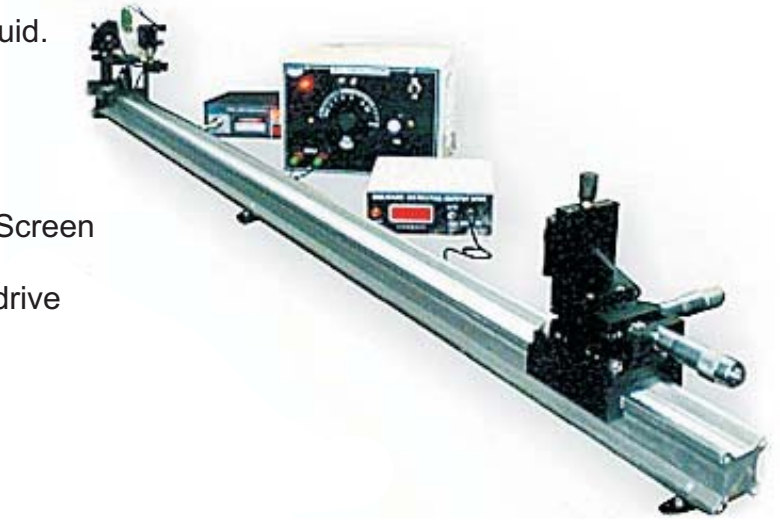
ULTRASONIC DIFFRACTION

Model No: HO-EQ-D-06

AIM: -

1) To find the velocity of ultrasonic wave in the liquid
2) To find the bulk modulus of the given liquid.
3) To find the compressibility of the liquid.



Components and Equipments: -

- Diode Laser with power supply
- Detector output measurement Unit / Screen
- Bread board/Graduated optical Rail
- X-translation stage with micrometer drive
- Water tank with stand
- Quarts crystal
- RF oscillator, etc.

Theory: -

The ultrasonic waves generated by the transducer T, travels down the medium (liquid), get reflected at the bottom (flat glass plate) of the cell. The incident and reflected waves interfere and stationery / standing waves pattern are formed. The velocity of ultrasonic waves in a liquid is calculated using the formula.

$$V_{liq} = V_w (d_w / d_{liq}),$$

Where V_w = 1500m/sec.(velocity of sound in water)

The bulk modulus of the liquid $\beta_s = pV^2$

Where, p is the density of the liquid and V is the ultrasonic velocity in liquid.

The adiabatic compressibility of a liquid can also be calculated using the relation,

$$K = 1/ pV^2$$

The angle of diffraction can be found from the distance L (crystal to screen or detector) and the order length D.

$$\theta = \tan^{-1}\left(\frac{D}{L}\right)$$

λ' for sound wave is given by

$$\lambda' = \frac{n\lambda}{Sin\theta}$$

Then the velocity of sound wave in the given liquid is

$$V = f\lambda'$$

Where, f is the frequency of the oscillator.

Procedure: -

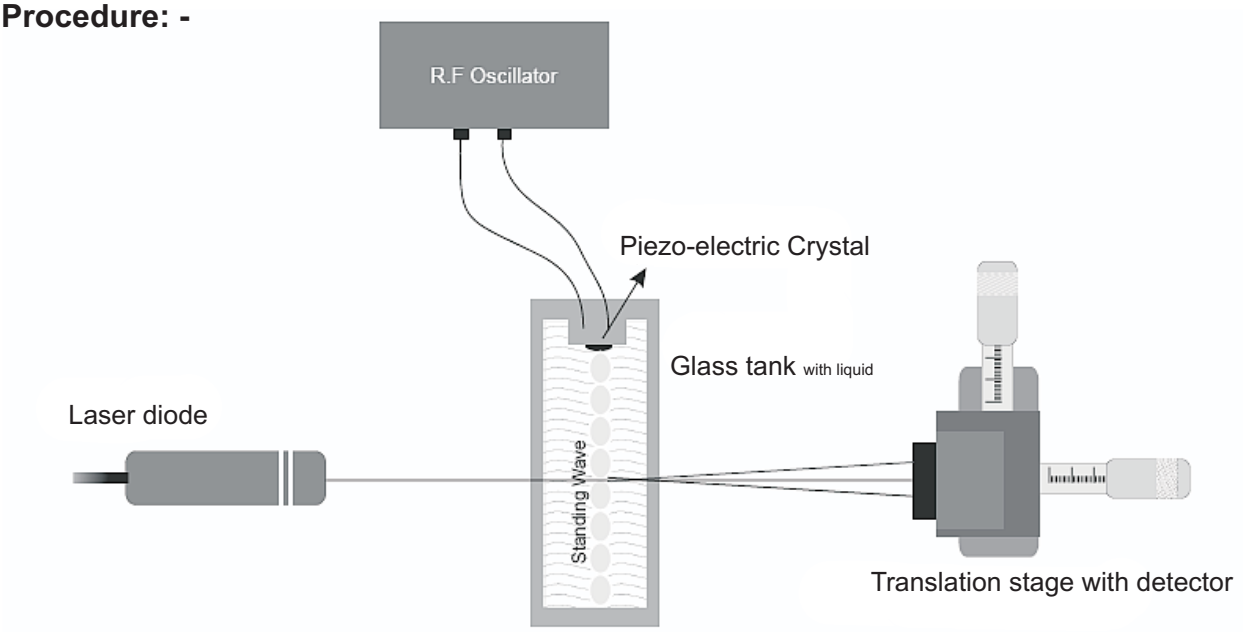


Fig. Optical system for observation of diffraction by ultrasonic waves

Switch on the Diode laser. Adjust the kinematic setup provided on the laser mount, to get the beam in the field of standing wave generated. Mount the given transducer (Quarts crystal) between the electrodes and adjust the set up so that the electrodes are exactly parallel to the wall of the rectangular glass cell. Fill the cell with water till the top surface of the upper electrodes is well immersed. Ensure that there is no air bubbles below the transducer and also at the bottom surface of the lower electrode.

Now connect the two terminals of the electrodes (Upper and lower) to the terminals of the variable Frequency Oscillator. Switch on the oscillator and wait for few minutes. Keep the laser spot falling on detector stage and adjust the dial of the oscillator until you get a very good fringe pattern on both sides of the central bright image. Take the translation stage readings on the vertical scale for each order (Fringe).

Draw a graph between the readings of the scale (Y axis) and the order of the fringe (on X axis). The slope of the straight line gives fringe width d. Repeat the experiment for various liquids. Determine liquid in each case.

Observations : -

Sl No:	Order (n)	Readings (D) cm			Angle of ultrasonic diffraction	$\lambda' = \frac{n\lambda}{\text{Sin}\,\theta}$
		Left	Right	Average	$\theta = \tan^{-1}\left(\frac{D}{L}\right)$	
1	1					
2	2					
3	3					

Result:-

The velocity of ultrasonic wave in the given liquid, V = ... m/s

The bulk modulus of the given liquid , β_s = ... Pa

The compressibility of the given liquid , K = ... Pa^{-1}