.7	3421.8	7.3296
110	0.00105049	460.60	462.91	1.4171	490	0.15725	3097.9	3443.9	7.3588
115	0.00105477	481.73	484.05	1.4719	500	0.15946	3115.2	3466.0	7.3876
120	0.00105920	502.89	505.22	1.5261	520	0.16386	3149.9	3510.4	7.4442
125	0.00106380	524.09	526.43	1.5797	540	0.16824	3184.7	3554.8	7.4996
130	0.00106856	545.34	547.69	1.6328	560	0.17261	3219.7	3599.4	7.5538
135	0.00107349	566.64	569.00	1.6853	580	0.17696	3254.9	3644.2	7.6069
140	0.00107860	587.98	590.35	1.7373	600	0.18130	3290.3	3689.2	7.6589
145	0.00108388	609.39	611.77	1.7888	620	0.18562	3325.9	3734.3	7.7100
150	0.00108934	630.84	633.24	1.8399	640	0.18994	3361.7	3779.6	7.7603
155	0.00109500	652.38	654.79	1.8905	660	0.19425	3397.8	3825.2	7.8096
160	0.00110085	673.98	676.40	1.9407	680	0.19855	3434.2	3871.0	7.8581
165	0.00110690	695.64	698.08	1.9905	700	0.20285	3470.7	3917.0	7.9059
170	0.00111317	717.40	719.85	2.0399	720	0.20713	3507.5	3963.2	7.9529
175	0.00111966	739.25	741.71	2.0889	740	0.21142	3544.6	4009.7	7.9993
180	0.00112638	761.18	763.66	2.1376	760	0.21569	3581.9	4056.4	8.0449
185	0.00113335	783.22	785.71	2.1860	780	0.21996	3619.5	4103.4	8.0900
190	0.00114058	805.35	807.86	2.2341	800	0.22423	3657.3	4150.6	8.1344
195	0.00114808	827.61	830.14	2.2819	820	0.22849	3695.4	4198.1	8.1782
200	0.00115587	849.99	852.53	2.3295	840	0.23275	3733.7	4245.8	8.2214
210	0.00117239	895.15	897.73	2.4240	860	0.23701	3772.3	4293.7	8.2641
217.249	0.00118523	928.26	930.87	2.4921	880	0.24126	3811.1	4341.9	8.3063
217.249	0.0906980	2600.6	2800.1	6.3038	900	0.24551	3850.3	4390.4	8.3480
220	0.0915850	2607.5	2809.0	6.3218	920	0.24975	3889.7	4439.1	8.3892
230	0.0946670	2630.9	2839.2	6.3826	940	0.25400	3929.3	4488.1	8.4299
240	0.0975920	2652.8	2867.5	6.4383	960	0.25824	3969.2	4537.3	8.4701
250	0.10041	2673.6	2894.5	6.4903	980	0.26247	4009.4	4586.8	8.5099
260	0.10313	2693.6	2920.5	6.5396	1000	0.26671	4049.7	4636.5	8.5492
270	0.10579	2713.1	2945.8	6.5866					

Water/Steam at $p = 2.5$ MPa ($T_{\text{sat}} = 223.950^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099894	0.00	2.50	0.00000	270	0.0919920	2704.6	2934.6	6.5114
5	0.00099886	21.00	23.50	0.07621	280	0.0943580	2724.2	2960.1	6.5581
10	0.00099915	41.96	44.46	0.15086	290	0.0966700	2743.4	2985.1	6.6028
15	0.00099978	62.87	65.37	0.22408	300	0.0989370	2762.3	3009.6	6.6459
20	0.00100070	83.76	86.26	0.29596	310	0.10117	2780.7	3033.6	6.6875
25	0.00100188	104.64	107.14	0.36658	320	0.10336	2799.0	3057.4	6.7278
30	0.00100329	125.50	128.01	0.43599	330	0.10553	2817.0	3080.8	6.7670
35	0.00100493	146.36	148.87	0.50426	340	0.10767	2834.8	3104.0	6.8052
40	0.00100678	167.22	169.74	0.57143	350	0.10979	2852.5	3127.0	6.8424
45	0.00100882	188.09	190.61	0.63755	360	0.11188	2870.1	3149.8	6.8788
50	0.00101104	208.96	211.49	0.70266	370	0.11397	2887.6	3172.5	6.9143
55	0.00101344	229.84	232.37	0.76679	380	0.11603	2905.0	3195.1	6.9492
60	0.00101601	250.72	253.26	0.82998	390	0.11808	2922.5	3217.7	6.9834
65	0.00101874	271.62	274.17	0.89226	400	0.12012	2939.8	3240.1	7.0170
70	0.00102164	292.53	295.08	0.95366	410	0.12215	2957.1	3262.5	7.0500
75	0.00102469	313.46	316.02	1.0142	420	0.12416	2974.4	3284.8	7.0824
80	0.00102789	334.39	336.96	1.0740	430	0.12617	2991.7	3307.1	7.1143
85	0.00103125	355.35	357.93	1.1329	440	0.12816	3008.9	3329.3	7.1458
90	0.00103476	376.33	378.92	1.1911	450	0.13015	3026.2	3351.6	7.1767
95	0.00103843	397.33	399.93	1.2486	460	0.13213	3043.5	3373.8	7.2073
100	0.00104224	418.36	420.97	1.3053	470	0.13411	3060.7	3396.0	7.2374
105	0.00104621	439.41	442.03	1.3614	480	0.13607	3078.1	3418.3	7.2671
110	0.00105033	460.50	463.13	1.4168	490	0.13804	3095.4	3440.5	7.2964
115	0.00105460	481.62	484.26	1.4716	500	0.13999	3112.7	3462.7	7.3254
120	0.00105904	502.78	505.43	1.5258	520	0.14389	3147.6	3507.3	7.3823
125	0.00106363	523.98	526.64	1.5794	540	0.14777	3182.6	3552.0	7.4379
130	0.00106839	545.22	547.89	1.6325	560	0.15163	3217.7	3596.8	7.4923
135	0.00107331	566.52	569.20	1.6850	580	0.15548	3253.0	3641.7	7.5456
140	0.00107841	587.85	590.55	1.7370	600	0.15931	3288.5	3686.8	7.5979
145	0.00108368	609.25	611.96	1.7885	620	0.16314	3324.3	3732.1	7.6491
150	0.00108914	630.71	633.43	1.8395	640	0.16695	3360.1	3777.5	7.6995
155	0.00109479	652.23	654.97	1.8901	660	0.17076	3396.3	3823.2	7.7490
160	0.00110063	673.82	676.57	1.9403	680	0.17456	3432.7	3869.1	7.7976
165	0.00110668	695.48	698.25	1.9901	700	0.17835	3469.3	3915.2	7.8455
170	0.00111293	717.24	720.02	2.0395	720	0.18213	3506.2	3961.5	7.8926
175	0.00111942	739.07	741.87	2.0885	740	0.18591	3543.3	4008.1	7.9390
180	0.00112613	760.99	763.81	2.1372	760	0.18968	3580.7	4054.9	7.9848
185	0.00113309	783.02	785.85	2.1856	780	0.19345	3618.3	4101.9	8.0299
190	0.00114030	805.15	808.00	2.2337	800	0.19721	3656.2	4149.2	8.0743
195	0.00114779	827.40	830.27	2.2815	820	0.20097	3694.3	4196.7	8.1182
200	0.00115556	849.76	852.65	2.3290	840	0.20473	3732.7	4244.5	8.1615
210	0.00117205	894.90	897.83	2.4235	860	0.20848	3771.3	4292.5	8.2043
220	0.00118994	940.66	943.63	2.5173	880	0.21223	3810.2	4340.8	8.2465
223.950	0.00119743	958.92	961.91	2.5543	900	0.21597	3849.4	4389.3	8.2882
223.950	0.0799490	2602.0	2801.9	6.2558	920	0.21972	3888.8	4438.1	8.3294
230	0.0817020	2617.5	2821.8	6.2955	940	0.22346	3928.5	4487.1	8.3702
240	0.0844450	2641.2	2852.3	6.3555	960	0.22719	3968.3	4536.3	8.4104
250	0.0870530	2663.3	2880.9	6.4107	980	0.23093	4008.5	4585.8	8.4503
260	0.0895620	2684.3	2908.2	6.4625	1000	0.23466	4049.0	4635.6	8.4896
270	0.0919920	2704.6	2934.6	6.5114					

Water/Steam at $p = 3.0$ MPa ($T_{\text{sat}} = 233.853^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099869	0.01	3.01	0.00003	270	0.0750660	2689.7	2914.9	6.3987
5	0.00099861	21.00	24.00	0.07619	280	0.0771620	2710.7	2942.2	6.4486
10	0.00099892	41.94	44.94	0.15081	290	0.0791960	2731.0	2968.6	6.4959
15	0.00099955	62.85	65.85	0.22400	300	0.0811790	2750.8	2994.3	6.5412
20	0.00100047	83.73	86.73	0.29586	310	0.0831190	2770.1	3019.5	6.5847
25	0.00100165	104.60	107.60	0.36645	320	0.0850220	2789.1	3044.2	6.6266
30	0.00100307	125.45	128.46	0.43584	330	0.0868930	2807.7	3068.4	6.6672
35	0.00100471	146.31	149.32	0.50409	340	0.0887370	2826.2	3092.4	6.7066
40	0.00100656	167.16	170.18	0.57124	350	0.0905560	2844.4	3116.1	6.7449
45	0.00100860	188.02	191.05	0.63734	360	0.0923550	2862.4	3139.5	6.7823
50	0.00101082	208.89	211.92	0.70243	370	0.0941340	2880.4	3162.8	6.8187
55	0.00101322	229.75	232.79	0.76654	380	0.0958970	2898.2	3185.9	6.8544
60	0.00101579	250.63	253.68	0.82971	390	0.0976450	2915.9	3208.8	6.8892
65	0.00101852	271.52	274.58	0.89198	400	0.0993790	2933.6	3231.7	6.9234
70	0.00102141	292.43	295.49	0.95336	410	0.101110	2951.1	3254.4	6.9570
75	0.00102446	313.35	316.42	1.0139	420	0.10281	2968.7	3277.1	6.9900
80	0.00102766	334.28	337.36	1.0736	430	0.10451	2986.2	3299.7	7.0224
85	0.00103101	355.23	358.32	1.1326	440	0.10620	3003.7	3322.3	7.0542
90	0.00103452	376.21	379.31	1.1908	450	0.10789	3021.1	3344.8	7.0856
95	0.00103818	397.20	400.31	1.2482	460	0.10956	3038.6	3367.3	7.1165
100	0.00104199	418.21	421.34	1.3050	470	0.11123	3056.1	3389.8	7.1470
105	0.00104595	439.26	442.40	1.3610	480	0.11289	3073.6	3412.3	7.1770
110	0.00105006	460.35	463.50	1.4164	490	0.11455	3091.1	3434.8	7.2066
115	0.00105433	481.46	484.62	1.4712	500	0.11620	3108.6	3457.2	7.2359
120	0.00105876	502.60	505.78	1.5254	520	0.11948	3143.8	3502.2	7.2933
125	0.00106334	523.80	526.99	1.5790	540	0.12274	3179.0	3547.2	7.3493
130	0.00106809	545.03	548.23	1.6320	560	0.12599	3214.3	3592.3	7.4041
135	0.00107301	566.31	569.53	1.6845	580	0.12922	3249.8	3637.5	7.4577
140	0.00107810	587.64	590.87	1.7365	600	0.13245	3285.4	3682.8	7.5103
145	0.00108336	609.03	612.28	1.7880	620	0.13566	3321.3	3728.3	7.5618
150	0.00108881	630.47	633.74	1.8390	640	0.13886	3357.4	3774.0	7.6124
155	0.00109444	651.99	655.27	1.8896	660	0.14205	3393.8	3819.9	7.6621
160	0.00110027	673.57	676.87	1.9397	680	0.14523	3430.3	3866.0	7.7109
165	0.00110630	695.22	698.54	1.9895	700	0.14841	3467.0	3912.2	7.7590
170	0.00111255	716.95	720.29	2.0388	720	0.15157	3504.0	3958.7	7.8062
175	0.00111901	738.77	742.13	2.0878	740	0.15474	3541.2	4005.4	7.8528
180	0.00112571	760.68	764.06	2.1365	760	0.15790	3578.7	4052.4	7.8987
185	0.00113265	782.69	786.09	2.1849	780	0.16105	3616.4	4099.5	7.9439
190	0.00113984	804.81	808.23	2.2329	800	0.16420	3654.3	4146.9	7.9885
195	0.00114731	827.04	830.48	2.2807	820	0.16734	3692.6	4194.6	8.0325
200	0.00115506	849.39	852.86	2.3282	840	0.17048	3731.0	4242.4	8.0759
210	0.00117149	894.50	898.01	2.4227	860	0.17362	3769.6	4290.5	8.1187
220	0.00118931	940.19	943.76	2.5164	880	0.17675	3808.6	4338.9	8.1610
230	0.00120873	986.60	990.23	2.6097	900	0.17988	3847.9	4387.5	8.2028
233.853	0.00121669	1004.6	1008.3	2.6455	920	0.18301	3887.3	4436.3	8.2441
233.853	0.0666640	2603.2	2803.2	6.1856	940	0.18613	3927.0	4485.4	8.2849
240	0.0682300	2619.8	2824.5	6.2274	960	0.18925	3967.0	4534.8	8.3252
250	0.0706270	2644.6	2856.5	6.2893	980	0.19237	4007.2	4584.3	8.3651
260	0.0728950	2667.7	2886.4	6.3459	1000	0.19549	4047.6	4634.1	8.4045
270	0.0750660	2689.7	2914.9	6.3987					

Water/Steam at $p = 3.5$ MPa ($T_{\text{sat}} = 242.557^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099844	0.02	3.51	0.00006	270	0.0628980	2673.7	2893.8	6.2968
5	0.00099837	21.01	24.50	0.07618	280	0.0648170	2696.3	2923.2	6.3503
10	0.00099868	41.93	45.43	0.15076	290	0.0666640	2718.0	2951.3	6.4006
15	0.00099932	62.82	66.32	0.22392	300	0.0684530	2738.8	2978.4	6.4484
20	0.00100024	83.70	87.20	0.29575	310	0.0701940	2759.1	3004.8	6.4940
25	0.00100143	104.55	108.06	0.36632	320	0.0718940	2778.9	3030.5	6.5377
30	0.00100285	125.41	128.92	0.43569	330	0.0735590	2798.2	3055.7	6.5799
35	0.00100449	146.25	149.77	0.50391	340	0.0751940	2817.2	3080.4	6.6206
40	0.00100634	167.11	170.63	0.57104	350	0.0768040	2836.0	3104.8	6.6601
45	0.00100838	187.95	191.48	0.63713	360	0.0783900	2854.5	3128.9	6.6984
50	0.00101060	208.81	212.35	0.70219	370	0.0799560	2873.0	3152.8	6.7358
55	0.00101300	229.67	233.22	0.76629	380	0.0815050	2891.1	3176.4	6.7723
60	0.00101556	250.55	254.10	0.82945	390	0.0830380	2909.3	3199.9	6.8079
65	0.00101829	271.44	275.00	0.89169	400	0.0845560	2927.3	3223.2	6.8427
70	0.00102118	292.33	295.90	0.95307	410	0.0860620	2945.1	3246.3	6.8769
75	0.00102423	313.24	316.82	1.0136	420	0.0875560	2963.0	3269.4	6.9104
80	0.00102742	334.16	337.76	1.0733	430	0.0890390	2980.7	3292.3	6.9433
85	0.00103078	355.11	358.72	1.1322	440	0.0905130	2998.4	3315.2	6.9756
90	0.00103428	376.07	379.69	1.1904	450	0.0919780	3016.1	3338.0	7.0074
95	0.00103793	397.06	400.69	1.2478	460	0.0934350	3033.8	3360.8	7.0387
100	0.00104173	418.07	421.72	1.3046	470	0.0948850	3051.5	3383.6	7.0695
105	0.00104569	439.11	442.77	1.3606	480	0.0963280	3069.2	3406.3	7.0998
110	0.00104980	460.19	463.86	1.4160	490	0.0977640	3086.8	3429.0	7.1298
115	0.00105406	481.29	484.98	1.4708	500	0.0991950	3104.4	3451.6	7.1593
120	0.00105848	502.44	506.14	1.5249	520	0.10204	3139.9	3497.0	7.2172
125	0.00106306	523.61	527.33	1.5785	540	0.10487	3175.3	3542.3	7.2737
130	0.00106780	544.83	548.57	1.6315	560	0.10768	3210.8	3587.7	7.3288
135	0.00107271	566.11	569.86	1.6840	580	0.11047	3246.6	3633.2	7.3828
140	0.00107778	587.43	591.20	1.7360	600	0.11325	3282.5	3678.9	7.4356
145	0.00108304	608.81	612.60	1.7874	620	0.11602	3318.5	3724.6	7.4874
150	0.00108847	630.24	634.05	1.8384	640	0.11879	3354.7	3770.5	7.5383
155	0.00109410	651.74	655.57	1.8890	660	0.12154	3391.2	3816.6	7.5882
160	0.00109991	673.31	677.16	1.9391	680	0.12428	3427.8	3862.8	7.6372
165	0.00110593	694.95	698.82	1.9889	700	0.12702	3464.7	3909.3	7.6854
170	0.00111216	716.68	720.57	2.0382	720	0.12975	3501.8	3955.9	7.7329
175	0.00111861	738.48	742.40	2.0872	740	0.13247	3539.2	4002.8	7.7796
180	0.00112529	760.38	764.32	2.1358	760	0.13519	3576.6	4049.8	7.8256
185	0.00113221	782.38	786.34	2.1842	780	0.13790	3614.5	4097.1	7.8709
190	0.00113938	804.47	808.46	2.2322	800	0.14061	3652.5	4144.6	7.9156
195	0.00114683	826.69	830.70	2.2799	820	0.14332	3690.8	4192.4	7.9597
200	0.00115456	849.02	853.06	2.3275	840	0.14602	3729.2	4240.3	8.0032
210	0.00117094	894.08	898.18	2.4218	860	0.14871	3768.1	4288.6	8.0461
220	0.00118869	939.74	943.90	2.5155	880	0.15141	3807.1	4337.0	8.0885
230	0.00120803	986.09	990.32	2.6087	900	0.15410	3846.4	4385.7	8.1303
240	0.00122921	1033.3	1037.6	2.7016	920	0.15678	3885.9	4434.6	8.1717
242.557	0.00123497	1045.5	1049.8	2.7254	940	0.15947	3925.7	4483.8	8.2126
242.557	0.0570580	2602.9	2802.6	6.1243	960	0.16215	3965.7	4533.2	8.2529
250	0.0587570	2624.1	2829.7	6.1764	980	0.16483	4005.9	4582.8	8.2929
260	0.0608880	2649.8	2862.9	6.2393	1000	0.16751	4046.4	4632.7	8.3324
270	0.0628980	2673.7	2893.8	6.2968					

Water/Steam at $p = 4.0$ MPa ($T_{\text{sat}} = 250.354^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099819	0.03	4.02	0.00009	270	0.0536930	2656.4	2871.2	6.2016
5	0.00099813	21.00	24.99	0.07617	280	0.0554970	2680.9	2902.9	6.2595
10	0.00099844	41.92	45.91	0.15072	290	0.0572170	2704.1	2933.0	6.3133
15	0.00099909	62.80	66.80	0.22385	300	0.0588700	2726.2	2961.7	6.3639
20	0.00100001	83.67	87.67	0.29564	310	0.0604680	2747.5	2989.4	6.4118
25	0.00100120	104.52	108.52	0.36619	320	0.0620210	2768.2	3016.3	6.4576
30	0.00100263	125.36	129.37	0.43553	330	0.0635360	2788.4	3042.5	6.5014
35	0.00100427	146.20	150.22	0.50374	340	0.0650190	2808.0	3068.1	6.5435
40	0.00100612	167.05	171.07	0.57085	350	0.0664730	2827.4	3093.3	6.5843
45	0.00100816	187.89	191.92	0.63691	360	0.0679030	2846.5	3118.1	6.6238
50	0.00101038	208.74	212.78	0.70196	370	0.0693110	2865.4	3142.6	6.6621
55	0.00101277	229.59	233.64	0.76604	380	0.0707010	2884.0	3166.8	6.6994
60	0.00101534	250.46	254.52	0.82918	390	0.0720730	2902.4	3190.7	6.7358
65	0.00101807	271.34	275.41	0.89141	400	0.0734310	2920.8	3214.5	6.7714
70	0.00102095	292.23	296.31	0.95277	410	0.0747760	2939.0	3238.1	6.8061
75	0.00102399	313.13	317.23	1.0133	420	0.0761080	2957.1	3261.5	6.8402
80	0.00102719	334.05	338.16	1.0730	430	0.0774290	2975.1	3284.8	6.8736
85	0.00103054	354.99	359.11	1.1319	440	0.0787410	2993.0	3308.0	6.9064
90	0.00103403	375.94	380.08	1.1900	450	0.0800430	3011.0	3331.2	6.9386
95	0.00103768	396.93	401.08	1.2475	460	0.0813370	3028.9	3354.2	6.9703
100	0.00104148	417.93	422.10	1.3042	470	0.0826230	3046.7	3377.2	7.0015
105	0.00104543	438.97	443.15	1.3602	480	0.0839020	3064.6	3400.2	7.0321
110	0.00104953	460.02	464.22	1.4156	490	0.0851750	3082.4	3423.1	7.0624
115	0.00105379	481.12	485.34	1.4703	500	0.0864420	3100.2	3446.0	7.0922
120	0.00105820	502.26	506.49	1.5245	520	0.0889590	3136.0	3491.8	7.1506
125	0.00106277	523.43	527.68	1.5780	540	0.0914570	3171.7	3537.5	7.2075
130	0.00106751	544.64	548.91	1.6310	560	0.0939380	3207.4	3583.2	7.2631
135	0.00107240	565.90	570.19	1.6835	580	0.0964050	3243.4	3629.0	7.3174
140	0.00107747	587.22	591.53	1.7354	600	0.0988590	3279.5	3674.9	7.3705
145	0.00108272	608.58	612.91	1.7869	620	0.10130	3315.7	3720.9	7.4226
150	0.00108814	630.01	634.36	1.8379	640	0.10373	3352.1	3767.0	7.4737
155	0.00109375	651.49	655.87	1.8884	660	0.10616	3388.6	3813.2	7.5238
160	0.00109956	673.05	677.45	1.9385	680	0.10857	3425.4	3859.7	7.5730
165	0.00110556	694.69	699.11	1.9882	700	0.11098	3462.4	3906.3	7.6214
170	0.00111178	716.39	720.84	2.0376	720	0.11338	3499.6	3953.1	7.6690
175	0.00111821	738.19	742.66	2.0865	740	0.11577	3537.0	4000.1	7.7159
180	0.00112487	760.07	764.57	2.1352	760	0.11816	3574.7	4047.3	7.7620
185	0.00113177	782.05	786.58	2.1835	780	0.12054	3612.5	4094.7	7.8074
190	0.00113893	804.13	808.69	2.2315	800	0.12292	3650.6	4142.3	7.8523
195	0.00114635	826.33	830.92	2.2792	820	0.12530	3689.0	4190.2	7.8964
200	0.00115405	848.65	853.27	2.3267	840	0.12767	3727.6	4238.3	7.9400
210	0.00117038	893.67	898.35	2.4210	860	0.13003	3766.5	4286.6	7.9830
220	0.00118807	939.29	944.04	2.5146	880	0.13240	3805.5	4335.1	8.0255
230	0.00120733	985.59	990.42	2.6077	900	0.13476	3844.9	4383.9	8.0674
240	0.00122842	1032.7	1037.6	2.7005	920	0.13712	3884.4	4432.9	8.1088
250	0.00125169	1080.8	1085.8	2.7935	940	0.13947	3924.2	4482.1	8.1498
250.354	0.00125256	1082.5	1087.5	2.7968	960	0.14183	3964.3	4531.6	8.1902
260	0.0497760	2601.7	2800.8	6.0696	980	0.14418	4004.6	4581.3	8.2302
270	0.0536930	2656.4	2871.2	6.2016	1000	0.14652	4045.1	4631.2	8.2697

Water/Steam at $p = 4.5 \text{ MPa}$ ($T_{\text{sat}} = 257.437^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099793	0.04	4.53	0.00011
5	0.00099789	21.00	25.49	0.07615
10	0.00099821	41.91	46.40	0.15067
15	0.00099885	62.79	67.28	0.22377
20	0.00099979	83.64	88.14	0.29554
25	0.00100098	104.49	108.99	0.36605
30	0.00100240	125.32	129.83	0.43538
35	0.00100405	146.15	150.67	0.50356
40	0.00100590	166.98	171.51	0.57066
45	0.00100794	187.82	192.36	0.63670
50	0.00101016	208.66	213.21	0.70173
55	0.00101255	229.51	234.07	0.76579
60	0.00101511	250.37	254.94	0.82892
65	0.00101784	271.24	275.82	0.89113
70	0.00102072	292.13	296.72	0.95247
75	0.00102376	313.02	317.63	1.0130
80	0.00102696	333.94	338.56	1.0727
85	0.00103030	354.86	359.50	1.1315
90	0.00103379	375.82	380.47	1.1897
95	0.00103744	396.79	401.46	1.2471
100	0.00104123	417.78	422.47	1.3038
105	0.00104517	438.82	443.52	1.3598
110	0.00104927	459.87	464.59	1.4152
115	0.00105352	480.96	485.70	1.4699
120	0.00105793	502.08	506.84	1.5240
125	0.00106249	523.24	528.02	1.5776
130	0.00106721	544.45	549.25	1.6305
135	0.00107210	565.71	570.53	1.6830
140	0.00107716	587.00	591.85	1.7349
145	0.00108240	608.36	613.23	1.7864
150	0.00108781	629.77	634.67	1.8373
155	0.00109341	651.26	656.18	1.8879
160	0.00109920	672.80	677.75	1.9379
165	0.00110519	694.42	699.39	1.9876
170	0.00111139	716.12	721.12	2.0369
175	0.00111781	737.90	742.93	2.0859
180	0.00112445	759.77	764.83	2.1345
185	0.00113134	781.74	786.83	2.1827
190	0.00113847	803.81	808.93	2.2307
195	0.00114587	825.98	831.14	2.2784
200	0.00115355	848.28	853.47	2.3259
210	0.00116983	893.27	898.53	2.4201
220	0.00118745	938.84	944.18	2.5136
230	0.00120663	985.09	990.52	2.6067
240	0.00122763	1032.2	1037.7	2.6994
250	0.00125077	1080.2	1085.8	2.7922
257.437	0.00126965	1116.5	1122.2	2.8615
257.437	0.0440590	2599.6	2797.9	6.0197
260	0.0445720	2608.0	2808.6	6.0397
270	0.0464510	2637.7	2846.7	6.1105

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.0464510	2637.7	2846.7	6.1105
280	0.0481860	2664.5	2881.3	6.1737
290	0.0498210	2689.4	2913.6	6.2316
300	0.0513780	2713.0	2944.2	6.2854
310	0.0528730	2735.5	2973.4	6.3359
320	0.0543170	2757.2	3001.6	6.3838
330	0.0557200	2778.2	3028.9	6.4295
340	0.0570870	2798.6	3055.5	6.4732
350	0.0584230	2818.6	3081.5	6.5153
360	0.0597330	2838.2	3107.0	6.5560
370	0.0610210	2857.5	3132.1	6.5953
380	0.0622880	2876.6	3156.9	6.6336
390	0.0635380	2895.5	3181.4	6.6708
400	0.0647720	2914.1	3205.6	6.7070
410	0.0659910	2932.7	3229.7	6.7425
420	0.0671990	2951.1	3253.5	6.7771
430	0.0683940	2969.4	3277.2	6.8111
440	0.0695800	2987.7	3300.8	6.8443
450	0.0707560	3005.8	3324.2	6.8770
460	0.0719240	3023.9	3347.6	6.9091
470	0.0730830	3042.0	3370.9	6.9406
480	0.0742360	3060.0	3394.1	6.9716
490	0.0753810	3078.0	3417.2	7.0022
500	0.0765210	3096.1	3440.4	7.0323
520	0.0787840	3132.0	3486.5	7.0912
540	0.0810270	3168.0	3532.6	7.1486
560	0.0832530	3204.0	3578.6	7.2046
580	0.0854640	3240.1	3624.7	7.2592
600	0.0876620	3276.4	3670.9	7.3127
620	0.0898480	3312.8	3717.1	7.3650
640	0.0920240	3349.3	3763.4	7.4163
660	0.0941910	3386.0	3809.9	7.4666
680	0.0963490	3422.9	3856.5	7.5161
700	0.0985000	3460.1	3903.3	7.5646
720	0.10064	3497.3	3950.2	7.6124
740	0.10278	3534.9	3997.4	7.6594
760	0.10491	3572.6	4044.7	7.7057
780	0.10704	3610.6	4092.3	7.7512
800	0.10916	3648.8	4140.0	7.7962
820	0.11128	3687.2	4188.0	7.8404
840	0.11340	3725.9	4236.2	7.8841
860	0.11551	3764.8	4284.6	7.9272
880	0.11762	3803.9	4333.2	7.9698
900	0.11972	3843.4	4382.1	8.0118
920	0.12182	3882.9	4431.1	8.0533
940	0.12392	3922.9	4480.5	8.0942
960	0.12602	3962.9	4530.0	8.1348
980	0.12811	4003.3	4579.8	8.1748
1000	0.13020	4043.9	4629.8	8.2144

Water/Steam at $p = 5.0$ MPa ($T_{\text{sat}} = 263.941^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099768	0.04	5.03	0.00014	270	0.0405670	2617.0	2819.8	6.0211
5	0.00099764	20.99	25.98	0.07614	280	0.0422740	2646.7	2858.1	6.0909
10	0.00099797	41.89	46.88	0.15062	290	0.0438560	2673.7	2893.0	6.1536
15	0.00099862	62.76	67.75	0.22369	300	0.0453460	2699.0	2925.7	6.2110
20	0.00099956	83.61	88.61	0.29543	310	0.0467660	2722.8	2956.6	6.2646
25	0.00100075	104.45	109.45	0.36592	320	0.0481300	2745.6	2986.2	6.3149
30	0.00100218	125.27	130.28	0.43522	330	0.0494460	2767.5	3014.7	6.3626
35	0.00100383	146.10	151.12	0.50339	340	0.0507240	2788.8	3042.4	6.4080
40	0.00100568	166.92	171.95	0.57046	350	0.0519690	2809.5	3069.3	6.4516
45	0.00100772	187.75	192.79	0.63649	360	0.0531860	2829.7	3095.6	6.4935
50	0.00100994	208.59	213.64	0.70150	370	0.0543780	2849.6	3121.5	6.5340
55	0.00101233	229.43	234.49	0.76555	380	0.0555490	2869.2	3146.9	6.5732
60	0.00101489	250.29	255.36	0.82865	390	0.0567020	2888.4	3171.9	6.6112
65	0.00101762	271.15	276.24	0.89085	400	0.0578370	2907.5	3196.7	6.6483
70	0.00102050	292.03	297.13	0.95218	410	0.0589580	2926.4	3221.2	6.6844
75	0.00102353	312.91	318.03	1.0127	420	0.0600660	2945.1	3245.4	6.7196
80	0.00102672	333.82	338.95	1.0723	430	0.0611620	2963.7	3269.5	6.7541
85	0.00103006	354.75	359.90	1.1312	440	0.0622480	2982.2	3293.4	6.7879
90	0.00103355	375.69	380.86	1.1893	450	0.0633230	3000.6	3317.2	6.8210
95	0.00103719	396.65	401.84	1.2467	460	0.0643900	3018.9	3340.9	6.8535
100	0.00104098	417.65	422.85	1.3034	470	0.0654490	3037.2	3364.4	6.8854
105	0.00104492	438.67	443.89	1.3594	480	0.0665000	3055.4	3387.9	6.9168
110	0.00104901	459.70	464.95	1.4147	490	0.0675450	3073.6	3411.3	6.9477
115	0.00105325	480.79	486.06	1.4695	500	0.0685830	3091.8	3434.7	6.9781
120	0.00105765	501.90	507.19	1.5236	520	0.0706420	3128.0	3481.2	7.0375
125	0.00106220	523.06	528.37	1.5771	540	0.0726810	3164.3	3527.7	7.0954
130	0.00106692	544.26	549.59	1.6301	560	0.0747030	3200.6	3574.1	7.1517
135	0.00107180	565.50	570.86	1.6825	580	0.0767100	3236.8	3620.4	7.2067
140	0.00107685	586.80	592.18	1.7344	600	0.0787040	3273.3	3666.8	7.2605
145	0.00108208	608.14	613.55	1.7858	620	0.0806850	3309.9	3713.3	7.3131
150	0.00108748	629.54	634.98	1.8368	640	0.0826570	3346.6	3759.9	7.3647
155	0.00109307	651.01	656.48	1.8873	660	0.0846190	3383.4	3806.5	7.4152
160	0.00109885	672.55	678.04	1.9374	680	0.0865720	3420.4	3853.3	7.4649
165	0.00110482	694.16	699.68	1.9870	700	0.0885180	3457.7	3900.3	7.5136
170	0.00111101	715.84	721.40	2.0363	720	0.0904570	3495.1	3947.4	7.5615
175	0.00111741	737.60	743.19	2.0852	740	0.0923900	3532.8	3994.7	7.6087
180	0.00112404	759.46	765.08	2.1338	760	0.0943180	3570.6	4042.2	7.6551
185	0.00113091	781.42	787.07	2.1821	780	0.0962400	3608.6	4089.8	7.7008
190	0.00113802	803.47	809.16	2.2300	800	0.0981580	3646.9	4137.7	7.7458
195	0.00114540	825.63	831.36	2.2777	820	0.10007	3685.4	4185.8	7.7902
200	0.00115306	847.91	853.68	2.3251	840	0.10198	3724.2	4234.1	7.8340
210	0.00116928	892.86	898.71	2.4193	860	0.10389	3763.2	4282.6	7.8771
220	0.00118684	938.39	944.32	2.5127	880	0.10579	3802.3	4331.3	7.9198
230	0.00120594	984.59	990.62	2.6057	900	0.10769	3841.8	4380.2	7.9618
240	0.00122684	1031.6	1037.7	2.6983	920	0.10958	3881.5	4429.4	8.0034
250	0.00124987	1079.5	1085.7	2.7910	940	0.11148	3921.4	4478.8	8.0445
260	0.00127547	1128.5	1134.9	2.8841	960	0.11337	3961.5	4528.4	8.0850
263.941	0.00128639	1148.2	1154.6	2.9210	980	0.11526	4002.0	4578.3	8.1251
263.941	0.0394460	2597.0	2794.2	5.9737	1000	0.11715	4042.5	4628.3	8.1648
270	0.0405670	2617.0	2819.8	6.0211					

Water/Steam at $p = 5.5$ MPa ($T_{\text{sat}} = 269.965^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099743	0.05	5.54	0.00016
5	0.00099740	20.99	26.48	0.07612
10	0.00099774	41.88	47.37	0.15057
15	0.00099839	62.74	68.23	0.22361
20	0.00099933	83.58	89.08	0.29532
25	0.00100053	104.41	109.91	0.36579
30	0.00100196	125.23	130.74	0.43507
35	0.00100361	146.04	151.56	0.50321
40	0.00100546	166.86	172.39	0.57027
45	0.00100750	187.69	193.23	0.63627
50	0.00100972	208.52	214.07	0.70127
55	0.00101211	229.35	234.92	0.76530
60	0.00101467	250.20	255.78	0.82839
65	0.00101739	271.05	276.65	0.89057
70	0.00102027	291.93	297.54	0.95188
75	0.00102330	312.81	318.44	1.0123
80	0.00102649	333.70	339.35	1.0720
85	0.00102982	354.63	360.29	1.1309
90	0.00103331	375.56	381.24	1.1890
95	0.00103694	396.52	402.22	1.2463
100	0.00104073	417.51	423.23	1.3030
105	0.00104466	438.51	444.26	1.3590
110	0.00104875	459.55	465.32	1.4143
115	0.00105298	480.62	486.41	1.4690
120	0.00105737	501.73	507.55	1.5231
125	0.00106192	522.88	528.72	1.5766
130	0.00106663	544.06	549.93	1.6296
135	0.00107150	565.30	571.19	1.6820
140	0.00107654	586.58	592.50	1.7339
145	0.00108176	607.92	613.87	1.7853
150	0.00108715	629.31	635.29	1.8362
155	0.00109273	650.77	656.78	1.8867
160	0.00109849	672.30	678.34	1.9368
165	0.00110446	693.90	699.97	1.9864
170	0.00111063	715.56	721.67	2.0357
175	0.00111701	737.32	743.46	2.0846
180	0.00112363	759.16	765.34	2.1331
185	0.00113047	781.10	787.32	2.1814
190	0.00113757	803.13	809.39	2.2293
195	0.00114493	825.28	831.58	2.2769
200	0.00115256	847.55	853.89	2.3243
210	0.00116873	892.45	898.88	2.4184
220	0.00118623	937.94	944.46	2.5118
230	0.00120525	984.09	990.72	2.6047
240	0.00122606	1031.1	1037.8	2.6972
250	0.00124897	1078.8	1085.7	2.7898
260	0.00127442	1127.8	1134.8	2.8828
269.965	0.00130290	1177.9	1185.1	2.9762
269.965	0.0356420	2593.7	2789.7	5.9307
270	0.0356480	2593.8	2789.9	5.9310

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.0356480	2593.8	2789.9	5.9310
280	0.0373670	2627.4	2832.9	6.0095
290	0.0389250	2657.0	2871.1	6.0779
300	0.0403730	2684.1	2906.2	6.1397
310	0.0417400	2709.5	2939.1	6.1966
320	0.0430430	2733.6	2970.3	6.2496
330	0.0442940	2756.5	3000.1	6.2995
340	0.0455020	2778.6	3028.9	6.3468
350	0.0466750	2800.1	3056.8	6.3920
360	0.0478170	2821.0	3084.0	6.4352
370	0.0489340	2841.4	3110.5	6.4769
380	0.0500270	2861.5	3136.6	6.5171
390	0.0511010	2881.2	3162.3	6.5561
400	0.0521580	2900.6	3187.5	6.5939
410	0.0531990	2919.9	3212.5	6.6307
420	0.0542260	2939.0	3237.2	6.6666
430	0.0552410	2957.9	3261.7	6.7017
440	0.0562450	2976.7	3286.0	6.7360
450	0.0572390	2995.3	3310.1	6.7696
460	0.0582240	3013.9	3334.1	6.8025
470	0.0592000	3032.3	3357.9	6.8348
480	0.0601690	3050.8	3381.7	6.8666
490	0.0611310	3069.1	3405.3	6.8978
500	0.0620860	3087.4	3428.9	6.9285
520	0.0639790	3124.0	3475.9	6.9885
540	0.0658520	3160.5	3522.7	7.0468
560	0.0677080	3197.0	3569.4	7.1035
580	0.0695480	3233.6	3616.1	7.1589
600	0.0713740	3270.2	3662.8	7.2130
620	0.0731880	3307.0	3709.5	7.2659
640	0.0749920	3343.8	3756.3	7.3177
660	0.0767870	3380.9	3803.2	7.3685
680	0.0785730	3418.0	3850.2	7.4183
700	0.0803510	3455.4	3897.3	7.4672
720	0.0821230	3492.9	3944.6	7.5153
740	0.0838880	3530.6	3992.0	7.5626
760	0.0856480	3568.5	4039.6	7.6091
780	0.0874030	3606.7	4087.4	7.6549
800	0.0891520	3645.1	4135.4	7.7001
820	0.0908980	3683.7	4183.6	7.7446
840	0.0926400	3722.5	4232.0	7.7884
860	0.0943780	3761.5	4280.6	7.8317
880	0.0961120	3800.8	4329.4	7.8744
900	0.0978440	3840.3	4378.4	7.9166
920	0.0995730	3880.0	4427.7	7.9582
940	0.10130	3920.0	4477.1	7.9993
960	0.10302	3960.2	4526.8	8.0399
980	0.10474	4000.6	4576.7	8.0801
1000	0.10646	4041.4	4626.9	8.1198

Water/Steam at $p = 6.0$ MPa ($T_{\text{sat}} = 275.585^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099718	0.06	6.04	0.00019
5	0.00099716	20.99	26.97	0.07611
10	0.00099750	41.86	47.85	0.15052
15	0.00099816	62.72	68.71	0.22353
20	0.00099911	83.55	89.54	0.29522
25	0.00100031	104.37	110.37	0.36566
30	0.00100174	125.18	131.19	0.43492
35	0.00100339	145.99	152.01	0.50304
40	0.00100524	166.81	172.84	0.57007
45	0.00100728	187.62	193.66	0.63606
50	0.00100950	208.44	214.50	0.70104
55	0.00101189	229.27	235.34	0.76505
60	0.00101445	250.11	256.20	0.82812
65	0.00101717	270.97	277.07	0.89029
70	0.00102004	291.83	297.95	0.95159
75	0.00102307	312.70	318.84	1.0120
80	0.00102626	333.59	339.75	1.0717
85	0.00102959	354.50	360.68	1.1305
90	0.00103307	375.43	381.63	1.1886
95	0.00103670	396.38	402.60	1.2460
100	0.00104048	417.36	423.60	1.3026
105	0.00104441	438.36	444.63	1.3586
110	0.00104848	459.39	465.68	1.4139
115	0.00105271	480.45	486.77	1.4686
120	0.00105710	501.56	507.90	1.5227
125	0.00106164	522.69	529.06	1.5762
130	0.00106634	543.87	550.27	1.6291
135	0.00107120	565.10	571.53	1.6815
140	0.00107624	586.37	592.83	1.7334
145	0.00108144	607.70	614.19	1.7848
150	0.00108682	629.09	635.61	1.8357
155	0.00109239	650.54	657.09	1.8862
160	0.00109814	672.04	678.63	1.9362
165	0.00110409	693.63	700.25	1.9858
170	0.00111025	715.29	721.95	2.0351
175	0.00111662	737.03	743.73	2.0839
180	0.00112321	758.86	765.60	2.1325
185	0.00113004	780.78	787.56	2.1807
190	0.00113712	802.81	809.63	2.2286
195	0.00114446	824.93	831.80	2.2762
200	0.00115207	847.18	854.09	2.3235
210	0.00116818	892.05	899.06	2.4176
220	0.00118562	937.50	944.61	2.5109
230	0.00120457	983.59	990.82	2.6037
240	0.00122528	1030.4	1037.8	2.6961
250	0.00124807	1078.2	1085.7	2.7886
260	0.00127337	1127.1	1134.7	2.8814
270	0.00130177	1177.3	1185.1	2.9750

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00130177	1177.3	1185.1	2.9750
275.585	0.00131926	1206.0	1213.9	3.0278
275.585	0.0324480	2589.9	2784.6	5.8901
280	0.0331990	2606.1	2805.3	5.9277
290	0.0347620	2638.9	2847.5	6.0034
300	0.0361890	2668.4	2885.5	6.0703
310	0.0375210	2695.5	2920.6	6.1310
320	0.0387800	2720.9	2953.6	6.1871
330	0.0399810	2745.0	2984.9	6.2395
340	0.0411350	2768.1	3014.9	6.2888
350	0.0422510	2790.4	3043.9	6.3357
360	0.0433330	2812.0	3072.0	6.3804
370	0.0443880	2833.1	3099.4	6.4233
380	0.0454180	2853.6	3126.1	6.4646
390	0.0464280	2873.8	3152.4	6.5045
400	0.0474190	2893.7	3178.2	6.5432
410	0.0483950	2913.3	3203.7	6.5807
420	0.0493550	2932.8	3228.9	6.6173
430	0.0503030	2952.0	3253.8	6.6530
440	0.0512400	2971.0	3278.4	6.6878
450	0.0521660	2989.9	3302.9	6.7219
460	0.0530830	3008.7	3327.2	6.7552
470	0.0539910	3027.5	3351.4	6.7880
480	0.0548910	3046.1	3375.4	6.8201
490	0.0557840	3064.6	3399.3	6.8516
500	0.0566710	3083.1	3423.1	6.8826
520	0.0584260	3119.9	3470.5	6.9432
540	0.0601610	3156.7	3517.7	7.0020
560	0.0618770	3193.5	3564.8	7.0591
580	0.0635780	3230.3	3611.8	7.1149
600	0.0652650	3267.1	3658.7	7.1693
620	0.0669410	3304.1	3705.7	7.2224
640	0.0686050	3341.1	3752.7	7.2745
660	0.0702600	3378.2	3799.8	7.3255
680	0.0719070	3415.6	3847.0	7.3755
700	0.0735450	3453.0	3894.3	7.4246
720	0.0751770	3490.6	3941.7	7.4729
740	0.0768030	3528.5	3989.3	7.5203
760	0.0784230	3566.5	4037.0	7.5670
780	0.0800380	3604.8	4085.0	7.6129
800	0.0816480	3643.2	4133.1	7.6582
820	0.0832540	3681.9	4181.4	7.7028
840	0.0848560	3720.8	4229.9	7.7467
860	0.0864540	3759.9	4278.6	7.7901
880	0.0880490	3799.2	4327.5	7.8329
900	0.0896410	3838.8	4376.6	7.8751
920	0.0912300	3878.5	4425.9	7.9168
940	0.0928160	3918.6	4475.5	7.9580
960	0.0944000	3958.8	4525.2	7.9987
980	0.0959810	3999.3	4575.2	8.0389
1000	0.0975600	4040.0	4625.4	8.0786

Water/Steam at $p = 6.5$ MPa ($T_{\text{sat}} = 280.858^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099694	0.07	6.55	0.00021	270	0.00130054	1176.4	1184.9	2.9735
5	0.00099692	20.98	27.46	0.07609	280	0.00133260	1228.1	1236.8	3.0682
10	0.00099727	41.86	48.34	0.15047	280.858	0.00133556	1232.7	1241.4	3.0764
15	0.00099793	62.69	69.18	0.22345	280.858	0.0297270	2585.7	2778.9	5.8516
20	0.00099888	83.52	90.01	0.29511	290	0.0311800	2619.3	2822.0	5.9289
25	0.00100009	104.33	110.83	0.36553	300	0.0326070	2651.6	2863.5	6.0019
30	0.00100152	125.13	131.64	0.43476	310	0.0339200	2680.7	2901.2	6.0671
35	0.00100317	145.94	152.46	0.50286	320	0.0351490	2707.7	2936.2	6.1266
40	0.00100502	166.75	173.28	0.56988	330	0.0363130	2733.1	2969.1	6.1817
45	0.00100706	187.55	194.10	0.63585	340	0.0374250	2757.2	3000.5	6.2333
50	0.00100928	208.37	214.93	0.70081	350	0.0384940	2780.4	3030.6	6.2820
55	0.00101167	229.19	235.77	0.76480	360	0.0395280	2802.8	3059.7	6.3283
60	0.00101422	250.03	256.62	0.82786	370	0.0405320	2824.4	3087.9	6.3725
65	0.00101694	270.87	277.48	0.89001	380	0.0415110	2845.6	3115.4	6.4150
70	0.00101982	291.72	298.35	0.95129	390	0.0424670	2866.4	3142.4	6.4559
75	0.00102284	312.59	319.24	1.0117	400	0.0434040	2886.7	3168.8	6.4954
80	0.00102602	333.48	340.15	1.0713	410	0.0443250	2906.7	3194.8	6.5338
85	0.00102935	354.38	361.07	1.1302	420	0.0452300	2926.4	3220.4	6.5710
90	0.00103283	375.31	382.02	1.1883	430	0.0461220	2946.0	3245.8	6.6073
95	0.00103645	396.25	402.99	1.2456	440	0.0470020	2965.3	3270.8	6.6427
100	0.00104023	417.22	423.98	1.3022	450	0.0478710	2984.4	3295.6	6.6773
105	0.00104415	438.21	445.00	1.3582	460	0.0487300	3003.6	3320.3	6.7111
110	0.00104822	459.24	466.05	1.4135	470	0.0495810	3022.4	3344.7	6.7442
115	0.00105245	480.29	487.13	1.4682	480	0.0504230	3041.3	3369.0	6.7767
120	0.00105682	501.38	508.25	1.5222	490	0.0512590	3060.0	3393.2	6.8086
125	0.00106136	522.51	529.41	1.5757	500	0.0520870	3078.7	3417.3	6.8399
130	0.00106605	543.68	550.61	1.6286	520	0.0537260	3115.9	3465.1	6.9011
135	0.00107091	564.90	571.86	1.6810	540	0.0553440	3153.0	3512.7	6.9603
140	0.00107593	586.17	593.16	1.7329	560	0.0569430	3190.1	3560.2	7.0179
145	0.00108112	607.48	614.51	1.7842	580	0.0585260	3227.0	3607.4	7.0740
150	0.00108649	628.86	635.92	1.8351	600	0.0600960	3264.1	3654.7	7.1288
155	0.00109205	650.29	657.39	1.8856	620	0.0616530	3301.2	3701.9	7.1822
160	0.00109779	671.79	678.93	1.9356	640	0.0632000	3338.3	3749.1	7.2345
165	0.00110373	693.37	700.54	1.9852	660	0.0647370	3375.6	3796.4	7.2858
170	0.00110987	715.02	722.23	2.0344	680	0.0662660	3413.1	3843.8	7.3360
175	0.00111623	736.74	744.00	2.0833	700	0.0677860	3450.7	3891.3	7.3853
180	0.00112280	758.56	765.86	2.1318	720	0.0693000	3488.4	3938.9	7.4337
185	0.00112962	780.47	787.81	2.1800	740	0.0708080	3526.3	3986.6	7.4813
190	0.00113667	802.47	809.86	2.2278	760	0.0723100	3564.5	4034.5	7.5281
195	0.00114399	824.59	832.03	2.2754	780	0.0738060	3602.8	4082.5	7.5741
200	0.00115158	846.81	854.30	2.3228	800	0.0752980	3641.4	4130.8	7.6195
210	0.00116764	891.65	899.24	2.4168	820	0.0767860	3680.1	4179.2	7.6642
220	0.00118501	937.05	944.75	2.5100	840	0.0782690	3719.1	4227.8	7.7083
230	0.00120389	983.10	990.93	2.6027	860	0.0797490	3758.2	4276.6	7.7517
240	0.00122451	1029.9	1037.9	2.6951	880	0.0812260	3797.6	4325.6	7.7946
250	0.00124719	1077.6	1085.7	2.7874	900	0.0826990	3837.3	4374.8	7.8369
260	0.00127234	1126.4	1134.7	2.8801	920	0.0841700	3877.1	4424.2	7.8786
270	0.00130054	1176.4	1184.9	2.9735	940	0.0856380	3917.2	4473.8	7.9199
					960	0.0871030	3957.4	4523.6	7.9606
					980	0.0885660	3998.0	4573.7	8.0009
					1000	0.0900270	4038.8	4624.0	8.0407

Water/Steam at $p = 7.0$ MPa ($T_{\text{sat}} = 285.829^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099669	0.07	7.05	0.00023
5	0.00099668	20.98	27.96	0.07607
10	0.00099703	41.84	48.82	0.15041
15	0.00099771	62.68	69.66	0.22336
20	0.00099866	83.49	90.48	0.29500
25	0.00099986	104.29	111.29	0.36540
30	0.00100130	125.09	132.10	0.43461
35	0.00100295	145.89	152.91	0.50269
40	0.00100480	166.69	173.72	0.56968
45	0.00100684	187.49	194.54	0.63563
50	0.00100906	208.30	215.36	0.70058
55	0.00101145	229.11	236.19	0.76456
60	0.00101400	249.94	257.04	0.82760
65	0.00101672	270.77	277.89	0.88973
70	0.00101959	291.62	298.76	0.95100
75	0.00102262	312.49	319.65	1.0114
80	0.00102579	333.37	340.55	1.0710
85	0.00102912	354.27	361.47	1.1298
90	0.00103259	375.18	382.41	1.1879
95	0.00103621	396.12	403.37	1.2452
100	0.00103998	417.08	424.36	1.3019
105	0.00104390	438.06	445.37	1.3578
110	0.00104796	459.07	466.41	1.4131
115	0.00105218	480.12	487.49	1.4677
120	0.00105655	501.21	508.61	1.5218
125	0.00106108	522.33	529.76	1.5753
130	0.00106576	543.49	550.95	1.6282
135	0.00107061	564.70	572.19	1.6805
140	0.00107562	585.95	593.48	1.7324
145	0.00108081	607.26	614.83	1.7837
150	0.00108617	628.63	636.23	1.8346
155	0.00109171	650.05	657.69	1.8850
160	0.00109744	671.54	679.22	1.9350
165	0.00110336	693.11	700.83	1.9846
170	0.00110949	714.74	722.51	2.0338
175	0.00111583	736.46	744.27	2.0826
180	0.00112239	758.25	766.11	2.1311
185	0.00112919	780.16	788.06	2.1793
190	0.00113623	802.15	810.10	2.2271
195	0.00114352	824.25	832.25	2.2747
200	0.00115109	846.45	854.51	2.3220
210	0.00116710	891.25	899.42	2.4159
220	0.00118441	936.61	944.90	2.5091
230	0.00120321	982.62	991.04	2.6017
240	0.00122374	1029.3	1037.9	2.6940
250	0.00124631	1077.0	1085.7	2.7862
260	0.00127131	1125.7	1134.6	2.8788
270	0.00129932	1175.7	1184.8	2.9720

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00129932	1175.7	1184.8	2.9720
280	0.00133112	1227.3	1236.6	3.0665
285.829	0.00135186	1258.2	1267.7	3.1224
285.829	0.0273780	2581.0	2772.6	5.8148
290	0.0280430	2597.8	2794.1	5.8529
300	0.0294920	2633.5	2839.9	5.9337
310	0.0308010	2665.0	2880.6	6.0041
320	0.0320120	2693.8	2917.9	6.0675
330	0.0331490	2720.7	2952.7	6.1257
340	0.0342290	2746.0	2985.6	6.1797
350	0.0352620	2770.1	3016.9	6.2304
360	0.0362570	2793.2	3047.0	6.2784
370	0.0372190	2815.7	3076.2	6.3241
380	0.0381550	2837.4	3104.5	6.3677
390	0.0390670	2858.6	3132.1	6.4097
400	0.0399580	2879.5	3159.2	6.4502
410	0.0408320	2899.9	3185.7	6.4894
420	0.0416900	2920.0	3211.8	6.5273
430	0.0425340	2939.9	3237.6	6.5643
440	0.0433660	2959.5	3263.1	6.6002
450	0.0441870	2979.0	3288.3	6.6353
460	0.0449970	2998.3	3313.3	6.6696
470	0.0457990	3017.4	3338.0	6.7032
480	0.0465920	3036.5	3362.6	6.7360
490	0.0473780	3055.5	3387.1	6.7683
500	0.0481570	3074.3	3411.4	6.8000
520	0.0496960	3111.8	3459.7	6.8617
540	0.0512140	3149.2	3507.7	6.9214
560	0.0527130	3186.5	3555.5	6.9794
580	0.0541960	3223.7	3603.1	7.0359
600	0.0556650	3260.9	3650.6	7.0910
620	0.0571210	3298.3	3698.1	7.1447
640	0.0585670	3335.5	3745.5	7.1973
660	0.0600030	3373.0	3793.0	7.2487
680	0.0614310	3410.6	3840.6	7.2992
700	0.0628500	3448.3	3888.2	7.3486
720	0.0642630	3486.2	3936.0	7.3972
740	0.0656690	3524.2	3983.9	7.4450
760	0.0670700	3562.4	4031.9	7.4919
780	0.0684650	3600.8	4080.1	7.5381
800	0.0698550	3639.4	4128.4	7.5836
820	0.0712420	3678.3	4177.0	7.6284
840	0.0726240	3717.3	4225.7	7.6725
860	0.0740030	3756.6	4274.6	7.7160
880	0.0753780	3796.1	4323.7	7.7590
900	0.0767500	3835.8	4373.0	7.8014
920	0.0781190	3875.6	4422.4	7.8432
940	0.0794850	3915.7	4472.1	7.8845
960	0.0808490	3956.2	4522.1	7.9253
980	0.0822110	3996.7	4572.2	7.9656
1000	0.0835710	4037.5	4622.5	8.0055

Water/Steam at $p = 7.5$ MPa ($T_{\text{sat}} = 290.535^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099644	0.09	7.56	0.00025	270	0.00129812	1174.9	1184.6	2.9705
5	0.00099644	20.98	28.45	0.07605	280	0.00132967	1226.3	1236.3	3.0648
10	0.00099680	41.82	49.30	0.15036	290	0.00136609	1279.8	1290.0	3.1610
15	0.00099748	62.65	70.13	0.22328	290.535	0.00136821	1282.6	1292.9	3.1662
20	0.00099843	83.46	90.95	0.29489	290.535	0.0253300	2575.9	2765.9	5.7793
25	0.00099964	104.25	111.75	0.36526	300	0.0267420	2613.8	2814.4	5.8646
30	0.00100108	125.04	132.55	0.43445	310	0.0280630	2648.3	2858.8	5.9414
35	0.00100273	145.83	153.35	0.50251	320	0.0292680	2679.2	2898.7	6.0093
40	0.00100458	166.63	174.16	0.56949	330	0.0303880	2707.6	2935.5	6.0709
45	0.00100662	187.42	194.97	0.63542	340	0.0314440	2734.3	2970.1	6.1277
50	0.00100884	208.22	215.79	0.70035	350	0.0324490	2759.4	3002.8	6.1806
55	0.00101123	229.04	236.62	0.76431	360	0.0334120	2783.4	3034.0	6.2304
60	0.00101378	249.86	257.46	0.82733	370	0.0343400	2806.6	3064.1	6.2776
65	0.00101650	270.69	278.31	0.88945	380	0.0352390	2829.0	3093.3	6.3225
70	0.00101937	291.52	299.17	0.95070	390	0.0361130	2850.9	3121.7	6.3656
75	0.00102239	312.38	320.05	1.0111	400	0.0369660	2872.2	3149.4	6.4071
80	0.00102556	333.26	340.95	1.0707	410	0.0378010	2893.0	3176.5	6.4471
85	0.00102888	354.14	361.86	1.1295	420	0.0386190	2913.5	3203.1	6.4858
90	0.00103235	375.05	382.79	1.1876	430	0.0394220	2933.7	3229.4	6.5234
95	0.00103597	395.98	403.75	1.2449	440	0.0402120	2953.7	3255.3	6.5600
100	0.00103973	416.93	424.73	1.3015	450	0.0409920	2973.5	3280.9	6.5956
105	0.00104364	437.91	445.74	1.3574	460	0.0417600	2993.0	3306.2	6.6304
110	0.00104770	458.92	466.78	1.4127	470	0.0425200	3012.4	3331.3	6.6644
115	0.00105191	479.96	487.85	1.4673	480	0.0432700	3031.7	3356.2	6.6977
120	0.00105628	501.04	508.96	1.5213	490	0.0440140	3050.8	3380.9	6.7303
125	0.00106080	522.15	530.11	1.5748	500	0.0447500	3069.9	3405.5	6.7623
130	0.00106547	543.30	551.29	1.6277	520	0.0462030	3107.7	3454.2	6.8246
135	0.00107031	564.50	572.53	1.6800	540	0.0476340	3145.3	3502.6	6.8848
140	0.00107532	585.75	593.81	1.7319	560	0.0490460	3183.0	3550.8	6.9433
145	0.00108049	607.05	615.15	1.7832	580	0.0504420	3220.4	3598.7	7.0001
150	0.00108584	628.40	636.54	1.8341	600	0.0518240	3257.8	3646.5	7.0555
155	0.00109137	649.81	658.00	1.8845	620	0.0531930	3295.3	3694.2	7.1096
160	0.00109709	671.29	679.52	1.9344	640	0.0545520	3332.8	3741.9	7.1624
165	0.00110300	692.84	701.11	1.9840	660	0.0559000	3370.4	3789.6	7.2141
170	0.00110911	714.46	722.78	2.0332	680	0.0572400	3408.1	3837.4	7.2647
175	0.00111544	736.17	744.54	2.0820	700	0.0585720	3445.9	3885.2	7.3144
180	0.00112199	757.96	766.37	2.1304	720	0.0598970	3483.9	3933.1	7.3631
185	0.00112876	779.83	788.30	2.1786	740	0.0612150	3522.1	3981.2	7.4110
190	0.00113578	801.82	810.34	2.2264	760	0.0625280	3560.3	4029.3	7.4581
195	0.00114306	823.90	832.47	2.2739	780	0.0638360	3598.9	4077.7	7.5044
200	0.00115060	846.10	854.73	2.3212	800	0.0651380	3637.6	4126.1	7.5500
210	0.00116656	890.86	899.61	2.4151	820	0.0664370	3676.5	4174.8	7.5949
220	0.00118381	936.17	945.05	2.5082	840	0.0677310	3715.6	4223.6	7.6391
230	0.00120254	982.12	991.14	2.6007	860	0.0690220	3754.9	4272.6	7.6828
240	0.00122298	1028.8	1038.0	2.6929	880	0.0703090	3794.4	4321.7	7.7258
250	0.00124543	1076.4	1085.7	2.7851	900	0.0715930	3834.2	4371.1	7.7682
260	0.00127030	1125.0	1134.5	2.8775	920	0.0728750	3874.1	4420.7	7.8101
270	0.00129812	1174.9	1184.6	2.9705	940	0.0741530	3914.4	4470.5	7.8515
					960	0.0754300	3954.8	4520.5	7.8924
					980	0.0767030	3995.4	4570.7	7.9327
					1000	0.0779750	4036.3	4621.1	7.9726

Water/Steam at $p = 8.0$ MPa ($T_{\text{sat}} = 295.008^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099619	0.09	8.06	0.00027
5	0.00099620	20.97	28.94	0.07603
10	0.00099657	41.82	49.79	0.15031
15	0.00099725	62.63	70.61	0.22320
20	0.00099821	83.42	91.41	0.29478
25	0.00099942	104.21	112.21	0.36513
30	0.00100086	125.00	133.01	0.43430
35	0.00100251	145.78	153.80	0.50234
40	0.00100437	166.57	174.60	0.56929
45	0.00100640	187.36	195.41	0.63521
50	0.00100862	208.15	216.22	0.70012
55	0.00101101	228.95	237.04	0.76406
60	0.00101356	249.77	257.88	0.82707
65	0.00101627	270.59	278.72	0.88917
70	0.00101914	291.43	299.58	0.95041
75	0.00102216	312.27	320.45	1.0108
80	0.00102533	333.14	341.34	1.0704
85	0.00102865	354.02	362.25	1.1292
90	0.00103211	374.92	383.18	1.1872
95	0.00103572	395.84	404.13	1.2445
100	0.00103948	416.79	425.11	1.3011
105	0.00104339	437.76	446.11	1.3570
110	0.00104744	458.77	467.15	1.4123
115	0.00105165	479.80	488.21	1.4669
120	0.00105600	500.86	509.31	1.5209
125	0.00106052	521.97	530.45	1.5743
130	0.00106519	543.11	551.63	1.6272
135	0.00107002	564.30	572.86	1.6795
140	0.00107501	585.54	594.14	1.7313
145	0.00108017	606.83	615.47	1.7827
150	0.00108551	628.18	636.86	1.8335
155	0.00109103	649.57	658.30	1.8839
160	0.00109674	671.05	679.82	1.9339
165	0.00110264	692.58	701.40	1.9834
170	0.00110874	714.19	723.06	2.0326
175	0.00111505	735.88	744.80	2.0813
180	0.00112158	757.66	766.63	2.1298
185	0.00112834	779.52	788.55	2.1779
190	0.00113534	801.49	810.57	2.2257
195	0.00114259	823.56	832.70	2.2732
200	0.00115011	845.74	854.94	2.3205
210	0.00116603	890.46	899.79	2.4143
220	0.00118322	935.73	945.20	2.5073
230	0.00120187	981.64	991.25	2.5997
240	0.00122222	1028.3	1038.1	2.6919
250	0.00124457	1075.7	1085.7	2.7839
260	0.00126929	1124.3	1134.5	2.8761
270	0.00129693	1174.1	1184.5	2.9690

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00129693	1174.1	1184.5	2.9690
280	0.00132823	1225.4	1236.0	3.0631
290	0.00136430	1278.7	1289.6	3.1590
295.008	0.00138467	1306.2	1317.3	3.2081
295.008	0.0235260	2570.5	2758.7	5.7450
300	0.0242790	2592.3	2786.5	5.7937
310	0.0256300	2630.4	2835.4	5.8783
320	0.0268400	2663.7	2878.4	5.9515
330	0.0279520	2694.0	2917.6	6.0170
340	0.0289920	2722.0	2953.9	6.0768
350	0.0299750	2748.3	2988.1	6.1321
360	0.0309120	2773.3	3020.6	6.1838
370	0.0318120	2797.3	3051.8	6.2327
380	0.0326810	2820.4	3081.8	6.2790
390	0.0335240	2842.8	3111.0	6.3233
400	0.0343440	2864.6	3139.4	6.3658
410	0.0351440	2885.9	3167.1	6.4067
420	0.0359280	2906.9	3194.3	6.4462
430	0.0366960	2927.4	3221.0	6.4845
440	0.0374510	2947.7	3247.3	6.5217
450	0.0381940	2967.7	3273.3	6.5579
460	0.0389260	2987.6	3299.0	6.5931
470	0.0396480	3007.2	3324.4	6.6276
480	0.0403620	3026.7	3349.6	6.6613
490	0.0410680	3046.2	3374.7	6.6942
500	0.0417670	3065.4	3399.5	6.7266
520	0.0431450	3103.5	3448.7	6.7895
540	0.0445010	3141.6	3497.6	6.8503
560	0.0458380	3179.3	3546.0	6.9092
580	0.0471580	3217.0	3594.3	6.9664
600	0.0484630	3254.7	3642.4	7.0221
620	0.0497560	3292.4	3690.4	7.0764
640	0.0510380	3330.0	3738.3	7.1295
660	0.0523100	3367.7	3786.2	7.1814
680	0.0535730	3405.6	3834.2	7.2323
700	0.0548280	3443.6	3882.2	7.2821
720	0.0560770	3481.7	3930.3	7.3310
740	0.0573180	3520.0	3978.5	7.3791
760	0.0585540	3558.4	4026.8	7.4263
780	0.0597850	3596.9	4075.2	7.4727
800	0.0610110	3635.7	4123.8	7.5184
820	0.0622330	3674.6	4172.5	7.5635
840	0.0634500	3713.9	4221.5	7.6078
860	0.0646640	3753.3	4270.6	7.6515
880	0.0658740	3792.8	4319.8	7.6946
900	0.0670820	3832.6	4369.3	7.7371
920	0.0682860	3872.7	4419.0	7.7791
940	0.0694880	3912.9	4468.8	7.8206
960	0.0706870	3953.4	4518.9	7.8615
980	0.0718840	3994.0	4569.1	7.9019
1000	0.0730790	4035.0	4619.6	7.9419

Water/Steam at $p = 9.0$ MPa ($T_{\text{sat}} = 303.345^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099569	0.10	9.06	0.00031	270	0.00129458	1172.5	1184.2	2.9661
5	0.00099572	20.97	29.93	0.07599	280	0.00132540	1223.6	1235.5	3.0598
10	0.00099610	41.79	50.75	0.15020	290	0.00136080	1276.6	1288.8	3.1552
15	0.00099679	62.59	71.56	0.22303	300	0.00140239	1331.9	1344.5	3.2533
20	0.00099776	83.37	92.35	0.29457	303.345	0.00141811	1351.1	1363.9	3.2870
25	0.00099898	104.14	113.13	0.36486	303.345	0.0204900	2558.5	2742.9	5.6791
30	0.00100042	124.91	133.91	0.43399	310	0.0214480	2589.7	2782.7	5.7478
35	0.00100208	145.68	154.70	0.50199	320	0.0227080	2629.6	2834.0	5.8350
40	0.00100393	166.44	175.48	0.56890	330	0.0238310	2664.5	2879.0	5.9101
45	0.00100597	187.23	196.28	0.63478	340	0.0248590	2696.0	2919.7	5.9771
50	0.00100819	208.01	217.08	0.69966	350	0.0258160	2725.0	2957.3	6.0380
55	0.00101057	228.79	237.89	0.76357	360	0.0267180	2752.1	2992.6	6.0942
60	0.00101312	249.59	258.71	0.82654	370	0.0275770	2777.9	3026.1	6.1467
65	0.00101583	270.41	279.55	0.88862	380	0.0283990	2802.5	3058.1	6.1961
70	0.00101869	291.23	300.40	0.94982	390	0.0291920	2826.3	3089.0	6.2429
75	0.00102170	312.06	321.26	1.0102	400	0.0299600	2849.2	3118.8	6.2876
80	0.00102487	332.92	342.14	1.0697	410	0.0307060	2871.5	3147.9	6.3304
85	0.00102818	353.79	363.04	1.1285	420	0.0314330	2893.3	3176.2	6.3716
90	0.00103163	374.68	383.96	1.1865	430	0.0321440	2914.6	3203.9	6.4114
95	0.00103524	395.58	404.90	1.2438	440	0.0328410	2935.6	3231.2	6.4499
100	0.00103899	416.51	425.86	1.3003	450	0.0335240	2956.3	3258.0	6.4872
105	0.00104288	437.46	446.85	1.3562	460	0.0341970	2976.7	3284.5	6.5235
110	0.00104693	458.46	467.88	1.4114	470	0.0348590	2996.9	3310.6	6.5589
115	0.00105112	479.47	488.93	1.4660	480	0.0355120	3016.8	3336.4	6.5935
120	0.00105546	500.52	510.02	1.5200	490	0.0361560	3036.6	3362.0	6.6272
125	0.00105996	521.61	531.15	1.5734	500	0.0367930	3056.3	3387.4	6.6603
130	0.00106461	542.74	552.32	1.6263	520	0.0380470	3095.2	3437.6	6.7244
135	0.00106942	563.91	573.53	1.6786	540	0.0392780	3133.8	3487.3	6.7862
140	0.00107440	585.12	594.79	1.7303	560	0.0404880	3172.1	3536.5	6.8461
145	0.00107955	606.39	616.11	1.7816	580	0.0416820	3210.3	3585.4	6.9041
150	0.00108487	627.72	637.48	1.8324	600	0.0428610	3248.4	3634.1	6.9605
155	0.00109036	649.11	658.92	1.8828	620	0.0440270	3286.4	3682.6	7.0154
160	0.00109604	670.55	680.41	1.9327	640	0.0451810	3324.4	3731.0	7.0690
165	0.00110192	692.06	701.98	1.9822	660	0.0463260	3362.5	3779.4	7.1214
170	0.00110799	713.65	723.62	2.0313	680	0.0474610	3400.6	3827.7	7.1726
175	0.00111427	735.32	745.35	2.0801	700	0.0485890	3438.8	3876.1	7.2229
180	0.00112077	757.06	767.15	2.1285	720	0.0497090	3477.1	3924.5	7.2721
185	0.00112749	778.90	789.05	2.1765	740	0.0508230	3515.6	3973.0	7.3205
190	0.00113446	800.84	811.05	2.2243	760	0.0519310	3554.2	4021.6	7.3680
195	0.00114167	822.88	833.15	2.2717	780	0.0530340	3593.0	4070.3	7.4147
200	0.00114915	845.03	855.37	2.3189	800	0.0541320	3631.9	4119.1	7.4606
210	0.00116496	889.68	900.16	2.4126	820	0.0552260	3671.1	4168.1	7.5058
220	0.00118203	934.86	945.50	2.5055	840	0.0563150	3710.5	4217.3	7.5503
230	0.00120055	980.68	991.48	2.5978	860	0.0574010	3749.9	4266.5	7.5942
240	0.00122072	1027.2	1038.2	2.6897	880	0.0584830	3789.7	4316.0	7.6375
250	0.00124285	1074.6	1085.8	2.7815	900	0.0595620	3829.6	4365.7	7.6802
260	0.00126730	1123.0	1134.4	2.8736	920	0.0606390	3869.7	4415.5	7.7223
270	0.00129458	1172.5	1184.2	2.9661	940	0.0617120	3910.1	4465.5	7.7639
					960	0.0627830	3950.7	4515.7	7.8049
					980	0.0638520	3991.4	4566.1	7.8454
					1000	0.0649180	4032.4	4616.7	7.8855

Water/Steam at $p = 10.0$ MPa ($T_{\text{sat}} = 310.997^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099520	0.12	10.07	0.00034
5	0.00099524	20.96	30.91	0.07595
10	0.00099564	41.76	51.72	0.15009
15	0.00099634	62.55	72.51	0.22287
20	0.00099731	83.31	93.28	0.29435
25	0.00099854	104.06	114.05	0.36460
30	0.00099998	124.82	134.82	0.43368
35	0.00100164	145.57	155.59	0.50163
40	0.00100350	166.32	176.36	0.56851
45	0.00100554	187.09	197.15	0.63436
50	0.00100775	207.86	217.94	0.69920
55	0.00101014	228.64	238.74	0.76307
60	0.00101268	249.42	259.55	0.82602
65	0.00101539	270.23	280.38	0.88806
70	0.00101824	291.03	301.21	0.94923
75	0.00102125	311.86	322.07	1.0096
80	0.00102441	332.70	342.94	1.0691
85	0.00102771	353.54	363.82	1.1278
90	0.00103116	374.42	384.73	1.1858
95	0.00103475	395.31	405.66	1.2430
100	0.00103849	416.24	426.62	1.2996
105	0.00104238	437.18	447.60	1.3554
110	0.00104641	458.15	468.61	1.4106
115	0.00105059	479.14	489.65	1.4652
120	0.00105492	500.18	510.73	1.5191
125	0.00105940	521.25	531.84	1.5725
130	0.00106404	542.36	553.00	1.6253
135	0.00106884	563.51	574.20	1.6776
140	0.00107380	584.71	595.45	1.7293
145	0.00107892	605.96	616.75	1.7806
150	0.00108422	627.27	638.11	1.8313
155	0.00108970	648.63	659.53	1.8817
160	0.00109535	670.06	681.01	1.9315
165	0.00110120	691.55	702.56	1.9810
170	0.00110725	713.11	724.18	2.0301
175	0.00111350	734.76	745.89	2.0788
180	0.00111997	756.48	767.68	2.1271
185	0.00112666	778.28	789.55	2.1752
190	0.00113358	800.19	811.53	2.2229
195	0.00114076	822.20	833.61	2.2703
200	0.00114819	844.32	855.80	2.3174
210	0.00116390	888.89	900.53	2.4110
220	0.00118086	934.00	945.81	2.5037
230	0.00119923	979.72	991.71	2.5959
240	0.00121924	1026.1	1038.3	2.6876
250	0.00124115	1073.4	1085.8	2.7792
260	0.00126533	1121.6	1134.3	2.8710
270	0.00129227	1171.0	1183.9	2.9633

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00129227	1171.0	1183.9	2.9633
280	0.00132263	1221.8	1235.0	3.0565
290	0.00135739	1274.4	1288.0	3.1514
300	0.00139804	1329.3	1343.3	3.2488
310	0.00144709	1387.5	1402.0	3.3502
310.997	0.00145259	1393.6	1408.1	3.3606
310.997	0.0180300	2545.2	2725.5	5.6160
320	0.0192700	2590.1	2782.8	5.7133
330	0.0204440	2631.4	2835.8	5.8019
340	0.0214870	2667.2	2882.1	5.8782
350	0.0224400	2699.6	2924.0	5.9459
360	0.0233250	2729.4	2962.7	6.0075
370	0.0241580	2757.3	2998.9	6.0642
380	0.0249500	2783.7	3033.2	6.1172
390	0.0257070	2808.8	3065.9	6.1669
400	0.0264360	2833.0	3097.4	6.2141
410	0.0271420	2856.5	3127.9	6.2590
420	0.0278260	2879.2	3157.5	6.3020
430	0.0284930	2901.5	3186.4	6.3434
440	0.0291440	2923.2	3214.6	6.3833
450	0.0297820	2944.5	3242.3	6.4219
460	0.0304070	2965.5	3269.6	6.4593
470	0.0310220	2986.3	3296.5	6.4957
480	0.0316260	3006.7	3323.0	6.5311
490	0.0322230	3027.0	3349.2	6.5657
500	0.0328110	3047.0	3375.1	6.5995
520	0.0339660	3086.7	3426.4	6.6649
540	0.0350970	3125.9	3476.9	6.7278
560	0.0362070	3164.8	3526.9	6.7886
580	0.0373000	3203.5	3576.5	6.8474
600	0.0383780	3242.0	3625.8	6.9045
620	0.0394420	3280.4	3674.8	6.9600
640	0.0404950	3318.8	3723.7	7.0142
660	0.0415380	3357.1	3772.5	7.0670
680	0.0425720	3395.6	3821.3	7.1187
700	0.0435970	3434.0	3870.0	7.1693
720	0.0446150	3472.6	3918.7	7.2189
740	0.0456270	3511.3	3967.6	7.2676
760	0.0466330	3550.1	4016.4	7.3153
780	0.0476330	3589.1	4065.4	7.3623
800	0.0486290	3628.2	4114.5	7.4085
820	0.0496200	3667.5	4163.7	7.4539
840	0.0506070	3706.9	4213.0	7.4986
860	0.0515900	3746.6	4262.5	7.5427
880	0.0525700	3786.5	4312.2	7.5861
900	0.0535470	3826.5	4362.0	7.6290
920	0.0545210	3866.8	4412.0	7.6712
940	0.0554920	3907.3	4462.2	7.7129
960	0.0564600	3947.9	4512.5	7.7541
980	0.0574260	3988.7	4563.0	7.7947
1000	0.0583900	4029.9	4613.8	7.8349

Water/Steam at $p = 11.0$ MPa ($T_{\text{sat}} = 318.079^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099471	0.13	11.07	0.00037	270	0.00129000	1169.5	1183.7	2.9604
5	0.00099477	20.95	31.89	0.07590	280	0.00131992	1220.1	1234.6	3.0533
10	0.00099517	41.73	52.68	0.14998	290	0.00135407	1272.4	1287.3	3.1477
15	0.00099588	62.50	73.45	0.22270	300	0.00139383	1326.9	1342.2	3.2444
20	0.00099687	83.24	94.21	0.29412	310	0.00144149	1384.4	1400.3	3.3449
25	0.00099810	103.99	114.97	0.36433	318.079	0.00148851	1434.0	1450.4	3.4303
30	0.00099955	124.72	135.72	0.43337	318.079	0.0159900	2530.4	2706.3	5.5545
35	0.00100121	145.47	156.48	0.50128	320	0.0162740	2542.1	2721.1	5.5793
40	0.00100306	166.22	177.25	0.56812	330	0.0175650	2593.3	2786.5	5.6888
45	0.00100510	186.96	198.02	0.63393	340	0.0186560	2635.4	2840.6	5.7777
50	0.00100732	207.72	218.80	0.69874	350	0.0196250	2672.0	2887.9	5.8542
55	0.00100970	228.48	239.59	0.76258	360	0.0205090	2705.0	2930.6	5.9223
60	0.00101224	249.26	260.39	0.82549	370	0.0213310	2735.4	2970.0	5.9840
65	0.00101494	270.04	281.20	0.88750	380	0.0221030	2763.8	3006.9	6.0410
70	0.00101780	290.83	302.03	0.94865	390	0.0228360	2790.7	3041.9	6.0941
75	0.00102080	311.64	322.87	1.0089	400	0.0235370	2816.3	3075.2	6.1440
80	0.00102395	332.47	343.73	1.0684	410	0.0242120	2840.9	3107.2	6.1912
85	0.00102725	353.31	364.61	1.1271	420	0.0248640	2864.7	3138.2	6.2362
90	0.00103069	374.17	385.51	1.1851	430	0.0254960	2887.8	3168.3	6.2793
95	0.00103427	395.05	406.43	1.2423	440	0.0261120	2910.4	3197.6	6.3207
100	0.00103800	415.95	427.37	1.2988	450	0.0267130	2932.5	3226.3	6.3607
105	0.00104188	436.88	448.34	1.3546	460	0.0273010	2954.1	3254.4	6.3993
110	0.00104590	457.84	469.34	1.4098	470	0.0278770	2975.4	3282.0	6.4367
115	0.00105006	478.82	490.37	1.4643	480	0.0284430	2996.4	3309.3	6.4731
120	0.00105438	499.84	511.44	1.5183	490	0.0290000	3017.1	3336.1	6.5085
125	0.00105885	520.89	532.54	1.5716	500	0.0295490	3037.7	3362.7	6.5431
130	0.00106347	541.98	553.68	1.6244	520	0.0306240	3078.1	3415.0	6.6099
135	0.00106825	563.12	574.87	1.6766	540	0.0316740	3118.0	3466.4	6.6739
140	0.00107319	584.30	596.11	1.7283	560	0.0327030	3157.5	3517.2	6.7356
145	0.00107830	605.54	617.40	1.7795	580	0.0337140	3196.6	3567.5	6.7953
150	0.00108358	626.82	638.74	1.8303	600	0.0347090	3235.6	3617.4	6.8531
155	0.00108903	648.16	660.14	1.8806	620	0.0356910	3274.4	3667.0	6.9092
160	0.00109467	669.57	681.61	1.9304	640	0.0366610	3313.1	3716.4	6.9639
165	0.00110049	691.03	703.14	1.9798	660	0.0376210	3351.8	3765.6	7.0173
170	0.00110651	712.58	724.75	2.0289	680	0.0385710	3390.5	3814.8	7.0694
175	0.00111273	734.19	746.43	2.0775	700	0.0395130	3429.3	3863.9	7.1204
180	0.00111917	755.89	768.20	2.1258	720	0.0404480	3468.1	3913.0	7.1703
185	0.00112582	777.68	790.06	2.1738	740	0.0413760	3507.0	3962.1	7.2193
190	0.00113271	799.55	812.01	2.2215	760	0.0422980	3545.9	4011.2	7.2673
195	0.00113985	821.53	834.07	2.2688	780	0.0432150	3585.1	4060.5	7.3146
200	0.00114724	843.61	856.23	2.3159	800	0.0441260	3624.4	4109.8	7.3610
210	0.00116286	888.12	900.91	2.4094	820	0.0450340	3663.9	4159.3	7.4066
220	0.00117970	933.15	946.13	2.5020	840	0.0459370	3703.5	4208.8	7.4515
230	0.00119794	978.77	991.95	2.5940	860	0.0468370	3743.3	4258.5	7.4958
240	0.00121777	1025.1	1038.5	2.6855	880	0.0477330	3783.2	4308.3	7.5394
250	0.00123948	1072.2	1085.8	2.7769	900	0.0486250	3823.4	4358.3	7.5824
260	0.00126340	1120.3	1134.2	2.8685	920	0.0495150	3863.8	4408.5	7.6247
270	0.00129000	1169.5	1183.7	2.9604	940	0.0504020	3904.4	4458.8	7.6666
					960	0.0512870	3945.1	4509.3	7.7079
					980	0.0521690	3986.1	4560.0	7.7486
					1000	0.0530490	4027.4	4610.9	7.7889

Water/Steam at $p = 12.0$ MPa ($T_{\text{sat}} = 324.675^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099422	0.14	12.07	0.00039
5	0.00099429	20.94	32.87	0.07585
10	0.00099471	41.70	53.64	0.14987
15	0.00099543	62.45	74.40	0.22252
20	0.00099642	83.18	95.14	0.29390
25	0.00099766	103.92	115.89	0.36406
30	0.00099911	124.64	136.63	0.43305
35	0.00100078	145.36	157.37	0.50093
40	0.00100263	166.10	178.13	0.56773
45	0.00100467	186.83	198.89	0.63350
50	0.00100689	207.58	219.66	0.69828
55	0.00100927	228.33	240.44	0.76209
60	0.00101181	249.09	261.23	0.82497
65	0.00101450	269.86	282.03	0.88695
70	0.00101735	290.64	302.85	0.94806
75	0.00102035	311.44	323.68	1.0083
80	0.00102349	332.25	344.53	1.0678
85	0.00102678	353.08	365.40	1.1265
90	0.00103021	373.92	386.28	1.1844
95	0.00103379	394.78	407.19	1.2416
100	0.00103751	415.67	428.12	1.2980
105	0.00104138	436.58	449.08	1.3538
110	0.00104538	457.53	470.07	1.4090
115	0.00104954	478.50	491.09	1.4635
120	0.00105384	499.50	512.15	1.5174
125	0.00105830	520.54	533.24	1.5707
130	0.00106291	541.62	554.37	1.6234
135	0.00106767	562.74	575.55	1.6756
140	0.00107259	583.90	596.77	1.7273
145	0.00107768	605.11	618.04	1.7785
150	0.00108294	626.37	639.37	1.8292
155	0.00108837	647.70	660.76	1.8794
160	0.00109398	669.08	682.21	1.9293
165	0.00109978	690.52	703.72	1.9786
170	0.00110577	712.04	725.31	2.0276
175	0.00111197	733.64	746.98	2.0763
180	0.00111837	755.31	768.73	2.1245
185	0.00112500	777.07	790.57	2.1724
190	0.00113185	798.92	812.50	2.2201
195	0.00113895	820.86	834.53	2.2674
200	0.00114630	842.91	856.67	2.3144
210	0.00116182	887.35	901.29	2.4077
220	0.00117855	932.30	946.44	2.5002
230	0.00119665	977.84	992.20	2.5921
240	0.00121633	1024.0	1038.6	2.6835
250	0.00123783	1071.0	1085.9	2.7747
260	0.00126150	1119.0	1134.1	2.8660
270	0.00128778	1167.9	1183.4	2.9576

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00128778	1167.9	1183.4	2.9576
280	0.00131727	1218.3	1234.1	3.0501
290	0.00135083	1270.4	1286.6	3.1440
300	0.00138976	1324.5	1341.2	3.2401
310	0.00143613	1381.5	1398.7	3.3397
320	0.00149366	1442.6	1460.5	3.4447
324.675	0.00152630	1473.2	1491.5	3.4967
324.675	0.0142640	2514.2	2685.4	5.4939
330	0.0150210	2547.9	2728.2	5.5651
340	0.0162100	2599.1	2793.6	5.6727
350	0.0172210	2641.4	2848.1	5.7609
360	0.0181210	2678.4	2895.9	5.8371
370	0.0189430	2711.9	2939.2	5.9049
380	0.0197060	2742.7	2979.2	5.9665
390	0.0204240	2771.5	3016.6	6.0234
400	0.0211060	2798.7	3052.0	6.0764
410	0.0217580	2824.7	3085.8	6.1262
420	0.0223850	2849.7	3118.3	6.1734
430	0.0229900	2873.8	3149.7	6.2184
440	0.0235770	2897.2	3180.1	6.2614
450	0.0241490	2920.0	3209.8	6.3028
460	0.0247070	2942.4	3238.9	6.3427
470	0.0252520	2964.3	3267.3	6.3812
480	0.0257870	2985.9	3295.3	6.4186
490	0.0263120	3007.1	3322.8	6.4549
500	0.0268280	3028.1	3350.0	6.4903
520	0.0278370	3069.4	3403.4	6.5585
540	0.0288210	3109.9	3455.8	6.6237
560	0.0297820	3150.0	3507.4	6.6864
580	0.0307250	3189.7	3558.4	6.7469
600	0.0316510	3229.1	3608.9	6.8054
620	0.0325640	3268.3	3659.1	6.8622
640	0.0334650	3307.4	3709.0	6.9175
660	0.0343560	3346.4	3758.7	6.9713
680	0.0352370	3385.4	3808.2	7.0239
700	0.0361090	3424.4	3857.7	7.0753
720	0.0369750	3463.5	3907.2	7.1256
740	0.0378330	3502.6	3956.6	7.1748
760	0.0386850	3541.8	4006.0	7.2232
780	0.0395320	3581.2	4055.6	7.2706
800	0.0403750	3620.6	4105.1	7.3173
820	0.0412120	3660.3	4154.8	7.3631
840	0.0420450	3700.1	4204.6	7.4083
860	0.0428750	3740.0	4254.5	7.4527
880	0.0437010	3780.1	4304.5	7.4965
900	0.0445240	3820.4	4354.7	7.5396
920	0.0453440	3860.9	4405.0	7.5821
940	0.0461610	3901.6	4455.5	7.6241
960	0.0469760	3942.4	4506.1	7.6655
980	0.0477890	3983.5	4557.0	7.7064
1000	0.0485990	4024.8	4608.0	7.7467

Water/Steam at $p = 13.0$ MPa ($T_{\text{sat}} = 330.854^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099373	0.15	13.07	0.00041	270	0.00128559	1166.5	1183.2	2.9549
5	0.00099382	20.93	33.85	0.07580	280	0.00131467	1216.6	1233.7	3.0470
10	0.00099425	41.68	54.61	0.14975	290	0.00134768	1268.4	1285.9	3.1405
15	0.00099498	62.41	75.34	0.22235	300	0.00138581	1322.2	1340.2	3.2360
20	0.00099598	83.12	96.07	0.29368	310	0.00143098	1378.6	1397.2	3.3346
25	0.00099722	103.84	116.80	0.36379	320	0.00148650	1438.9	1458.2	3.4383
30	0.00099868	124.55	137.53	0.43274	330	0.00155909	1505.1	1525.4	3.5506
35	0.00100035	145.27	158.27	0.50058	330.854	0.00156649	1511.1	1531.5	3.5608
40	0.00100220	165.98	179.01	0.56734	330.854	0.0127800	2496.6	2662.7	5.4336
45	0.00100424	186.70	199.76	0.63308	340	0.0140290	2556.6	2739.0	5.5591
50	0.00100646	207.43	220.51	0.69782	350	0.0151190	2607.2	2803.7	5.6638
55	0.00100883	228.17	241.28	0.76160	360	0.0160530	2649.4	2858.1	5.7504
60	0.00101137	248.91	262.06	0.82444	370	0.0168880	2686.7	2906.2	5.8257
65	0.00101406	269.68	282.86	0.88639	380	0.0176530	2720.2	2949.7	5.8929
70	0.00101691	290.44	303.66	0.94748	390	0.0183640	2751.3	2990.0	5.9541
75	0.00101990	311.23	324.49	1.0077	400	0.0190330	2780.3	3027.7	6.0106
80	0.00102304	332.02	345.32	1.0671	410	0.0196690	2807.8	3063.5	6.0633
85	0.00102632	352.84	366.18	1.1258	420	0.0202760	2834.0	3097.6	6.1129
90	0.00102975	373.67	387.06	1.1837	430	0.0208610	2859.2	3130.4	6.1599
95	0.00103331	394.53	407.96	1.2408	440	0.0214260	2883.7	3162.2	6.2047
100	0.00103702	415.40	428.88	1.2973	450	0.0219740	2907.3	3193.0	6.2476
105	0.00104088	436.30	449.83	1.3531	460	0.0225070	2930.4	3223.0	6.2888
110	0.00104488	457.23	470.81	1.4082	470	0.0230270	2952.9	3252.3	6.3286
115	0.00104902	478.17	491.81	1.4626	480	0.0235350	2975.1	3281.1	6.3670
120	0.00105331	499.17	512.86	1.5165	490	0.0240340	2996.9	3309.3	6.4043
125	0.00105775	520.19	533.94	1.5698	500	0.0245230	3018.3	3337.1	6.4405
130	0.00106234	541.25	555.06	1.6225	520	0.0254770	3060.5	3391.7	6.5101
135	0.00106709	562.35	576.22	1.6747	540	0.0264040	3101.7	3445.0	6.5766
140	0.00107200	583.49	597.43	1.7263	560	0.0273090	3142.5	3497.5	6.6403
145	0.00107707	604.69	618.69	1.7775	580	0.0281940	3182.7	3549.2	6.7016
150	0.00108231	625.93	640.00	1.8281	600	0.0290630	3222.6	3600.4	6.7609
155	0.00108772	647.23	661.37	1.8783	620	0.0299180	3262.2	3651.1	6.8184
160	0.00109330	668.60	682.81	1.9281	640	0.0307610	3301.6	3701.5	6.8742
165	0.00109908	690.02	704.31	1.9775	660	0.0315930	3341.0	3751.7	6.9286
170	0.00110504	711.51	725.88	2.0264	680	0.0324150	3380.3	3801.7	6.9816
175	0.00111121	733.08	747.53	2.0750	700	0.0332290	3419.5	3851.5	7.0333
180	0.00111758	754.73	769.26	2.1232	720	0.0340360	3458.8	3901.3	7.0840
185	0.00112417	776.46	791.07	2.1711	740	0.0348350	3498.2	3951.1	7.1336
190	0.00113099	798.28	812.98	2.2187	760	0.0356290	3537.6	4000.8	7.1822
195	0.00113805	820.20	834.99	2.2659	780	0.0364170	3577.2	4050.6	7.2299
200	0.00114536	842.22	857.11	2.3129	800	0.0372000	3616.8	4100.4	7.2768
210	0.00116079	886.59	901.68	2.4061	820	0.0379780	3656.7	4150.4	7.3229
220	0.00117741	931.46	946.77	2.4985	840	0.0387530	3696.5	4200.3	7.3682
230	0.00119538	976.91	992.45	2.5902	860	0.0395230	3736.7	4250.5	7.4128
240	0.00121489	1023.0	1038.8	2.6814	880	0.0402900	3776.9	4300.7	7.4567
250	0.00123620	1069.9	1086.0	2.7724	900	0.0410540	3817.3	4351.0	7.5000
260	0.00125963	1117.6	1134.0	2.8635	920	0.0418150	3857.9	4401.5	7.5427
270	0.00128559	1166.5	1183.2	2.9549	940	0.0425730	3898.8	4452.2	7.5848
					960	0.0433290	3939.7	4503.0	7.6263
					980	0.0440820	3980.8	4553.9	7.6673
					1000	0.0448330	4022.2	4605.0	7.7078

Water/Steam at $p = 14.0$ MPa ($T_{\text{sat}} = 336.666^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099325	0.16	14.07	0.00043
5	0.00099335	20.92	34.83	0.07574
10	0.00099379	41.66	55.57	0.14963
15	0.00099453	62.37	76.29	0.22218
20	0.00099554	83.06	97.00	0.29345
25	0.00099678	103.77	117.72	0.36352
30	0.00099825	124.46	138.44	0.43243
35	0.00099992	145.16	159.16	0.50022
40	0.00100178	165.87	179.89	0.56695
45	0.00100382	186.57	200.62	0.63265
50	0.00100603	207.29	221.37	0.69736
55	0.00100840	228.01	242.13	0.76110
60	0.00101094	248.75	262.90	0.82392
65	0.00101363	269.49	283.68	0.88584
70	0.00101647	290.25	304.48	0.94689
75	0.00101945	311.02	325.29	1.0071
80	0.00102258	331.80	346.12	1.0665
85	0.00102586	352.61	366.97	1.1251
90	0.00102928	373.42	387.83	1.1830
95	0.00103284	394.26	408.72	1.2401
100	0.00103654	415.12	429.63	1.2965
105	0.00104038	436.00	450.57	1.3523
110	0.00104437	456.92	471.54	1.4073
115	0.00104850	477.86	492.54	1.4618
120	0.00105278	498.83	513.57	1.5156
125	0.00105720	519.83	534.63	1.5689
130	0.00106178	540.88	555.74	1.6216
135	0.00106651	561.96	576.89	1.6737
140	0.00107140	583.09	598.09	1.7253
145	0.00107646	604.26	619.33	1.7764
150	0.00108167	625.49	640.63	1.8271
155	0.00108706	646.77	661.99	1.8772
160	0.00109263	668.11	683.41	1.9270
165	0.00109838	689.51	704.89	1.9763
170	0.00110432	710.99	726.45	2.0252
175	0.00111046	732.53	748.08	2.0738
180	0.00111680	754.15	769.79	2.1219
185	0.00112336	775.86	791.59	2.1698
190	0.00113014	797.65	813.47	2.2173
195	0.00113716	819.54	835.46	2.2645
200	0.00114443	841.53	857.55	2.3114
210	0.00115977	885.83	902.07	2.4045
220	0.00117628	930.63	947.10	2.4968
230	0.00119412	975.99	992.71	2.5883
240	0.00121348	1022.0	1039.0	2.6794
250	0.00123459	1068.7	1086.0	2.7702
260	0.00125778	1116.4	1134.0	2.8610
270	0.00128344	1165.0	1183.0	2.9521

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00128344	1165.0	1183.0	2.9521
280	0.00131212	1215.0	1233.4	3.0440
290	0.00134460	1266.5	1285.3	3.1370
300	0.00138198	1319.9	1339.2	3.2319
310	0.00142603	1375.8	1395.8	3.3297
320	0.00147972	1435.3	1456.0	3.4322
330	0.00154883	1500.2	1521.9	3.5423
336.666	0.00160974	1548.5	1571.0	3.6232
336.666	0.0114850	2477.1	2637.9	5.3727
340	0.0119970	2504.3	2672.3	5.4290
350	0.0132320	2567.9	2753.1	5.5598
360	0.0142280	2617.3	2816.5	5.6607
370	0.0150910	2659.1	2870.4	5.7453
380	0.0158660	2696.2	2918.3	5.8192
390	0.0165770	2729.8	2961.9	5.8855
400	0.0172400	2760.9	3002.3	5.9459
410	0.0178650	2790.2	3040.3	6.0019
420	0.0184590	2817.8	3076.2	6.0542
430	0.0190280	2844.2	3110.6	6.1034
440	0.0195750	2869.6	3143.7	6.1501
450	0.0201040	2894.2	3175.7	6.1946
460	0.0206160	2918.1	3206.7	6.2373
470	0.0211150	2941.4	3237.0	6.2783
480	0.0216020	2964.2	3266.6	6.3178
490	0.0220780	2986.5	3295.6	6.3561
500	0.0225440	3008.5	3324.1	6.3932
520	0.0234520	3051.5	3379.8	6.4643
540	0.0243320	3093.6	3434.2	6.5320
560	0.0251880	3134.9	3487.5	6.5968
580	0.0260250	3175.5	3539.9	6.6591
600	0.0268450	3216.0	3591.8	6.7191
620	0.0276500	3256.0	3643.1	6.7772
640	0.0284430	3295.8	3694.0	6.8336
660	0.0292250	3335.6	3744.7	6.8885
680	0.0299970	3375.1	3795.1	6.9419
700	0.0307610	3414.6	3845.3	6.9941
720	0.0315170	3454.3	3895.5	7.0451
740	0.0322660	3493.9	3945.6	7.0950
760	0.0330090	3533.5	3995.6	7.1440
780	0.0337460	3573.3	4045.7	7.1920
800	0.0344790	3613.1	4095.8	7.2391
820	0.0352070	3653.0	4145.9	7.2854
840	0.0359310	3693.1	4196.1	7.3309
860	0.0366500	3733.3	4246.4	7.3757
880	0.0373670	3773.7	4296.8	7.4198
900	0.0380800	3814.3	4347.4	7.4632
920	0.0387900	3854.9	4398.0	7.5060
940	0.0394980	3895.8	4448.8	7.5483
960	0.0402030	3937.0	4499.8	7.5899
980	0.0409050	3978.2	4550.9	7.6310
1000	0.0416050	4019.6	4602.1	7.6716

Water/Steam at $p = 15.0$ MPa ($T_{\text{sat}} = 342.155^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099276	0.18	15.07	0.00045	270	0.00128133	1163.7	1182.9	2.9495
5	0.00099288	20.92	35.81	0.07569	280	0.00130963	1213.4	1233.0	3.0409
10	0.00099334	41.63	56.53	0.14951	290	0.00134159	1264.6	1284.7	3.1335
15	0.00099409	62.32	77.23	0.22200	300	0.00137826	1317.6	1338.3	3.2279
20	0.00099510	83.00	97.93	0.29323	310	0.00142125	1373.1	1394.4	3.3250
25	0.00099635	103.68	118.63	0.36325	320	0.00147326	1431.9	1454.0	3.4263
30	0.00099782	124.37	139.34	0.43211	330	0.00153932	1495.7	1518.8	3.5345
35	0.00099949	145.06	160.05	0.49987	340	0.00163113	1567.9	1592.4	3.6555
40	0.00100135	165.75	180.77	0.56656	342.155	0.00165695	1585.3	1610.2	3.6846
45	0.00100339	186.44	201.49	0.63223	342.155	0.0103380	2455.6	2610.7	5.3106
50	0.00100560	207.15	222.23	0.69690	350	0.0114810	2520.9	2693.1	5.4437
55	0.00100797	227.86	242.98	0.76061	360	0.0125820	2581.0	2769.7	5.5657
60	0.00101051	248.58	263.74	0.82340	370	0.0134930	2629.0	2831.4	5.6625
65	0.00101319	269.31	284.51	0.88529	380	0.0142890	2670.4	2884.7	5.7446
70	0.00101603	290.06	305.30	0.94631	390	0.0150080	2707.1	2932.2	5.8168
75	0.00101901	310.81	326.10	1.0065	400	0.0156710	2740.6	2975.7	5.8819
80	0.00102213	331.59	346.92	1.0659	410	0.0162900	2771.8	3016.1	5.9415
85	0.00102540	352.37	367.75	1.1245	420	0.0168750	2800.9	3054.0	5.9967
90	0.00102881	373.18	388.61	1.1823	430	0.0174310	2828.6	3090.1	6.0484
95	0.00103236	394.00	409.49	1.2394	440	0.0179640	2855.2	3124.7	6.0971
100	0.00103605	414.85	430.39	1.2958	450	0.0184770	2880.7	3157.9	6.1434
105	0.00103989	435.72	451.32	1.3515	460	0.0189730	2905.5	3190.1	6.1876
110	0.00104386	456.61	472.27	1.4065	470	0.0194550	2929.5	3221.3	6.2299
115	0.00104798	477.54	493.26	1.4610	480	0.0199230	2953.0	3251.8	6.2706
120	0.00105225	498.50	514.28	1.5148	490	0.0203800	2975.9	3281.6	6.3099
125	0.00105666	519.48	535.33	1.5680	500	0.0208270	2998.4	3310.8	6.3480
130	0.00106122	540.51	556.43	1.6206	520	0.0216960	3042.4	3367.8	6.4207
135	0.00106594	561.58	577.57	1.6727	540	0.0225340	3085.2	3423.2	6.4897
140	0.00107081	582.69	598.75	1.7243	560	0.0233490	3127.2	3477.4	6.5556
145	0.00107585	603.84	619.98	1.7754	580	0.0241440	3168.4	3530.6	6.6187
150	0.00108104	625.05	641.27	1.8260	600	0.0249210	3209.3	3583.1	6.6796
155	0.00108641	646.31	662.61	1.8762	620	0.0256840	3249.8	3635.1	6.7384
160	0.00109196	667.63	684.01	1.9259	640	0.0264330	3290.0	3686.5	6.7954
165	0.00109768	689.01	705.48	1.9751	660	0.0271720	3330.0	3737.6	6.8508
170	0.00110360	710.47	727.02	2.0240	680	0.0279010	3370.0	3788.5	6.9047
175	0.00110971	731.98	748.63	2.0725	700	0.0286210	3409.8	3839.1	6.9572
180	0.00111602	753.58	770.32	2.1206	720	0.0293340	3449.6	3889.6	7.0086
185	0.00112255	775.26	792.10	2.1684	740	0.0300390	3489.4	3940.0	7.0589
190	0.00112930	797.03	813.97	2.2159	760	0.0307380	3529.3	3990.4	7.1081
195	0.00113628	818.89	835.93	2.2631	780	0.0314320	3569.2	4040.7	7.1563
200	0.00114351	840.84	857.99	2.3100	800	0.0321210	3609.3	4091.1	7.2037
210	0.00115876	885.08	902.46	2.4030	820	0.0328050	3649.3	4141.4	7.2502
220	0.00117516	929.80	947.43	2.4951	840	0.0334850	3689.6	4191.9	7.2959
230	0.00119287	975.08	992.97	2.5865	860	0.0341610	3730.0	4242.4	7.3409
240	0.00121208	1021.0	1039.2	2.6774	880	0.0348330	3770.5	4293.0	7.3852
250	0.00123301	1067.6	1086.1	2.7680	900	0.0355030	3811.2	4343.7	7.4288
260	0.00125596	1115.2	1134.0	2.8586	920	0.0361690	3852.0	4394.5	7.4717
270	0.00128133	1163.7	1182.9	2.9495	940	0.0368320	3893.0	4445.5	7.5141
					960	0.0374930	3934.2	4496.6	7.5559
					980	0.0381520	3975.5	4547.8	7.5971
					1000	0.0388080	4017.1	4599.2	7.6378

Water/Steam at $p = 16.0$ MPa ($T_{\text{sat}} = 347.355^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099228	0.18	16.06	0.00046
5	0.00099241	20.90	36.78	0.07563
10	0.00099288	41.59	57.48	0.14939
15	0.00099364	62.28	78.18	0.22182
20	0.00099466	82.95	98.86	0.29300
25	0.00099592	103.62	119.55	0.36297
30	0.00099739	124.28	140.24	0.43180
35	0.00099906	144.96	160.94	0.49952
40	0.00100092	165.64	181.65	0.56617
45	0.00100296	186.31	202.36	0.63180
50	0.00100517	207.01	223.09	0.69644
55	0.00100755	227.70	243.82	0.76012
60	0.00101007	248.41	264.57	0.82288
65	0.00101276	269.14	285.34	0.88474
70	0.00101559	289.86	306.11	0.94573
75	0.00101856	310.61	326.91	1.0059
80	0.00102168	331.36	347.71	1.0652
85	0.00102494	352.14	368.54	1.1238
90	0.00102835	372.94	389.39	1.1816
95	0.00103189	393.74	410.25	1.2387
100	0.00103557	414.57	431.14	1.2950
105	0.00103939	435.43	452.06	1.3507
110	0.00104336	456.32	473.01	1.4057
115	0.00104747	477.22	493.98	1.4601
120	0.00105172	498.16	514.99	1.5139
125	0.00105612	519.13	536.03	1.5671
130	0.00106067	540.15	557.12	1.6197
135	0.00106537	561.19	578.24	1.6718
140	0.00107022	582.29	599.41	1.7233
145	0.00107524	603.43	620.63	1.7744
150	0.00108042	624.61	641.90	1.8250
155	0.00108577	645.86	663.23	1.8751
160	0.00109129	667.16	684.62	1.9247
165	0.00109699	688.52	706.07	1.9740
170	0.00110288	709.94	727.59	2.0228
175	0.00110896	731.44	749.18	2.0713
180	0.00111525	753.02	770.86	2.1194
185	0.00112174	774.66	792.61	2.1671
190	0.00112846	796.40	814.46	2.2145
195	0.00113540	818.23	836.40	2.2617
200	0.00114259	840.16	858.44	2.3085
210	0.00115775	884.34	902.86	2.4014
220	0.00117405	928.99	947.77	2.4934
230	0.00119164	974.17	993.24	2.5847
240	0.00121069	1020.0	1039.4	2.6754
250	0.00123144	1066.5	1086.2	2.7658
260	0.00125417	1113.8	1133.9	2.8562
270	0.00127925	1162.2	1182.7	2.9468

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00127925	1162.2	1182.7	2.9468
280	0.00130718	1211.8	1232.7	3.0380
290	0.00133865	1262.7	1284.1	3.1302
300	0.00137464	1315.4	1337.4	3.2240
310	0.00141665	1370.5	1393.2	3.3204
320	0.00146711	1428.6	1452.1	3.4206
330	0.00153044	1491.3	1515.8	3.5271
340	0.00161630	1561.5	1587.4	3.6447
347.355	0.00170944	1622.3	1649.7	3.7457
347.355	0.00930880	2431.9	2580.8	5.2463
350	0.00976580	2460.7	2617.0	5.3045
360	0.0110610	2538.8	2715.8	5.4619
370	0.0120460	2595.7	2788.4	5.5756
380	0.0128780	2642.3	2848.3	5.6681
390	0.0136130	2682.8	2900.6	5.7476
400	0.0142810	2719.1	2947.6	5.8179
410	0.0148990	2752.3	2990.7	5.8816
420	0.0154780	2783.4	3031.0	5.9401
430	0.0160260	2812.6	3069.0	5.9945
440	0.0165480	2840.3	3105.1	6.0455
450	0.0170490	2866.9	3139.7	6.0937
460	0.0175310	2892.5	3173.0	6.1395
470	0.0179980	2917.3	3205.3	6.1832
480	0.0184510	2941.5	3236.7	6.2252
490	0.0188920	2965.0	3267.3	6.2656
500	0.0193230	2988.1	3297.3	6.3046
520	0.0201570	3033.1	3355.6	6.3790
540	0.0209610	3076.7	3412.1	6.4493
560	0.0217390	3119.4	3467.2	6.5163
580	0.0224970	3161.2	3521.2	6.5804
600	0.0232380	3202.6	3574.4	6.6421
620	0.0239630	3243.6	3627.0	6.7016
640	0.0246750	3284.2	3679.0	6.7591
660	0.0253760	3324.6	3730.6	6.8150
680	0.0260670	3364.8	3781.9	6.8694
700	0.0267490	3404.9	3832.9	6.9224
720	0.0274230	3445.0	3883.8	6.9741
740	0.0280910	3485.0	3934.5	7.0247
760	0.0287520	3525.1	3985.1	7.0742
780	0.0294070	3565.2	4035.7	7.1227
800	0.0300580	3605.4	4086.3	7.1703
820	0.0307030	3645.8	4137.0	7.2171
840	0.0313450	3686.1	4187.6	7.2630
860	0.0319830	3726.6	4238.3	7.3082
880	0.0326170	3767.2	4289.1	7.3526
900	0.0332470	3808.0	4340.0	7.3964
920	0.0338750	3849.0	4391.0	7.4395
940	0.0345000	3890.2	4442.2	7.4819
960	0.0351230	3931.4	4493.4	7.5238
980	0.0357430	3972.9	4544.8	7.5652
1000	0.0363610	4014.5	4596.3	7.6060

Water/Steam at $p = 17.0$ MPa ($T_{\text{sat}} = 352.293^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099179	0.20	17.06	0.00047	270	0.00127720	1160.8	1182.5	2.9442
5	0.00099194	20.90	37.76	0.07556	280	0.00130477	1210.1	1232.3	3.0350
10	0.00099242	41.57	58.44	0.14926	290	0.00133577	1260.9	1283.6	3.1268
15	0.00099319	62.24	79.12	0.22164	300	0.00137112	1313.3	1336.6	3.2202
20	0.00099422	82.89	99.79	0.29277	310	0.00141219	1367.9	1391.9	3.3158
25	0.00099548	103.54	120.46	0.36270	320	0.00146122	1425.5	1450.3	3.4151
30	0.00099696	124.19	141.14	0.43148	330	0.00152211	1487.2	1513.1	3.5201
35	0.00099864	144.85	161.83	0.49916	340	0.00160296	1555.6	1582.9	3.6347
40	0.00100050	165.51	182.52	0.56578	350	0.00172698	1637.2	1666.6	3.7702
45	0.00100254	186.19	203.23	0.63138	352.293	0.00176926	1659.9	1690.0	3.8077
50	0.00100475	206.86	223.94	0.69598	352.293	0.00837090	2405.2	2547.5	5.1787
55	0.00100712	227.55	244.67	0.75963	360	0.00960380	2487.8	2651.1	5.3434
60	0.00100964	248.25	265.41	0.82236	370	0.0107130	2557.8	2739.9	5.4826
65	0.00101232	268.95	286.16	0.88419	380	0.0115980	2611.5	2808.7	5.5888
70	0.00101515	289.67	306.93	0.94515	390	0.0123590	2656.6	2866.7	5.6770
75	0.00101812	310.40	327.71	1.0053	400	0.0130380	2696.3	2917.9	5.7536
80	0.00102123	331.15	348.51	1.0646	410	0.0136600	2732.0	2964.2	5.8219
85	0.00102449	351.91	369.33	1.1231	420	0.0142370	2765.0	3007.0	5.8841
90	0.00102788	372.69	390.16	1.1809	430	0.0147790	2795.9	3047.1	5.9414
95	0.00103142	393.49	411.02	1.2379	440	0.0152930	2824.9	3084.9	5.9949
100	0.00103509	414.30	431.90	1.2943	450	0.0157840	2852.7	3121.0	6.0451
105	0.00103890	435.15	452.81	1.3499	460	0.0162550	2879.3	3155.6	6.0927
110	0.00104286	456.01	473.74	1.4049	470	0.0167100	2904.9	3189.0	6.1379
115	0.00104695	476.90	494.70	1.4593	480	0.0171500	2929.8	3221.4	6.1812
120	0.00105119	497.83	515.70	1.5130	490	0.0175770	2954.1	3252.9	6.2227
125	0.00105558	518.79	536.73	1.5662	500	0.0179940	2977.7	3283.6	6.2628
130	0.00106011	539.78	557.80	1.6188	520	0.0187980	3023.6	3343.2	6.3389
135	0.00106480	560.82	578.92	1.6708	540	0.0195710	3068.1	3400.8	6.4106
140	0.00106964	581.89	600.07	1.7224	560	0.0203180	3111.5	3456.9	6.4787
145	0.00107464	603.01	621.28	1.7734	580	0.0210440	3154.0	3511.7	6.5438
150	0.00107980	624.18	642.54	1.8239	600	0.0217520	3195.9	3565.7	6.6063
155	0.00108512	645.40	663.85	1.8740	620	0.0224440	3237.3	3618.8	6.6665
160	0.00109062	666.68	685.22	1.9236	640	0.0231230	3278.3	3671.4	6.7247
165	0.00109630	688.02	706.66	1.9728	660	0.0237910	3319.1	3723.5	6.7811
170	0.00110217	709.42	728.16	2.0216	680	0.0244490	3359.6	3775.2	6.8360
175	0.00110822	730.90	749.74	2.0700	700	0.0250970	3400.0	3826.6	6.8894
180	0.00111448	752.44	771.39	2.1181	720	0.0257380	3440.4	3877.9	6.9415
185	0.00112094	774.07	793.13	2.1658	740	0.0263720	3480.6	3928.9	6.9924
190	0.00112762	795.79	814.96	2.2132	760	0.0269990	3520.9	3979.9	7.0422
195	0.00113453	817.59	836.88	2.2602	780	0.0276210	3561.2	4030.8	7.0910
200	0.00114168	839.49	858.90	2.3070	800	0.0282370	3601.6	4081.6	7.1388
210	0.00115676	883.60	903.26	2.3998	820	0.0288490	3642.1	4132.5	7.1858
220	0.00117295	928.17	948.11	2.4917	840	0.0294570	3682.6	4183.4	7.2319
230	0.00119042	973.27	993.51	2.5828	860	0.0300610	3723.3	4234.3	7.2772
240	0.00120932	1018.9	1039.5	2.6734	880	0.0306610	3764.1	4285.3	7.3218
250	0.00122989	1065.4	1086.3	2.7637	900	0.0312580	3805.0	4336.4	7.3658
260	0.00125240	1112.6	1133.9	2.8538	920	0.0318520	3846.0	4387.5	7.4090
270	0.00127720	1160.8	1182.5	2.9442	940	0.0324430	3887.3	4438.8	7.4516
					960	0.0330310	3928.7	4490.2	7.4936
					980	0.0336180	3970.2	4541.7	7.5351
					1000	0.0342020	4012.0	4593.4	7.5760

Water/Steam at $p = 18.0$ MPa ($T_{\text{sat}} = 356.992^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099131	0.21	18.05	0.00047
5	0.00099148	20.88	38.73	0.07550
10	0.00099197	41.54	59.40	0.14914
15	0.00099275	62.19	80.06	0.22146
20	0.00099378	82.83	100.72	0.29254
25	0.00099505	103.47	121.38	0.36242
30	0.00099653	124.10	142.04	0.43117
35	0.00099821	144.75	162.72	0.49881
40	0.00100008	165.40	183.40	0.56539
45	0.00100212	186.06	204.10	0.63095
50	0.00100432	206.72	224.80	0.69553
55	0.00100669	227.40	245.52	0.75914
60	0.00100922	248.08	266.25	0.82184
65	0.00101189	268.78	286.99	0.88364
70	0.00101471	289.49	307.75	0.94457
75	0.00101768	310.20	328.52	1.0047
80	0.00102079	330.94	349.31	1.0640
85	0.00102403	351.68	370.11	1.1225
90	0.00102742	372.45	390.94	1.1802
95	0.00103095	393.23	411.79	1.2372
100	0.00103461	414.04	432.66	1.2935
105	0.00103841	434.86	453.55	1.3492
110	0.00104236	455.71	474.47	1.4041
115	0.00104644	476.59	495.43	1.4585
120	0.00105067	497.50	516.41	1.5122
125	0.00105504	518.44	537.43	1.5653
130	0.00105956	539.42	558.49	1.6179
135	0.00106423	560.43	579.59	1.6699
140	0.00106905	581.50	600.74	1.7214
145	0.00107403	602.60	621.93	1.7724
150	0.00107918	623.74	643.17	1.8229
155	0.00108448	644.95	664.47	1.8729
160	0.00108996	666.21	685.83	1.9225
165	0.00109562	687.53	707.25	1.9717
170	0.00110146	708.91	728.74	2.0204
175	0.00110749	730.37	750.30	2.0688
180	0.00111371	751.88	771.93	2.1168
185	0.00112015	773.49	793.65	2.1645
190	0.00112680	795.18	815.46	2.2118
195	0.00113367	816.94	837.35	2.2588
200	0.00114078	838.82	859.35	2.3056
210	0.00115577	882.86	903.66	2.3983
220	0.00117186	927.37	948.46	2.4900
230	0.00118921	972.38	993.79	2.5810
240	0.00120797	1018.0	1039.7	2.6715
250	0.00122836	1064.3	1086.4	2.7615
260	0.00125065	1111.4	1133.9	2.8515
270	0.00127518	1159.4	1182.4	2.9416

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00127518	1159.4	1182.4	2.9416
280	0.00130241	1208.6	1232.0	3.0321
290	0.00133296	1259.1	1283.1	3.1236
300	0.00136769	1311.2	1335.8	3.2164
310	0.00140789	1365.5	1390.8	3.3114
320	0.00145558	1422.4	1448.6	3.4098
330	0.00151426	1483.3	1510.6	3.5133
340	0.00159081	1550.2	1578.8	3.6255
350	0.00170200	1628.1	1658.7	3.7547
356.992	0.00183980	1699.0	1732.1	3.8718
356.992	0.00750170	2374.8	2509.8	5.1061
360	0.00811120	2420.1	2566.1	5.1952
370	0.00945350	2513.7	2683.9	5.3799
380	0.0104190	2577.4	2764.9	5.5050
390	0.0112180	2628.4	2830.3	5.6042
400	0.0119160	2671.9	2886.4	5.6883
410	0.0125450	2710.6	2936.4	5.7620
420	0.0131230	2745.8	2982.0	5.8283
430	0.0136630	2778.5	3024.4	5.8890
440	0.0141710	2809.0	3064.1	5.9451
450	0.0146540	2838.0	3101.8	5.9975
460	0.0151170	2865.6	3137.7	6.0469
470	0.0155610	2892.2	3172.3	6.0938
480	0.0159900	2917.9	3205.7	6.1384
490	0.0164060	2942.8	3238.1	6.1812
500	0.0168100	2967.1	3269.7	6.2223
520	0.0175890	3014.1	3330.7	6.3002
540	0.0183350	3059.5	3389.5	6.3734
560	0.0190540	3103.5	3446.5	6.4427
580	0.0197520	3146.7	3502.2	6.5087
600	0.0204310	3189.0	3556.8	6.5720
620	0.0210940	3230.9	3610.6	6.6329
640	0.0217440	3272.4	3663.8	6.6918
660	0.0223820	3313.4	3716.3	6.7487
680	0.0230100	3354.3	3768.5	6.8041
700	0.0236290	3395.1	3820.4	6.8579
720	0.0242400	3435.7	3872.0	6.9104
740	0.0248440	3476.2	3923.4	6.9616
760	0.0254410	3516.7	3974.6	7.0117
780	0.0260330	3557.2	4025.8	7.0608
800	0.0266190	3597.8	4076.9	7.1089
820	0.0272010	3638.4	4128.0	7.1560
840	0.0277790	3679.1	4179.1	7.2024
860	0.0283520	3720.0	4230.3	7.2479
880	0.0289230	3760.8	4281.4	7.2927
900	0.0294890	3801.9	4332.7	7.3368
920	0.0300530	3843.0	4384.0	7.3801
940	0.0306140	3884.4	4435.5	7.4229
960	0.0311730	3925.9	4487.0	7.4650
980	0.0317290	3967.6	4538.7	7.5066
1000	0.0322820	4009.4	4590.5	7.5476

Water/Steam at $p = 19.0$ MPa ($T_{\text{sat}} = 361.473^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099084	0.21	19.04	0.00047	270	0.00127320	1158.1	1182.3	2.9390
5	0.00099102	20.87	39.70	0.07543	280	0.00130010	1207.1	1231.8	3.0293
10	0.00099152	41.51	60.35	0.14901	290	0.00133020	1257.3	1282.6	3.1203
15	0.00099231	62.15	81.00	0.22128	300	0.00136434	1309.2	1335.1	3.2127
20	0.00099335	82.77	101.64	0.29231	310	0.00140371	1363.0	1389.7	3.3071
25	0.00099462	103.39	122.29	0.36215	320	0.00145017	1419.4	1447.0	3.4046
30	0.00099611	124.01	142.94	0.43085	330	0.00150683	1479.6	1508.2	3.5068
35	0.00099779	144.65	163.61	0.49845	340	0.00157964	1545.0	1575.0	3.6168
40	0.00099965	165.29	184.28	0.56500	350	0.00168265	1619.9	1651.9	3.7412
45	0.00100169	185.93	204.96	0.63053	360	0.00187374	1719.6	1755.2	3.9054
50	0.00100390	206.59	225.66	0.69507	361.473	0.00192677	1740.6	1777.2	3.9401
55	0.00100627	227.24	246.36	0.75865	361.473	0.00667730	2339.1	2466.0	5.0256
60	0.00100879	247.91	267.08	0.82132	370	0.00821990	2460.1	2616.3	5.2610
65	0.00101146	268.59	287.81	0.88309	380	0.00931600	2538.9	2715.9	5.4147
70	0.00101428	289.29	308.56	0.94399	390	0.0101680	2597.5	2790.7	5.5284
75	0.00101724	309.99	329.32	1.0041	400	0.0108920	2645.9	2852.8	5.6215
80	0.00102034	330.71	350.10	1.0633	410	0.0115330	2688.0	2907.1	5.7015
85	0.00102358	351.45	370.90	1.1218	420	0.0121170	2725.8	2956.0	5.7725
90	0.00102696	372.21	391.72	1.1795	430	0.0126560	2760.3	3000.8	5.8368
95	0.00103048	392.97	412.55	1.2365	440	0.0131620	2792.5	3042.6	5.8958
100	0.00103413	413.76	433.41	1.2928	450	0.0136390	2822.9	3082.0	5.9506
105	0.00103793	434.58	454.30	1.3484	460	0.0140940	2851.6	3119.4	6.0020
110	0.00104186	455.41	475.21	1.4033	470	0.0145300	2879.2	3155.3	6.0506
115	0.00104593	476.28	496.15	1.4576	480	0.0149500	2905.8	3189.8	6.0967
120	0.00105015	497.18	517.13	1.5113	490	0.0153560	2931.3	3223.1	6.1407
125	0.00105451	518.09	538.13	1.5644	500	0.0157500	2956.3	3255.5	6.1829
130	0.00105901	539.06	559.18	1.6169	520	0.0165060	3004.4	3318.0	6.2627
135	0.00106367	560.06	580.27	1.6689	540	0.0172280	3050.7	3378.0	6.3374
140	0.00106847	581.10	601.40	1.7204	560	0.0179230	3095.5	3436.0	6.4079
145	0.00107344	602.18	622.58	1.7713	580	0.0185950	3139.3	3492.6	6.4750
150	0.00107856	623.32	643.81	1.8218	600	0.0192490	3182.3	3548.0	6.5391
155	0.00108385	644.51	665.10	1.8718	620	0.0198860	3224.6	3602.4	6.6008
160	0.00108930	665.74	686.44	1.9214	640	0.0205100	3266.4	3656.1	6.6603
165	0.00109494	687.04	707.84	1.9705	660	0.0211220	3307.9	3709.2	6.7178
170	0.00110075	708.40	729.31	2.0192	680	0.0217230	3349.1	3761.8	6.7736
175	0.00110675	729.83	750.86	2.0676	700	0.0223160	3390.1	3814.1	6.8278
180	0.00111295	751.33	772.48	2.1156	720	0.0229000	3430.9	3866.0	6.8807
185	0.00111936	772.90	794.17	2.1632	740	0.0234770	3471.7	3917.8	6.9323
190	0.00112597	794.57	815.96	2.2105	760	0.0240480	3512.4	3969.3	6.9827
195	0.00113281	816.31	837.83	2.2574	780	0.0246120	3553.2	4020.8	7.0320
200	0.00113989	838.15	859.81	2.3041	800	0.0251720	3593.9	4072.2	7.0803
210	0.00115479	882.13	904.07	2.3967	820	0.0257270	3634.7	4123.5	7.1277
220	0.00117078	926.57	948.81	2.4884	840	0.0262780	3675.6	4174.9	7.1743
230	0.00118801	971.51	994.08	2.5792	860	0.0268240	3716.5	4226.2	7.2200
240	0.00120663	1017.1	1040.0	2.6695	880	0.0273670	3757.6	4277.6	7.2649
250	0.00122685	1063.2	1086.5	2.7594	900	0.0279070	3798.8	4329.0	7.3092
260	0.00124893	1110.2	1133.9	2.8492	920	0.0284440	3840.2	4380.6	7.3527
270	0.00127320	1158.1	1182.3	2.9390	940	0.0289780	3881.6	4432.2	7.3956
					960	0.0295090	3923.2	4483.9	7.4379
					980	0.0300380	3965.0	4535.7	7.4796
					1000	0.0305650	4006.9	4587.6	7.5207

Water/Steam at $p = 20.0$ MPa ($T_{\text{sat}} = 365.749^\circ\text{C}$)

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00099036	0.22	20.03	0.00047
5	0.00099055	20.87	40.68	0.07536
10	0.00099107	41.49	61.31	0.14888
15	0.00099187	62.10	81.94	0.22109
20	0.00099292	82.71	102.57	0.29207
25	0.00099419	103.32	123.20	0.36187
30	0.00099568	123.93	143.84	0.43053
35	0.00099737	144.54	164.49	0.49810
40	0.00099923	165.18	185.16	0.56461
45	0.00100127	185.80	205.83	0.63010
50	0.00100348	206.44	226.51	0.69461
55	0.00100585	227.09	247.21	0.75817
60	0.00100836	247.75	267.92	0.82080
65	0.00101103	268.42	288.64	0.88254
70	0.00101384	289.10	309.38	0.94341
75	0.00101680	309.79	330.13	1.0035
80	0.00101989	330.50	350.90	1.0627
85	0.00102313	351.23	371.69	1.1211
90	0.00102650	371.96	392.49	1.1788
95	0.00103001	392.72	413.32	1.2358
100	0.00103366	413.50	434.17	1.2920
105	0.00103744	434.29	455.04	1.3476
110	0.00104136	455.11	475.94	1.4025
115	0.00104543	475.97	496.88	1.4568
120	0.00104963	496.85	517.84	1.5105
125	0.00105398	517.76	538.84	1.5635
130	0.00105847	538.70	559.87	1.6160
135	0.00106311	559.69	580.95	1.6680
140	0.00106790	580.71	602.07	1.7194
145	0.00107284	601.77	623.23	1.7703
150	0.00107795	622.89	644.45	1.8208
155	0.00108321	644.06	665.72	1.8707
160	0.00108865	665.28	687.05	1.9203
165	0.00109426	686.55	708.44	1.9694
170	0.00110005	707.89	729.89	2.0181
175	0.00110603	729.30	751.42	2.0664
180	0.00111220	750.78	773.02	2.1143
185	0.00111857	772.33	794.70	2.1619
190	0.00112516	793.96	816.46	2.2091
195	0.00113196	815.68	838.32	2.2561
200	0.00113900	837.49	860.27	2.3027
210	0.00115381	881.40	904.48	2.3952
220	0.00116971	925.77	949.16	2.4867
230	0.00118682	970.63	994.37	2.5774
240	0.00120530	1016.1	1040.2	2.6676
250	0.00122536	1062.2	1086.7	2.7573
260	0.00124723	1109.1	1134.0	2.8469
270	0.00127125	1156.8	1182.2	2.9365

T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00127125	1156.8	1182.2	2.9365
280	0.00129782	1205.5	1231.5	3.0265
290	0.00132750	1255.5	1282.1	3.1172
300	0.00136108	1307.2	1334.4	3.2091
310	0.00139966	1360.6	1388.6	3.3029
320	0.00144496	1416.6	1445.5	3.3996
330	0.00149978	1475.9	1505.9	3.5006
340	0.00156929	1540.2	1571.6	3.6086
350	0.00166490	1612.7	1646.0	3.7290
360	0.00182479	1703.6	1740.1	3.8787
365.749	0.00204000	1786.4	1827.2	4.0156
365.749	0.00586520	2295.0	2412.3	4.9314
370	0.00692340	2388.0	2526.5	5.1097
380	0.00825990	2494.2	2659.4	5.3149
390	0.00919060	2563.4	2747.2	5.4483
400	0.00995030	2617.9	2816.9	5.5525
410	0.0106100	2664.0	2876.2	5.6400
420	0.0112010	2704.7	2928.7	5.7163
430	0.0117430	2741.5	2976.4	5.7847
440	0.0122470	2775.5	3020.4	5.8469
450	0.0127210	2807.3	3061.7	5.9043
460	0.0131710	2837.3	3100.7	5.9579
470	0.0136000	2865.8	3137.8	6.0082
480	0.0140120	2893.3	3173.5	6.0559
490	0.0144090	2919.7	3207.9	6.1012
500	0.0147930	2945.3	3241.2	6.1446
520	0.0155300	2994.6	3305.2	6.2263
540	0.0162310	3041.8	3366.4	6.3025
560	0.0169040	3087.3	3425.4	6.3743
580	0.0175540	3131.8	3482.9	6.4424
600	0.0181850	3175.3	3539.0	6.5075
620	0.0187990	3218.1	3594.1	6.5699
640	0.0193990	3260.4	3648.4	6.6300
660	0.0199870	3302.3	3702.0	6.6881
680	0.0205650	3343.8	3755.1	6.7443
700	0.0211330	3385.1	3807.8	6.7990
720	0.0216940	3426.2	3860.1	6.8523
740	0.0222470	3467.3	3912.2	6.9042
760	0.0227930	3508.2	3964.1	6.9549
780	0.0233340	3549.1	4015.8	7.0045
800	0.0238690	3590.1	4067.5	7.0531
820	0.0244000	3631.0	4119.0	7.1007
840	0.0249270	3672.1	4170.6	7.1475
860	0.0254490	3713.2	4222.2	7.1934
880	0.0259680	3754.3	4273.7	7.2385
900	0.0264830	3795.7	4325.4	7.2829
920	0.0269960	3837.2	4377.1	7.3266
940	0.0275060	3878.7	4428.8	7.3696
960	0.0280130	3920.4	4480.7	7.4120
980	0.0285180	3962.2	4532.6	7.4538
1000	0.0290200	4004.3	4584.7	7.4950

Water/Steam at $p = 22.0$ MPa ($T_{\text{sat}} = 373.705^\circ\text{C}$)

T	v	u	h	s	T	v	u	h	s
$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K	$^\circ\text{C}$	m^3/kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00098941	0.24	22.01	0.00046	270	0.00126743	1154.1	1182.0	2.9315
5	0.00098963	20.84	42.61	0.07521	280	0.00129338	1202.5	1231.0	3.0209
10	0.00099017	41.43	63.21	0.14861	290	0.00132227	1252.2	1281.3	3.1110
15	0.00099099	62.01	83.81	0.22072	300	0.00135478	1303.2	1333.0	3.2021
20	0.00099205	82.58	104.41	0.29161	310	0.00139190	1356.1	1386.7	3.2948
25	0.00099334	103.17	125.02	0.36132	320	0.00143509	1411.1	1442.7	3.3900
30	0.00099484	123.75	145.64	0.42990	330	0.00148666	1469.1	1501.8	3.4889
35	0.00099653	144.35	166.27	0.49739	340	0.00155060	1531.3	1565.4	3.5934
40	0.00099840	164.95	186.91	0.56383	350	0.00163487	1599.9	1635.9	3.7075
45	0.00100044	185.55	207.56	0.62925	360	0.00176012	1680.7	1719.4	3.8404
50	0.00100264	206.16	228.22	0.69370	370	0.00202860	1797.9	1842.5	4.0332
55	0.00100500	226.79	248.90	0.75719	373.705	0.00270440	1951.8	2011.3	4.2945
60	0.00100752	247.42	269.59	0.81976	373.705	0.00364750	2092.9	2173.1	4.5446
65	0.00101018	268.07	290.29	0.88144	380	0.00612340	2369.8	2504.5	5.0555
70	0.00101298	288.72	311.01	0.94226	390	0.00737870	2481.6	2643.9	5.2675
75	0.00101593	309.39	331.74	1.0022	400	0.00825560	2554.2	2735.8	5.4051
80	0.00101901	330.07	352.49	1.0614	410	0.00897020	2611.1	2808.4	5.5122
85	0.00102223	350.77	373.26	1.1198	420	0.00958930	2659.0	2870.0	5.6018
90	0.00102559	371.49	394.05	1.1775	430	0.0101440	2701.3	2924.5	5.6798
95	0.00102908	392.21	414.85	1.2344	440	0.0106510	2739.4	2973.7	5.7494
100	0.00103271	412.96	435.68	1.2906	450	0.0111230	2774.5	3019.2	5.8127
105	0.00103648	433.74	456.54	1.3461	460	0.0115650	2807.3	3061.7	5.8710
110	0.00104038	454.53	477.42	1.4009	470	0.0119850	2838.1	3101.8	5.9254
115	0.00104442	475.35	498.33	1.4551	480	0.0123850	2867.5	3140.0	5.9764
120	0.00104860	496.20	519.27	1.5088	490	0.0127680	2895.6	3176.5	6.0246
125	0.00105292	517.08	540.24	1.5618	500	0.0131380	2922.8	3211.8	6.0705
130	0.00105738	537.99	561.25	1.6142	520	0.0138420	2974.5	3279.0	6.1563
135	0.00106199	558.95	582.31	1.6661	540	0.0145080	3023.6	3342.8	6.2358
140	0.00106675	579.93	603.40	1.7175	560	0.0151440	3070.8	3404.0	6.3102
145	0.00107166	600.96	624.54	1.7683	580	0.0157550	3116.7	3463.3	6.3805
150	0.00107673	622.04	645.73	1.8187	600	0.0163470	3161.4	3521.0	6.4473
155	0.00108196	643.17	666.97	1.8686	620	0.0169210	3205.1	3577.4	6.5113
160	0.00108735	664.35	688.27	1.9181	640	0.0174810	3248.3	3632.9	6.5727
165	0.00109292	685.59	709.63	1.9671	660	0.0180280	3291.0	3687.6	6.6319
170	0.00109866	706.88	731.05	2.0157	680	0.0185650	3333.2	3741.6	6.6892
175	0.00110458	728.24	752.54	2.0639	700	0.0190920	3375.1	3795.1	6.7447
180	0.00111070	749.67	774.11	2.1118	720	0.0196110	3416.8	3848.2	6.7988
185	0.00111701	771.18	795.75	2.1593	740	0.0201220	3458.3	3901.0	6.8514
190	0.00112354	792.76	817.48	2.2065	760	0.0206270	3499.7	3953.5	6.9027
195	0.00113027	814.42	839.29	2.2533	780	0.0211260	3541.0	4005.8	6.9529
200	0.00113724	836.18	861.20	2.2999	800	0.0216200	3582.4	4058.0	7.0020
210	0.00115189	879.97	905.31	2.3921	820	0.0221090	3623.7	4110.1	7.0500
220	0.00116759	924.19	949.88	2.4834	840	0.0225940	3665.0	4162.1	7.0972
230	0.00118448	968.90	994.96	2.5739	860	0.0230740	3706.5	4214.1	7.1435
240	0.00120269	1014.1	1040.6	2.6638	880	0.0235510	3747.9	4266.0	7.1889
250	0.00122242	1060.0	1086.9	2.7532	900	0.0240250	3789.4	4318.0	7.2336
260	0.00124390	1106.6	1134.0	2.8423	920	0.0244950	3831.2	4370.1	7.2776
270	0.00126743	1154.1	1182.0	2.9315	940	0.0249630	3873.0	4422.2	7.3209
					960	0.0254280	3914.9	4474.3	7.3636
					980	0.0258910	3957.0	4526.6	7.4056
					1000	0.0263520	3999.2	4578.9	7.4470

Water/Steam at $p = 25.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00098800	0.26	24.96	0.00041	270	0.00126190	1150.4	1181.9	2.9242
5	0.00098826	20.80	45.51	0.07496	280	0.00128699	1198.3	1230.5	3.0129
10	0.00098884	41.34	66.06	0.14819	290	0.00131478	1247.3	1280.2	3.1020
15	0.00098968	61.88	86.62	0.22015	300	0.00134590	1297.7	1331.3	3.1919
20	0.00099077	82.41	107.18	0.29089	310	0.00138100	1349.6	1384.1	3.2832
25	0.00099207	102.95	127.75	0.36047	320	0.00142150	1403.4	1438.9	3.3764
30	0.00099358	123.49	148.33	0.42894	330	0.00146900	1459.7	1496.4	3.4726
35	0.00099527	144.05	168.93	0.49632	340	0.00152640	1519.3	1557.5	3.5731
40	0.00099715	164.60	189.53	0.56265	350	0.00159880	1583.9	1623.9	3.6804
45	0.00099919	185.17	210.15	0.62798	360	0.00169690	1656.2	1698.6	3.7993
50	0.00100139	205.76	230.79	0.69233	370	0.00185030	1743.5	1789.8	3.9423
55	0.00100375	226.34	251.43	0.75573	380	0.00221820	1880.2	1935.7	4.1671
60	0.00100625	246.93	272.09	0.81821	390	0.00464740	2279.5	2395.7	4.8660
65	0.00100890	267.55	292.77	0.87981	400	0.00600470	2428.5	2578.6	5.1400
70	0.00101170	288.17	313.46	0.94054	410	0.00688330	2515.0	2687.1	5.3000
75	0.00101463	308.79	334.16	1.0004	420	0.00757920	2579.9	2769.4	5.4197
80	0.00101769	329.44	354.88	1.0595	430	0.00817250	2633.5	2837.8	5.5176
85	0.00102090	350.10	375.62	1.1178	440	0.00869860	2679.8	2897.3	5.6016
90	0.00102423	370.77	396.38	1.1754	450	0.00917630	2721.2	2950.6	5.6759
95	0.00102770	391.46	417.15	1.2322	460	0.00961760	2759.0	2999.4	5.7428
100	0.00103130	412.17	437.95	1.2883	470	0.0100300	2793.9	3044.6	5.8042
105	0.00103504	432.90	458.78	1.3438	480	0.0104190	2826.7	3087.2	5.8610
110	0.00103891	453.66	479.63	1.3986	490	0.0107890	2857.8	3127.5	5.9142
115	0.00104292	474.43	500.50	1.4527	500	0.0111430	2887.3	3165.9	5.9642
120	0.00104706	495.23	521.41	1.5062	520	0.0118110	2943.1	3238.4	6.0569
125	0.00105134	516.07	542.35	1.5591	540	0.0124360	2995.6	3306.5	6.1416
130	0.00105577	536.94	563.33	1.6115	560	0.0130290	3045.5	3371.2	6.2202
135	0.00106033	557.84	584.35	1.6633	580	0.0135950	3093.4	3433.3	6.2940
140	0.00106505	578.78	605.41	1.7146	600	0.0141400	3140.0	3493.5	6.3637
145	0.00106991	599.76	626.51	1.7654	620	0.0146670	3185.4	3552.1	6.4300
150	0.00107492	620.79	647.66	1.8156	640	0.0151790	3229.9	3609.4	6.4935
155	0.00108009	641.86	668.86	1.8654	660	0.0156780	3273.8	3665.7	6.5545
160	0.00108543	662.97	690.11	1.9148	680	0.0161650	3317.1	3721.2	6.6133
165	0.00109093	684.16	711.43	1.9637	700	0.0166430	3359.9	3776.0	6.6702
170	0.00109660	705.39	732.80	2.0122	720	0.0171130	3402.4	3830.2	6.7254
175	0.00110245	726.69	754.25	2.0604	740	0.0175740	3444.8	3884.1	6.7791
180	0.00110849	748.05	775.76	2.1081	760	0.0180290	3486.9	3937.6	6.8313
185	0.00111472	769.48	797.35	2.1555	780	0.0184780	3528.9	3990.8	6.8823
190	0.00112115	790.99	819.02	2.2025	800	0.0189220	3570.8	4043.8	6.9322
195	0.00112778	812.58	840.77	2.2492	820	0.0193610	3612.6	4096.6	6.9810
200	0.00113464	834.24	862.61	2.2956	840	0.0197950	3654.4	4149.3	7.0287
210	0.00114906	877.86	906.59	2.3876	860	0.0202250	3696.3	4201.9	7.0756
220	0.00116449	921.89	951.00	2.4786	880	0.0206520	3738.2	4254.5	7.1216
230	0.00118104	966.36	995.89	2.5687	900	0.0210750	3780.2	4307.1	7.1668
240	0.00119887	1011.3	1041.3	2.6582	920	0.0214960	3822.2	4359.6	7.2112
250	0.00121814	1056.9	1087.4	2.7471	940	0.0219130	3864.4	4412.2	7.2549
260	0.00123906	1103.2	1134.2	2.8357	960	0.0223280	3906.6	4464.8	7.2979
270	0.00126190	1150.4	1181.9	2.9242	980	0.0227400	3949.0	4517.5	7.3403
					1000	0.0231500	3991.5	4570.2	7.3820

Water/Steam at $p = 30.0$ MPa

T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00098567	0.29	29.86	0.00027
5	0.00098601	20.74	50.32	0.07450
10	0.00098664	41.19	70.79	0.14745
15	0.00098753	61.65	91.28	0.21916
20	0.00098865	82.11	111.77	0.28968
25	0.00098998	102.58	132.28	0.35905
30	0.00099150	123.07	152.81	0.42732
35	0.00099321	143.55	173.35	0.49452
40	0.00099509	164.05	193.90	0.56069
45	0.00099714	184.56	214.47	0.62586
50	0.00099933	205.07	235.05	0.69005
55	0.00100168	225.60	255.65	0.75330
60	0.00100417	246.13	276.26	0.81564
65	0.00100681	266.69	296.89	0.87710
70	0.00100958	287.24	317.53	0.93769
75	0.00101249	307.82	338.19	0.99746
80	0.00101553	328.39	358.86	1.0564
85	0.00101870	348.99	379.55	1.1146
90	0.00102200	369.60	400.26	1.1720
95	0.00102543	390.23	420.99	1.2287
100	0.00102899	410.87	441.74	1.2847
105	0.00103268	431.54	462.52	1.3400
110	0.00103651	452.22	483.32	1.3946
115	0.00104046	472.93	504.14	1.4486
120	0.00104455	493.66	525.00	1.5020
125	0.00104877	514.42	545.88	1.5548
130	0.00105312	535.22	566.81	1.6070
135	0.00105762	556.03	587.76	1.6587
140	0.00106226	576.89	608.76	1.7098
145	0.00106704	597.79	629.80	1.7605
150	0.00107197	618.73	650.89	1.8106
155	0.00107705	639.71	672.02	1.8602
160	0.00108228	660.74	693.21	1.9094
165	0.00108768	681.82	714.45	1.9582
170	0.00109324	702.95	735.75	2.0065
175	0.00109897	724.14	757.11	2.0545
180	0.00110488	745.39	778.54	2.1020
185	0.00111098	766.72	800.05	2.1492
190	0.00111726	788.10	821.62	2.1961
195	0.00112374	809.57	843.28	2.2426
200	0.00113043	831.11	865.02	2.2888
210	0.00114447	874.44	908.77	2.3803
220	0.00115947	918.15	952.93	2.4707
230	0.00117552	962.27	997.54	2.5603
240	0.00119275	1006.9	1042.7	2.6491
250	0.00121131	1052.1	1088.4	2.7373
260	0.00123137	1097.8	1134.7	2.8250
270	0.00125317	1144.2	1181.8	2.9126

T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00125317	1144.2	1181.8	2.9126
280	0.00127698	1191.5	1229.8	3.0001
290	0.00130315	1239.6	1278.7	3.0878
300	0.00133220	1288.9	1328.9	3.1760
310	0.00136460	1339.5	1380.4	3.2652
320	0.00140140	1391.7	1433.7	3.3557
330	0.00144360	1445.8	1489.1	3.4483
340	0.00149320	1502.3	1547.1	3.5438
350	0.00155290	1562.2	1608.8	3.6436
360	0.00162760	1626.8	1675.6	3.7498
370	0.00172680	1698.3	1750.1	3.8666
380	0.00187290	1782.0	1838.2	4.0025
390	0.00213310	1891.3	1955.3	4.1804
400	0.00279780	2068.9	2152.8	4.4757
410	0.00398090	2276.0	2395.4	4.8336
420	0.00492030	2405.3	2552.9	5.0627
430	0.00563660	2493.7	2662.8	5.2200
440	0.00622670	2562.1	2748.9	5.3416
450	0.00673730	2618.9	2821.0	5.4421
460	0.00719310	2668.2	2884.0	5.5286
470	0.00760830	2712.2	2940.4	5.6051
480	0.00799230	2752.2	2992.0	5.6741
490	0.00835150	2789.4	3039.9	5.7372
500	0.00869040	2824.0	3084.7	5.7956
520	0.00932000	2888.0	3167.6	5.9014
540	0.00990000	2946.6	3243.6	5.9961
560	0.0104420	3001.4	3314.7	6.0825
580	0.0109550	3053.6	3382.2	6.1625
600	0.0114450	3103.3	3446.7	6.2373
620	0.0119140	3151.7	3509.1	6.3079
640	0.0123680	3198.7	3569.7	6.3750
660	0.0128080	3244.6	3628.8	6.4391
680	0.0132360	3289.7	3686.8	6.5006
700	0.0136530	3334.3	3743.9	6.5598
720	0.0140620	3378.3	3800.2	6.6171
740	0.0144630	3421.9	3855.8	6.6726
760	0.0148570	3465.2	3910.9	6.7264
780	0.0152450	3508.4	3965.7	6.7789
800	0.0156280	3551.2	4020.0	6.8300
820	0.0160050	3594.0	4074.1	6.8800
840	0.0163780	3636.7	4128.0	6.9288
860	0.0167470	3679.3	4181.7	6.9766
880	0.0171120	3721.9	4235.3	7.0235
900	0.0174730	3764.6	4288.8	7.0695
920	0.0178320	3807.2	4342.2	7.1147
940	0.0181880	3850.0	4395.6	7.1591
960	0.0185410	3892.8	4449.0	7.2027
980	0.0188910	3935.7	4502.4	7.2457
1000	0.0192400	3978.6	4555.8	7.2880

Water/Steam at $p = 35.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00098338	0.30	34.72	0.00005	270	0.00124498	1138.4	1182.0	2.9014
5	0.00098379	20.67	55.10	0.07398	280	0.00126766	1185.0	1229.4	2.9879
10	0.00098447	41.04	75.50	0.14666	290	0.00129245	1232.5	1277.7	3.0744
15	0.00098540	61.42	95.91	0.21813	300	0.00131970	1280.8	1327.0	3.1612
20	0.00098656	81.81	116.34	0.28844	310	0.00134990	1330.4	1377.6	3.2486
25	0.00098791	102.22	136.80	0.35761	320	0.00138370	1381.1	1429.5	3.3370
30	0.00098946	122.64	157.27	0.42570	330	0.00142200	1433.4	1483.2	3.4268
35	0.00099118	143.06	177.75	0.49272	340	0.00146600	1487.8	1539.1	3.5186
40	0.00099307	163.50	198.26	0.55873	350	0.00151740	1544.5	1597.6	3.6132
45	0.00099511	183.95	218.78	0.62374	360	0.00157910	1604.3	1659.6	3.7120
50	0.00099731	204.40	239.31	0.68778	370	0.00165540	1668.6	1726.5	3.8168
55	0.00099965	224.87	259.86	0.75089	380	0.00175460	1739.0	1800.4	3.9308
60	0.00100213	245.36	280.43	0.81308	390	0.00189300	1819.1	1885.4	4.0599
65	0.00100475	265.84	301.01	0.87440	400	0.00210540	1914.9	1988.6	4.2143
70	0.00100750	286.34	321.60	0.93486	410	0.00247470	2037.3	2123.9	4.4138
75	0.00101038	306.85	342.21	0.99450	420	0.00308380	2184.0	2291.9	4.6579
80	0.00101339	327.37	362.84	1.0533	430	0.00378000	2315.3	2447.6	4.8809
85	0.00101654	347.91	383.49	1.1114	440	0.00441200	2417.4	2571.8	5.0564
90	0.00101980	368.46	404.15	1.1687	450	0.00495720	2497.5	2671.0	5.1945
95	0.00102320	389.02	424.83	1.2252	460	0.00543360	2563.4	2753.6	5.3080
100	0.00102672	409.60	445.54	1.2811	470	0.00585880	2619.7	2824.8	5.4046
105	0.00103037	430.20	466.26	1.3363	480	0.00624500	2669.5	2888.1	5.4891
110	0.00103414	450.82	487.01	1.3908	490	0.00660090	2714.3	2945.3	5.5646
115	0.00103805	471.46	507.79	1.4447	500	0.00693250	2755.3	2997.9	5.6331
120	0.00104208	492.12	528.59	1.4979	520	0.00753920	2829.0	3092.9	5.7544
125	0.00104624	512.81	549.43	1.5506	540	0.00808930	2895.0	3178.1	5.8605
130	0.00105053	533.52	570.29	1.6027	560	0.00859740	2955.5	3256.4	5.9556
135	0.00105496	554.28	591.20	1.6542	580	0.00907320	3012.0	3329.6	6.0425
140	0.00105953	575.06	612.14	1.7052	600	0.00952340	3065.6	3398.9	6.1228
145	0.00106423	595.87	633.12	1.7557	620	0.00995270	3117.0	3465.3	6.1980
150	0.00106908	616.72	654.14	1.8056	640	0.0103650	3166.6	3529.4	6.2689
155	0.00107407	637.62	675.21	1.8551	660	0.0107620	3214.8	3591.5	6.3363
160	0.00107922	658.56	696.33	1.9042	680	0.0111480	3262.0	3652.2	6.4006
165	0.00108451	679.54	717.50	1.9528	700	0.0115230	3308.3	3711.6	6.4622
170	0.00108997	700.58	738.73	2.0009	720	0.0118880	3353.8	3769.9	6.5216
175	0.00109559	721.67	760.02	2.0487	740	0.0122460	3398.8	3827.4	6.5789
180	0.00110138	742.82	781.37	2.0961	760	0.0125960	3443.4	3884.3	6.6345
185	0.00110734	764.03	802.79	2.1431	780	0.0129400	3487.6	3940.5	6.6884
190	0.00111349	785.31	824.28	2.1897	800	0.0132780	3531.6	3996.3	6.7409
195	0.00111983	806.65	845.84	2.2361	820	0.0136120	3575.3	4051.7	6.7920
200	0.00112636	828.06	867.48	2.2820	840	0.0139410	3618.8	4106.7	6.8419
210	0.00114005	871.12	911.02	2.3731	860	0.0142650	3662.2	4161.5	6.8907
220	0.00115464	914.53	954.94	2.4631	880	0.0145860	3705.6	4216.1	6.9385
230	0.00117022	958.32	999.28	2.5521	900	0.0149040	3749.0	4270.6	6.9853
240	0.00118690	1002.6	1044.1	2.6403	920	0.0152180	3792.3	4324.9	7.0312
250	0.00120481	1047.2	1089.4	2.7278	940	0.0155300	3835.6	4379.1	7.0763
260	0.00122411	1092.6	1135.4	2.8148	960	0.0158390	3878.9	4433.3	7.1205
270	0.00124498	1138.4	1182.0	2.9014	980	0.0161450	3922.3	4487.4	7.1641
					1000	0.0164500	3965.8	4541.5	7.2069

Water/Steam at $p = 40.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00098113	0.30	39.55	-0.00024	270	0.00123727	1132.9	1182.4	2.8908
5	0.00098160	20.59	59.85	0.07340	280	0.00125895	1178.9	1229.3	2.9764
10	0.00098234	40.89	80.18	0.14582	290	0.00128252	1225.7	1277.0	3.0618
15	0.00098331	61.20	100.53	0.21707	300	0.00130830	1273.3	1325.6	3.1473
20	0.00098450	81.52	120.90	0.28716	310	0.00133660	1321.8	1375.3	3.2332
25	0.00098588	101.85	141.29	0.35615	320	0.00136800	1371.5	1426.2	3.3198
30	0.00098744	122.21	161.71	0.42405	330	0.00140320	1422.4	1478.5	3.4073
35	0.00098917	142.58	182.15	0.49091	340	0.00144290	1474.9	1532.6	3.4962
40	0.00099107	162.96	202.60	0.55676	350	0.00148840	1529.3	1588.8	3.5871
45	0.00099311	183.35	223.07	0.62161	360	0.00154150	1586.0	1647.7	3.6808
50	0.00099531	203.75	243.56	0.68551	370	0.00160460	1645.7	1709.9	3.7783
55	0.00099764	224.15	264.06	0.74848	380	0.00168190	1709.3	1776.6	3.8813
60	0.00100011	244.58	284.58	0.81054	390	0.00178010	1778.4	1849.6	3.9921
65	0.00100271	265.01	305.12	0.87172	400	0.00191080	1855.0	1931.4	4.1145
70	0.00100545	285.45	325.67	0.93205	410	0.00209340	1941.8	2025.5	4.2533
75	0.00100831	305.91	346.24	0.99156	420	0.00236010	2042.0	2136.4	4.4144
80	0.00101129	326.37	366.82	1.0503	430	0.00274370	2154.8	2264.5	4.5979
85	0.00101441	346.84	387.42	1.1082	440	0.00320920	2265.8	2394.2	4.7810
90	0.00101764	367.33	408.04	1.1654	450	0.00369150	2364.1	2511.8	4.9448
95	0.00102100	387.84	428.68	1.2218	460	0.00414800	2447.5	2613.4	5.0844
100	0.00102449	408.35	449.33	1.2775	470	0.00456620	2518.2	2700.8	5.2028
105	0.00102809	428.89	470.01	1.3326	480	0.00494790	2579.2	2777.1	5.3048
110	0.00103182	449.45	490.72	1.3870	490	0.00529850	2633.1	2845.0	5.3944
115	0.00103568	470.01	511.44	1.4407	500	0.00562310	2681.6	2906.5	5.4744
120	0.00103965	490.61	532.20	1.4938	520	0.00621160	2766.6	3015.1	5.6132
125	0.00104376	511.23	552.98	1.5464	540	0.00673880	2840.8	3110.4	5.7319
130	0.00104799	531.87	573.79	1.5983	560	0.00722090	2907.7	3196.5	5.8365
135	0.00105236	552.55	594.64	1.6497	580	0.00766850	2969.2	3275.9	5.9307
140	0.00105685	573.26	615.53	1.7006	600	0.00808910	3026.8	3350.4	6.0170
145	0.00106149	593.99	636.45	1.7509	620	0.00848780	3081.5	3421.0	6.0970
150	0.00106626	614.77	657.42	1.8008	640	0.00886860	3134.0	3488.7	6.1719
155	0.00107117	635.57	678.42	1.8501	660	0.00923440	3184.6	3554.0	6.2427
160	0.00107622	656.43	699.48	1.8990	680	0.00958750	3233.9	3617.4	6.3098
165	0.00108142	677.32	720.58	1.9474	700	0.00992970	3281.9	3679.1	6.3740
170	0.00108678	698.27	741.74	1.9955	720	0.0102630	3329.1	3739.6	6.4355
175	0.00109229	719.27	762.96	2.0431	740	0.0105870	3375.6	3799.1	6.4948
180	0.00109797	740.31	784.23	2.0903	760	0.0109050	3421.4	3857.6	6.5520
185	0.00110381	761.42	805.57	2.1371	780	0.0112160	3466.8	3915.4	6.6074
190	0.00110983	782.58	826.97	2.1836	800	0.0115210	3511.8	3972.6	6.6612
195	0.00111603	803.81	848.45	2.2297	820	0.0118210	3556.5	4029.3	6.7136
200	0.00112241	825.10	870.00	2.2755	840	0.0121170	3600.9	4085.6	6.7646
210	0.00113578	867.91	913.34	2.3661	860	0.0124080	3645.2	4141.5	6.8144
220	0.00114999	911.04	957.04	2.4556	880	0.0126960	3689.3	4197.1	6.8630
230	0.00116514	954.49	1001.1	2.5442	900	0.0129800	3733.3	4252.5	6.9106
240	0.00118131	998.45	1045.7	2.6318	920	0.0132610	3777.3	4307.7	6.9573
250	0.00119863	1042.8	1090.7	2.7187	940	0.0135400	3821.1	4362.7	7.0030
260	0.00121723	1087.6	1136.3	2.8050	960	0.0138150	3865.1	4417.7	7.0480
270	0.00123727	1132.9	1182.4	2.8908	980	0.0140890	3908.9	4472.5	7.0921
					1000	0.0143600	3952.9	4527.3	7.1355

Water/Steam at $p = 45.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00097892	0.30	44.35	-0.00060	270	0.00122997	1127.8	1183.1	2.8806
5	0.00097945	20.50	64.58	0.07276	280	0.00125076	1173.2	1229.5	2.9653
10	0.00098024	40.72	84.83	0.14494	290	0.00127325	1219.4	1276.7	3.0498
15	0.00098125	60.96	105.12	0.21597	300	0.00129770	1266.2	1324.6	3.1342
20	0.00098247	81.23	125.44	0.28586	310	0.00132440	1313.9	1373.5	3.2188
25	0.00098387	101.51	145.78	0.35466	320	0.00135380	1362.6	1423.5	3.3038
30	0.00098545	121.79	166.14	0.42240	330	0.00138640	1412.3	1474.7	3.3894
35	0.00098720	142.11	186.53	0.48910	340	0.00142280	1463.4	1527.4	3.4760
40	0.00098910	162.42	206.93	0.55479	350	0.00146380	1515.9	1581.8	3.5640
45	0.00099114	182.76	227.36	0.61950	360	0.00151080	1570.3	1638.3	3.6539
50	0.00099333	203.10	247.80	0.68325	370	0.00156520	1626.9	1697.3	3.7464
55	0.00099566	223.46	268.26	0.74608	380	0.00162940	1686.3	1759.6	3.8425
60	0.00099812	243.82	288.74	0.80801	390	0.00170710	1749.1	1825.9	3.9433
65	0.00100071	264.20	309.23	0.86906	400	0.00180340	1816.5	1897.7	4.0507
70	0.00100342	284.59	329.74	0.92927	410	0.00192670	1889.7	1976.4	4.1667
75	0.00100626	304.98	350.26	0.98865	420	0.00208790	1969.7	2063.7	4.2937
80	0.00100923	325.38	370.80	1.0472	430	0.00230160	2057.5	2161.1	4.4331
85	0.00101231	345.81	391.36	1.1050	440	0.00258080	2151.8	2267.9	4.5839
90	0.00101552	366.23	411.93	1.1621	450	0.00291540	2246.4	2377.6	4.7367
95	0.00101884	386.67	432.52	1.2184	460	0.00327740	2335.2	2482.7	4.8810
100	0.00102229	407.14	453.14	1.2740	470	0.00364150	2415.1	2579.0	5.0115
105	0.00102585	427.61	473.77	1.3289	480	0.00399220	2485.9	2665.5	5.1272
110	0.00102954	448.09	494.42	1.3832	490	0.00432290	2548.6	2743.1	5.2295
115	0.00103335	468.60	515.10	1.4368	500	0.00463300	2604.7	2813.2	5.3207
120	0.00103728	489.13	535.81	1.4898	520	0.00519780	2701.8	2935.7	5.4773
125	0.00104133	509.68	556.54	1.5422	540	0.00570270	2784.9	3041.5	5.6091
130	0.00104550	530.26	577.31	1.5941	560	0.00616200	2858.5	3135.8	5.7236
135	0.00104981	550.86	598.10	1.6453	580	0.00658610	2925.3	3221.7	5.8255
140	0.00105424	571.49	618.93	1.6960	600	0.00698250	2987.3	3301.5	5.9179
145	0.00105880	592.15	639.80	1.7462	620	0.00735650	3045.5	3376.5	6.0029
150	0.00106349	612.85	660.71	1.7960	640	0.00771220	3100.9	3447.9	6.0820
155	0.00106832	633.59	681.66	1.8452	660	0.00805270	3154.0	3516.4	6.1562
160	0.00107329	654.35	702.65	1.8939	680	0.00838020	3205.4	3582.5	6.2263
165	0.00107841	675.16	723.69	1.9422	700	0.00869670	3255.4	3646.8	6.2930
170	0.00108367	696.01	744.78	1.9901	720	0.00900370	3304.2	3709.4	6.3568
175	0.00108908	716.92	765.93	2.0375	740	0.00930250	3352.2	3770.8	6.4179
180	0.00109465	737.87	787.13	2.0846	760	0.00959390	3399.4	3831.1	6.4769
185	0.00110037	758.87	808.39	2.1312	780	0.00987890	3445.9	3890.5	6.5338
190	0.00110627	779.94	829.72	2.1775	800	0.0101580	3492.0	3949.1	6.5889
195	0.00111234	801.05	851.11	2.2235	820	0.0104320	3537.7	4007.1	6.6425
200	0.00111858	822.23	872.57	2.2691	840	0.0107020	3583.0	4064.6	6.6946
210	0.00113164	864.80	915.72	2.3593	860	0.0109670	3628.1	4121.6	6.7454
220	0.00114550	907.66	959.21	2.4484	880	0.0112290	3672.9	4178.2	6.7949
230	0.00116024	950.89	1003.1	2.5364	900	0.0114870	3717.7	4234.6	6.8433
240	0.00117595	994.38	1047.3	2.6236	920	0.0117430	3762.3	4290.7	6.8907
250	0.00119272	1038.3	1092.0	2.7099	940	0.0119950	3806.7	4346.5	6.9372
260	0.00121068	1082.8	1137.3	2.7955	960	0.0122440	3851.2	4402.2	6.9827
270	0.00122997	1127.8	1183.1	2.8806	980	0.0124920	3895.7	4457.8	7.0274
					1000	0.0127370	3940.1	4513.3	7.0713

Water/Steam at $p = 50.0$ MPa

T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00097673	0.29	49.13	-0.00103
5	0.00097733	20.41	69.28	0.07207
10	0.00097816	40.56	89.47	0.14402
15	0.00097922	60.73	109.69	0.21483
20	0.00098047	80.93	129.95	0.28454
25	0.00098189	101.15	150.24	0.35316
30	0.00098349	121.39	170.56	0.42073
35	0.00098525	141.63	190.89	0.48727
40	0.00098715	161.89	211.25	0.55281
45	0.00098920	182.17	231.63	0.61738
50	0.00099139	202.46	252.03	0.68100
55	0.00099371	222.76	272.45	0.74369
60	0.00099616	243.07	292.88	0.80549
65	0.00099873	263.39	313.33	0.86642
70	0.00100143	283.73	333.80	0.92650
75	0.00100425	304.07	354.28	0.98575
80	0.00100719	324.42	374.78	1.0442
85	0.00101025	344.78	395.29	1.1019
90	0.00101343	365.15	415.82	1.1588
95	0.00101672	385.53	436.37	1.2150
100	0.00102013	405.93	456.94	1.2705
105	0.00102365	426.35	477.53	1.3253
110	0.00102730	446.78	498.14	1.3795
115	0.00103106	467.22	518.77	1.4330
120	0.00103494	487.68	539.43	1.4859
125	0.00103894	508.17	560.12	1.5381
130	0.00104306	528.68	580.83	1.5898
135	0.00104730	549.22	601.58	1.6410
140	0.00105167	569.78	622.36	1.6916
145	0.00105616	590.36	643.17	1.7417
150	0.00106079	610.98	664.02	1.7912
155	0.00106554	631.63	684.91	1.8403
160	0.00107043	652.32	705.84	1.8889
165	0.00107546	673.05	726.82	1.9371
170	0.00108063	693.82	747.85	1.9848
175	0.00108594	714.63	768.93	2.0321
180	0.00109141	735.49	790.06	2.0790
185	0.00109703	756.40	811.25	2.1255
190	0.00110281	777.36	832.50	2.1716
195	0.00110875	798.37	853.81	2.2174
200	0.00111486	819.45	875.19	2.2628
210	0.00112763	861.78	918.16	2.3527
220	0.00114116	904.39	961.45	2.4414
230	0.00115553	947.32	1005.1	2.5289
240	0.00117080	990.56	1049.1	2.6156
250	0.00118707	1034.1	1093.5	2.7013
260	0.00120444	1078.2	1138.4	2.7864
270	0.00122305	1122.7	1183.9	2.8708

T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
270	0.00122305	1122.7	1183.9	2.8708
280	0.00124303	1167.7	1229.9	2.9547
290	0.00126457	1213.4	1276.6	3.0383
300	0.00128790	1259.6	1324.0	3.1218
310	0.00131320	1306.5	1372.2	3.2052
320	0.00134090	1354.4	1421.4	3.2888
330	0.00137130	1403.0	1471.6	3.3728
340	0.00140490	1452.9	1523.1	3.4575
350	0.00144250	1504.0	1576.1	3.5431
360	0.00148480	1556.5	1630.7	3.6301
370	0.00153290	1610.8	1687.4	3.7189
380	0.00158840	1667.1	1746.5	3.8101
390	0.00165340	1725.9	1808.6	3.9045
400	0.00173070	1787.9	1874.4	4.0029
410	0.00182470	1853.5	1944.7	4.1066
420	0.00194090	1923.5	2020.5	4.2168
430	0.00208560	1998.2	2102.5	4.3342
440	0.00226600	2077.5	2190.8	4.4589
450	0.00248730	2160.3	2284.7	4.5896
460	0.00274540	2243.4	2380.7	4.7215
470	0.00302720	2323.4	2474.8	4.8489
480	0.00331860	2397.9	2563.8	4.9680
490	0.00360850	2466.1	2646.5	5.0771
500	0.00389000	2528.1	2722.6	5.1762
520	0.00441680	2636.2	2857.0	5.3479
540	0.00489470	2728.1	2972.8	5.4920
560	0.00533080	2808.5	3075.0	5.6163
580	0.00573310	2880.7	3167.4	5.7259
600	0.00610810	2947.1	3252.5	5.8245
620	0.00646100	3008.9	3332.0	5.9145
640	0.00679560	3067.4	3407.2	5.9978
660	0.00711490	3123.2	3478.9	6.0755
680	0.00742130	3176.8	3547.9	6.1486
700	0.00771660	3228.8	3614.6	6.2178
720	0.00800250	3279.3	3679.4	6.2838
740	0.00828010	3328.7	3742.7	6.3469
760	0.00855040	3377.3	3804.8	6.4076
780	0.00881430	3425.0	3865.7	6.4660
800	0.00907240	3472.2	3925.8	6.5225
820	0.00932550	3518.8	3985.1	6.5773
840	0.00957410	3565.1	4043.8	6.6304
860	0.00981850	3611.0	4101.9	6.6822
880	0.0100590	3656.6	4159.5	6.7326
900	0.0102960	3702.0	4216.8	6.7819
920	0.0105310	3747.2	4273.8	6.8300
940	0.0107620	3792.4	4330.5	6.8772
960	0.0109910	3837.4	4387.0	6.9233
980	0.0112170	3882.4	4443.2	6.9686
1000	0.0114410	3927.3	4499.4	7.0131

Water/Steam at $p = 60.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00097247	0.23	58.58	-0.00208	270	0.00121018	1113.3	1185.9	2.8522
5	0.00097318	20.21	78.60	0.07053	280	0.00122876	1157.5	1231.2	2.9348
10	0.00097411	40.22	98.67	0.14204	290	0.00124866	1202.1	1277.0	3.0169
15	0.00097524	60.27	118.78	0.21246	300	0.00127000	1247.3	1323.5	3.0986
20	0.00097654	80.35	138.94	0.28180	310	0.00129300	1293.0	1370.6	3.1801
25	0.00097802	100.45	159.13	0.35009	320	0.00131790	1339.3	1418.4	3.2615
30	0.00097965	120.57	179.35	0.41734	330	0.00134490	1386.4	1467.1	3.3429
35	0.00098143	140.70	199.59	0.48359	340	0.00137440	1434.3	1516.8	3.4245
40	0.00098334	160.86	219.86	0.54885	350	0.00140670	1483.1	1567.5	3.5065
45	0.00098540	181.04	240.16	0.61314	360	0.00144230	1532.9	1619.4	3.5892
50	0.00098758	201.22	260.47	0.67650	370	0.00148190	1583.8	1672.7	3.6727
55	0.00098989	221.42	280.81	0.73894	380	0.00152620	1636.0	1727.6	3.7574
60	0.00099232	241.62	301.16	0.80049	390	0.00157610	1689.7	1784.3	3.8436
65	0.00099486	261.84	321.53	0.86117	400	0.00163290	1745.2	1843.2	3.9317
70	0.00099753	282.06	341.91	0.92101	410	0.00169810	1802.6	1904.5	4.0221
75	0.00100031	302.29	362.31	0.98004	420	0.00177360	1862.2	1968.6	4.1153
80	0.00100321	322.54	382.73	1.0383	430	0.00186180	1924.2	2035.9	4.2116
85	0.00100621	342.79	403.16	1.0957	440	0.00196500	1988.5	2106.4	4.3112
90	0.00100933	363.05	423.61	1.1524	450	0.00208550	2055.1	2180.2	4.4140
95	0.00101257	383.33	444.08	1.2084	460	0.00222490	2123.3	2256.8	4.5191
100	0.00101591	403.61	464.56	1.2637	470	0.00238390	2192.5	2335.5	4.6257
105	0.00101936	423.90	485.06	1.3182	480	0.00256100	2261.3	2415.0	4.7320
110	0.00102292	444.21	505.59	1.3721	490	0.00275210	2328.6	2493.7	4.8358
115	0.00102660	464.53	526.13	1.4254	500	0.00295220	2393.2	2570.3	4.9356
120	0.00103039	484.88	546.70	1.4781	520	0.00336170	2512.2	2713.9	5.1189
125	0.00103429	505.23	567.29	1.5301	540	0.00376240	2617.0	2842.7	5.2794
130	0.00103830	525.61	587.91	1.5816	560	0.00414220	2709.4	2957.9	5.4193
135	0.00104243	546.01	608.56	1.6325	580	0.00449860	2791.9	3061.8	5.5426
140	0.00104668	566.44	629.24	1.6828	600	0.00483300	2866.8	3156.8	5.6527
145	0.00105105	586.89	649.95	1.7327	620	0.00514820	2935.9	3244.8	5.7524
150	0.00105554	607.36	670.69	1.7820	640	0.00544680	3000.4	3327.2	5.8437
155	0.00106015	627.86	691.47	1.8308	660	0.00573120	3061.4	3405.3	5.9282
160	0.00106489	648.40	712.29	1.8792	680	0.00600330	3119.5	3479.7	6.0071
165	0.00106976	668.97	733.16	1.9270	700	0.00626490	3175.4	3551.3	6.0814
170	0.00107476	689.57	754.06	1.9745	720	0.00651740	3229.4	3620.4	6.1518
175	0.00107989	710.22	775.01	2.0215	740	0.00676180	3281.8	3687.5	6.2187
180	0.00108517	730.90	796.01	2.0681	760	0.00699920	3333.0	3753.0	6.2827
185	0.00109058	751.63	817.06	2.1143	780	0.00723040	3383.3	3817.1	6.3441
190	0.00109615	772.40	838.17	2.1601	800	0.00745600	3432.6	3880.0	6.4033
195	0.00110186	793.22	859.33	2.2056	820	0.00767660	3481.3	3941.9	6.4604
200	0.00110773	814.09	880.55	2.2507	840	0.00789280	3529.3	4002.9	6.5158
210	0.00111997	855.99	923.19	2.3398	860	0.00810500	3576.9	4063.2	6.5694
220	0.00113289	898.13	966.10	2.4277	880	0.00831360	3624.1	4122.9	6.6217
230	0.00114657	940.51	1009.3	2.5145	900	0.00851880	3670.9	4182.0	6.6725
240	0.00116106	983.24	1052.9	2.6002	920	0.00872100	3717.4	4240.7	6.7221
250	0.00117643	1026.2	1096.8	2.6850	940	0.00892040	3763.8	4299.0	6.7706
260	0.00119277	1069.5	1141.1	2.7690	960	0.00911730	3810.0	4357.0	6.8180
270	0.00121018	1113.3	1185.9	2.8522	980	0.00931190	3856.0	4414.7	6.8644
					1000	0.00950430	3901.9	4472.2	6.9099

Water/Steam at $p = 70.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00096834	0.15	67.93	-0.00338	270	0.00119841	1104.6	1188.5	2.8348
5	0.00096916	19.99	87.83	0.06879	280	0.00121582	1148.1	1233.2	2.9162
10	0.00097017	39.87	107.78	0.13990	290	0.00123436	1191.9	1278.3	2.9970
15	0.00097137	59.80	127.80	0.20996	300	0.00125410	1236.1	1323.9	3.0773
20	0.00097273	79.76	147.85	0.27897	310	0.00127530	1280.8	1370.1	3.1572
25	0.00097425	99.75	167.95	0.34694	320	0.00129800	1326.0	1416.9	3.2368
30	0.00097591	119.77	188.08	0.41391	330	0.00132240	1371.7	1464.3	3.3162
35	0.00097771	139.80	208.24	0.47987	340	0.00134880	1418.2	1512.6	3.3954
40	0.00097964	159.86	228.43	0.54487	350	0.00137740	1465.2	1561.6	3.4748
45	0.00098169	179.93	248.65	0.60890	360	0.00140840	1513.0	1611.6	3.5543
50	0.00098387	200.01	268.88	0.67201	370	0.00144240	1561.6	1662.6	3.6342
55	0.00098617	220.11	289.14	0.73422	380	0.00147970	1611.1	1714.7	3.7147
60	0.00098858	240.21	309.41	0.79553	390	0.00152080	1661.6	1768.1	3.7958
65	0.00099110	260.32	329.70	0.85599	400	0.00156640	1713.3	1822.9	3.8779
70	0.00099374	280.45	350.01	0.91560	410	0.00161720	1766.1	1879.3	3.9610
75	0.00099648	300.58	370.33	0.97440	420	0.00167410	1820.3	1937.5	4.0455
80	0.00099934	320.72	390.67	1.0324	430	0.00173820	1875.8	1997.5	4.1315
85	0.00100230	340.87	411.03	1.0896	440	0.00181060	1932.9	2059.6	4.2192
90	0.00100536	361.02	431.40	1.1461	450	0.00189240	1991.2	2123.7	4.3084
95	0.00100854	381.18	451.78	1.2019	460	0.00198460	2050.8	2189.7	4.3991
100	0.00101181	401.36	472.19	1.2569	470	0.00208770	2111.4	2257.5	4.4909
105	0.00101520	421.55	492.61	1.3113	480	0.00220220	2172.2	2326.4	4.5831
110	0.00101869	441.74	513.05	1.3650	490	0.00232770	2233.3	2396.2	4.6751
115	0.00102228	461.95	533.51	1.4180	500	0.00246320	2293.7	2466.1	4.7660
120	0.00102599	482.17	553.99	1.4705	520	0.00275720	2410.3	2603.3	4.9412
125	0.00102980	502.41	574.50	1.5223	540	0.00306730	2518.6	2733.3	5.1032
130	0.00103371	522.67	595.03	1.5735	560	0.00337900	2617.5	2854.0	5.2499
135	0.00103774	542.94	615.58	1.6242	580	0.00368290	2707.3	2965.1	5.3816
140	0.00104188	563.24	636.17	1.6743	600	0.00397490	2789.2	3067.4	5.5002
145	0.00104613	583.55	656.78	1.7239	620	0.00425380	2864.5	3162.3	5.6077
150	0.00105050	603.90	677.43	1.7730	640	0.00451980	2934.7	3251.1	5.7060
155	0.00105498	624.25	698.10	1.8216	660	0.00477420	3000.6	3334.8	5.7966
160	0.00105958	644.65	718.82	1.8697	680	0.00501790	3063.0	3414.3	5.8809
165	0.00106430	665.07	739.57	1.9173	700	0.00525230	3122.6	3490.3	5.9599
170	0.00106914	685.52	760.36	1.9645	720	0.00547840	3180.0	3563.5	6.0343
175	0.00107411	706.00	781.19	2.0113	740	0.00569710	3235.5	3634.3	6.1049
180	0.00107921	726.53	802.07	2.0576	760	0.00590930	3289.3	3703.0	6.1721
185	0.00108444	747.09	823.00	2.1035	780	0.00611560	3342.0	3770.1	6.2364
190	0.00108981	767.68	843.97	2.1490	800	0.00631670	3393.5	3835.7	6.2981
195	0.00109532	788.32	864.99	2.1942	820	0.00651300	3444.2	3900.1	6.3576
200	0.00110097	809.00	886.07	2.2390	840	0.00670520	3494.0	3963.4	6.4150
210	0.00111273	850.51	928.40	2.3275	860	0.00689350	3543.3	4025.8	6.4705
220	0.00112512	892.22	970.98	2.4147	880	0.00707830	3591.9	4087.4	6.5244
230	0.00113819	934.13	1013.8	2.5008	900	0.00725990	3640.1	4148.3	6.5768
240	0.00115199	976.36	1057.0	2.5857	920	0.00743870	3688.0	4208.7	6.6279
250	0.00116658	1018.8	1100.5	2.6696	940	0.00761480	3735.6	4268.6	6.6776
260	0.00118203	1061.6	1144.3	2.7526	960	0.00778840	3782.8	4328.0	6.7262
270	0.00119841	1104.6	1188.5	2.8348	980	0.00795980	3829.9	4387.1	6.7737
					1000	0.00812910	3876.9	4445.9	6.8203

Water/Steam at $p = 80.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00096434	0.03	77.18	-0.00489	270	0.00118757	1096.5	1191.5	2.8184
5	0.00096525	19.74	96.96	0.06686	280	0.00120397	1139.3	1235.6	2.8988
10	0.00096634	39.51	116.82	0.13761	290	0.00122136	1182.4	1280.1	2.9785
15	0.00096760	59.32	136.73	0.20733	300	0.00123980	1225.9	1325.1	3.0576
20	0.00096902	79.18	156.70	0.27604	310	0.00125950	1269.7	1370.5	3.1362
25	0.00097057	99.07	176.72	0.34373	320	0.00128040	1314.0	1416.4	3.2142
30	0.00097226	118.99	196.77	0.41042	330	0.00130280	1358.7	1462.9	3.2919
35	0.00097408	138.92	216.85	0.47613	340	0.00132670	1403.9	1510.0	3.3694
40	0.00097602	158.88	236.96	0.54087	350	0.00135250	1449.5	1557.7	3.4466
45	0.00097808	178.85	257.10	0.60467	360	0.00138020	1495.8	1606.2	3.5238
50	0.00098026	198.84	277.26	0.66755	370	0.00141010	1542.7	1655.5	3.6010
55	0.00098254	218.84	297.44	0.72952	380	0.00144260	1590.2	1705.6	3.6784
60	0.00098494	238.84	317.64	0.79061	390	0.00147780	1638.5	1756.7	3.7560
65	0.00098744	258.86	337.86	0.85085	400	0.00151630	1687.5	1808.8	3.8340
70	0.00099005	278.89	358.09	0.91025	410	0.00155840	1737.3	1862.0	3.9125
75	0.00099276	298.92	378.34	0.96884	420	0.00160470	1788.1	1916.5	3.9916
80	0.00099557	318.96	398.61	1.0266	430	0.00165560	1839.8	1972.2	4.0714
85	0.00099849	339.01	418.89	1.0837	440	0.00171180	1892.4	2029.3	4.1520
90	0.00100151	359.06	439.18	1.1399	450	0.00177390	1945.9	2087.8	4.2335
95	0.00100463	379.13	459.50	1.1955	460	0.00184240	2000.2	2147.6	4.3156
100	0.00100784	399.19	479.82	1.2503	470	0.00191790	2055.3	2208.7	4.3984
105	0.00101116	419.28	500.17	1.3045	480	0.00200060	2110.9	2270.9	4.4815
110	0.00101458	439.36	520.53	1.3580	490	0.00209070	2166.6	2333.9	4.5647
115	0.00101810	459.46	540.91	1.4108	500	0.00218800	2222.4	2397.4	4.6473
120	0.00102173	479.57	561.31	1.4630	520	0.00240240	2332.4	2524.6	4.8097
125	0.00102545	499.69	581.73	1.5147	540	0.00263760	2438.3	2649.3	4.9650
130	0.00102928	519.84	602.18	1.5657	560	0.00288460	2538.1	2768.9	5.1104
135	0.00103321	539.99	622.65	1.6162	580	0.00313540	2631.2	2882.0	5.2445
140	0.00103725	560.16	643.14	1.6661	600	0.00338380	2717.4	2988.1	5.3674
145	0.00104139	580.35	663.66	1.7154	620	0.00362620	2797.4	3087.5	5.4800
150	0.00104564	600.56	684.21	1.7643	640	0.00386090	2871.9	3180.8	5.5834
155	0.00105000	620.80	704.80	1.8126	660	0.00408740	2942.0	3269.0	5.6789
160	0.00105447	641.05	725.41	1.8605	680	0.00430580	3008.3	3352.8	5.7677
165	0.00105906	661.34	746.06	1.9079	700	0.00451650	3071.4	3432.7	5.8507
170	0.00106376	681.64	766.74	1.9549	720	0.00472020	3131.9	3509.5	5.9288
175	0.00106858	701.98	787.47	2.0014	740	0.00491750	3190.2	3583.6	6.0027
180	0.00107352	722.35	808.23	2.0474	760	0.00510890	3246.6	3655.3	6.0728
185	0.00107858	742.75	829.04	2.0931	780	0.00529510	3301.5	3725.1	6.1397
190	0.00108377	763.19	849.89	2.1384	800	0.00547650	3355.2	3793.3	6.2038
195	0.00108909	783.65	870.78	2.1832	820	0.00565360	3407.7	3860.0	6.2654
200	0.00109454	804.17	891.73	2.2277	840	0.00582670	3459.3	3925.4	6.3248
210	0.00110587	845.31	933.78	2.3157	860	0.00599630	3510.1	3989.8	6.3821
220	0.00111777	886.63	976.05	2.4023	880	0.00616250	3560.3	4053.3	6.4376
230	0.00113030	928.18	1018.6	2.4876	900	0.00632580	3609.8	4115.9	6.4915
240	0.00114349	969.92	1061.4	2.5718	920	0.00648640	3659.0	4177.9	6.5439
250	0.00115739	1011.8	1104.4	2.6550	940	0.00664440	3707.7	4239.3	6.5949
260	0.00117207	1054.0	1147.8	2.7371	960	0.00680010	3756.1	4300.1	6.6446
270	0.00118757	1096.5	1191.5	2.8184	980	0.00695370	3804.2	4360.5	6.6932
					1000	0.00710530	3852.1	4420.5	6.7407

Water/Steam at $p = 90.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00096045	-0.10	86.34	-0.00661	270	0.00117751	1088.9	1194.9	2.8028
5	0.00096145	19.48	106.01	0.06477	280	0.00119304	1131.1	1238.5	2.8824
10	0.00096262	39.14	125.78	0.13518	290	0.00120944	1173.7	1282.5	2.9612
15	0.00096394	58.85	145.60	0.20460	300	0.00122680	1216.4	1326.8	3.0392
20	0.00096540	78.60	165.49	0.27302	310	0.00124510	1259.5	1371.6	3.1166
25	0.00096700	98.39	185.42	0.34045	320	0.00126460	1303.0	1416.8	3.1934
30	0.00096871	118.22	205.40	0.40688	330	0.00128530	1346.7	1462.4	3.2697
35	0.00097055	138.06	225.41	0.47235	340	0.00130740	1390.9	1508.6	3.3456
40	0.00097250	157.92	245.45	0.53686	350	0.00133080	1435.5	1555.3	3.4212
45	0.00097457	177.80	265.51	0.60044	360	0.00135600	1480.6	1602.6	3.4965
50	0.00097674	197.70	285.61	0.66309	370	0.00138290	1526.0	1650.5	3.5716
55	0.00097901	217.61	305.72	0.72485	380	0.00141170	1572.0	1699.1	3.6466
60	0.00098139	237.52	325.85	0.78574	390	0.00144280	1618.6	1748.5	3.7216
65	0.00098387	257.45	346.00	0.84577	400	0.00147630	1665.7	1798.6	3.7966
70	0.00098645	277.38	366.16	0.90496	410	0.00151260	1713.5	1849.6	3.8718
75	0.00098913	297.32	386.34	0.96335	420	0.00155180	1761.8	1901.5	3.9472
80	0.00099191	317.27	406.54	1.0209	430	0.00159440	1810.8	1954.3	4.0228
85	0.00099479	337.22	426.75	1.0778	440	0.00164070	1860.4	2008.1	4.0988
90	0.00099776	357.17	446.97	1.1338	450	0.00169100	1910.7	2062.9	4.1751
95	0.00100082	377.14	467.21	1.1892	460	0.00174570	1961.6	2118.7	4.2517
100	0.00100399	397.10	487.46	1.2438	470	0.00180520	2012.9	2175.4	4.3286
105	0.00100725	417.08	507.73	1.2978	480	0.00186960	2064.7	2233.0	4.4056
110	0.00101060	437.07	528.02	1.3511	490	0.00193920	2116.9	2291.4	4.4826
115	0.00101405	457.07	548.33	1.4038	500	0.00201400	2169.0	2350.3	4.5592
120	0.00101760	477.07	568.65	1.4558	520	0.00217840	2272.7	2468.8	4.7106
125	0.00102125	497.08	588.99	1.5072	540	0.00236070	2374.4	2586.9	4.8576
130	0.00102499	517.11	609.36	1.5580	560	0.00255670	2472.4	2702.5	4.9981
135	0.00102883	537.15	629.74	1.6083	580	0.00276120	2565.6	2814.1	5.1304
140	0.00103277	557.20	650.15	1.6580	600	0.00296930	2653.5	2920.7	5.2540
145	0.00103681	577.28	670.59	1.7071	620	0.00317700	2736.1	3022.0	5.3687
150	0.00104096	597.36	691.05	1.7558	640	0.00338180	2813.7	3118.1	5.4751
155	0.00104521	617.47	711.54	1.8039	660	0.00358200	2886.9	3209.3	5.5740
160	0.00104956	637.60	732.06	1.8516	680	0.00377690	2956.3	3296.2	5.6661
165	0.00105402	657.75	752.61	1.8988	700	0.00396620	3022.3	3379.3	5.7524
170	0.00105859	677.93	773.20	1.9455	720	0.00415000	3085.6	3459.1	5.8335
175	0.00106327	698.13	793.82	1.9917	740	0.00432860	3146.3	3535.9	5.9102
180	0.00106806	718.34	814.47	2.0376	760	0.00450220	3205.2	3610.4	5.9829
185	0.00107297	738.60	835.17	2.0830	780	0.00467130	3262.2	3682.6	6.0522
190	0.00107799	758.89	855.91	2.1280	800	0.00483620	3317.7	3753.0	6.1184
195	0.00108314	779.21	876.69	2.1726	820	0.00499720	3372.2	3821.9	6.1820
200	0.00108841	799.55	897.51	2.2169	840	0.00515460	3425.4	3889.3	6.2431
210	0.00109934	840.36	939.30	2.3043	860	0.00530880	3477.7	3955.5	6.3021
220	0.00111081	881.32	981.29	2.3903	880	0.00545990	3529.3	4020.7	6.3591
230	0.00112285	922.44	1023.5	2.4750	900	0.00560830	3580.3	4085.0	6.4144
240	0.00113550	963.80	1066.0	2.5586	920	0.00575420	3630.6	4148.5	6.4680
250	0.00114879	1005.3	1108.7	2.6410	940	0.00589760	3680.4	4211.2	6.5202
260	0.00116278	1046.9	1151.6	2.7224	960	0.00603900	3729.9	4273.4	6.5710
270	0.00117751	1088.9	1194.9	2.8028	980	0.00617820	3779.0	4335.0	6.6206
					1000	0.00631570	3827.8	4396.2	6.6690

Water/Steam at $p = 100.0$ MPa

T	v	u	h	s	T	v	u	h	s
°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K	°C	m ³ /kg	kJ/kg	kJ/kg	kJ/kg K
0	0.00095668	-0.27	95.40	-0.00851	270	0.00116812	1081.8	1198.6	2.7881
5	0.00095776	19.21	114.99	0.06252	280	0.00118289	1123.5	1241.8	2.8669
10	0.00095900	38.76	134.66	0.13263	290	0.00119844	1165.5	1285.3	2.9448
15	0.00096037	58.37	154.41	0.20176	300	0.00121480	1207.6	1329.1	3.0219
20	0.00096188	78.03	174.22	0.26992	310	0.00123210	1250.1	1373.3	3.0983
25	0.00096351	97.73	194.08	0.33710	320	0.00125030	1292.8	1417.8	3.1740
30	0.00096525	117.45	213.98	0.40331	330	0.00126960	1335.8	1462.8	3.2492
35	0.00096711	137.21	233.92	0.46855	340	0.00129010	1379.2	1508.2	3.3238
40	0.00096907	156.99	253.90	0.53284	350	0.00131180	1422.8	1554.0	3.3979
45	0.00097114	176.79	273.90	0.59620	360	0.00133480	1466.8	1600.3	3.4717
50	0.00097330	196.59	293.92	0.65865	370	0.00135930	1511.2	1647.1	3.5451
55	0.00097557	216.41	313.97	0.72021	380	0.00138540	1556.0	1694.5	3.6182
60	0.00097794	236.24	334.03	0.78089	390	0.00141330	1601.2	1742.5	3.6911
65	0.00098040	256.07	354.11	0.84073	400	0.00144310	1646.8	1791.1	3.7639
70	0.00098295	275.91	374.21	0.89973	410	0.00147510	1692.9	1840.4	3.8365
75	0.00098560	295.77	394.33	0.95792	420	0.00150940	1739.5	1890.4	3.9091
80	0.00098835	315.62	414.45	1.0153	430	0.00154620	1786.5	1941.1	3.9818
85	0.00099118	335.48	434.60	1.0720	440	0.00158570	1833.9	1992.5	4.0544
90	0.00099411	355.34	454.75	1.1279	450	0.00162820	1881.9	2044.7	4.1271
95	0.00099713	375.21	474.92	1.1830	460	0.00167400	1930.3	2097.7	4.1998
100	0.00100024	395.09	495.11	1.2375	470	0.00172320	1979.1	2151.4	4.2725
105	0.00100344	414.97	515.31	1.2913	480	0.00177600	2028.1	2205.7	4.3452
110	0.00100673	434.86	535.53	1.3444	490	0.00183260	2077.4	2260.7	4.4177
115	0.00101012	454.75	555.76	1.3968	500	0.00189300	2126.9	2316.2	4.4900
120	0.00101360	474.65	576.01	1.4487	520	0.00202510	2225.6	2428.1	4.6329
125	0.00101717	494.55	596.27	1.4999	540	0.00217150	2323.1	2540.2	4.7724
130	0.00102083	514.48	616.56	1.5505	560	0.00233010	2418.2	2651.2	4.9073
135	0.00102459	534.41	636.87	1.6006	580	0.00249820	2510.0	2759.8	5.0361
140	0.00102844	554.36	657.20	1.6501	600	0.00267230	2597.9	2865.1	5.1581
145	0.00103239	574.31	677.55	1.6991	620	0.00284940	2681.5	2966.4	5.2728
150	0.00103643	594.29	697.93	1.7475	640	0.00302690	2760.8	3063.5	5.3803
155	0.00104058	614.27	718.33	1.7954	660	0.00320280	2836.1	3156.4	5.4810
160	0.00104482	634.28	738.76	1.8429	680	0.00337600	2907.7	3245.3	5.5753
165	0.00104916	654.31	759.23	1.8898	700	0.00354560	2976.1	3330.7	5.6639
170	0.00105361	674.36	779.72	1.9364	720	0.00371140	3041.6	3412.7	5.7474
175	0.00105816	694.42	800.24	1.9824	740	0.00387320	3104.6	3491.9	5.8263
180	0.00106282	714.52	820.80	2.0280	760	0.00403110	3165.4	3568.5	5.9012
185	0.00106758	734.63	841.39	2.0732	780	0.00418520	3224.3	3642.8	5.9725
190	0.00107246	754.77	862.02	2.1180	800	0.00433580	3281.7	3715.3	6.0406
195	0.00107745	774.95	882.69	2.1624	820	0.00448290	3337.7	3786.0	6.1059
200	0.00108256	795.14	903.40	2.2064	840	0.00462700	3392.5	3855.2	6.1686
210	0.00109313	835.63	944.94	2.2933	860	0.00476810	3446.3	3923.1	6.2291
220	0.00110420	876.26	986.68	2.3788	880	0.00490650	3499.3	3989.9	6.2875
230	0.00111579	917.02	1028.6	2.4629	900	0.00504240	3551.4	4055.6	6.3440
240	0.00112795	958.01	1070.8	2.5459	920	0.00517600	3602.9	4120.5	6.3988
250	0.00114069	999.03	1113.1	2.6277	940	0.00530740	3653.8	4184.5	6.4521
260	0.00115407	1040.4	1155.8	2.7084	960	0.00543680	3704.2	4247.9	6.5039
270	0.00116812	1081.8	1198.6	2.7881	980	0.00556420	3754.3	4310.7	6.5545
					1000	0.00569000	3804.0	4373.0	6.6038