BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(MID SEMESTER EXAMINATION MO/2025)

CLASS: BTECH **SEMESTER: VII**
BRANCH: CHEMICAL **SESSION: MO/2025**

SUBJECT: CL429 CHEMICAL PROCESS INTENSIFICATION

TIME: 02 Hours **FULL MARKS: 25**

INSTRUCTIONS:
1. **The question paper contains 5 questions, each of 5 marks, for a total of 25 marks.**
2. **Attempt all questions.**
3. **The missing data, if any, may be assumed suitably.**
4. **Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates**

	Question	Marks	CO	BL
Q.1	The guiding principles of process intensification (PI), as discussed in class, involve - maximisation of the effectiveness of intra(inter) molecular events, providing species identical process experience, optimisation of driving force, and maximisation of synergistic effects. Provide suitable examples and justify how each of these principles constitutes the key component of PI	[5]	1	1
Q.2(a)	Using suitable examples, explain how policy (government) intervention and technological development contribute to the development of intensified processes (or equipment).	[2]	1,2	1,2
Q.2(b)	In the context of Sustainable Development Goals (SDG) of the UN, explain with suitable examples what global challenges can be addressed by process intensification technologies	[3]	2	2
Q.3(a)	What factors determine the design of compact heat exchangers?	[1]	2	2,3
Q.3(b)	In a chemical plant, 1 kg/s of oil (C_p=2.8 kJ/kg-K) is cooled from 120 ^oC to 50 ^oC in a double-pipe heat exchanger with an area of 4 m^2. Cooling water (20 ^oC) fed at 2.67 kg/s doesn't show any appreciable temperature drop for this heat load. The rated overall heat transfer coefficient (U) was 250 W/m^2-K. It is now planned to replace it with a compact heat exchanger with U= 659 W/m^2-K. The design equation for a heat exchanger is given by: $Q=UA\Delta T_{lm}$ Where, $\Delta T_{lm}=[(T_{hot,out}-T_{cold,in})-(T_{hot,in}-T_{cold,out})]/\ln[(T_{hot,out}-T_{cold,in})/(T_{hot,in}-T_{cold,out})]$ (i) Calculate the area required in the compact heat exchanger to carry out the same operation. (ii) Propose a design (with a sketch) for the compact heat exchanger	[3+1=4]	2	3,4
Q.4	It is intended to absorb a gas stream containing 15% CO_2 in a Rotating Packed Bed (RPB) using an aqueous NaOH solution as the absorbent. Calculate the exit CO_2 concentration if the RPB operated at 1800 RPM and 1 atm, achieving a rate of absorption per unit volume of 3.25 kmol/s-m^3. Given design data and correlations: Rate of absorption per unit volume $(N)=k_{ga}(p_{in}-p_{out})$ p= yP (y- mole fraction, P- Total pressure, p- partial pressure) Mass transfer coefficient (k_{ga}) = $7.62 \times 10^{-3} Re^{0.976} Gr^{0.132} Sc^{0.33}$ kmol/m^3-atm-s $Re=U_{tip}\rho D_p/\mu$ $\mu=1.76 \times 10^{-5}$ Pa-s Gr=1 D_{CO2}= 2 x 10^{-5} m^2/s D_p=0.005 m $Sc=\mu/\rho D_{CO2}$ ρ=1.145 kg/m^3	[5]	1,2	3,4
Q.5(a)	With a neat sketch and a suitable example, explain the role of cavitation in process intensification	[4]	3	1,2
Q.5(b)	What is the topic of your course project?	[1]	1	4

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