

FINAL EXAM

INSTRUCTIONS: QUESTION ONE IS COMPULSORY AND THEN ATTEMPT ANY OTHER FOUR QUESTIONS.

TIME: 3 HOURS

1. a. State and explain TWO common types of shell and tube exchangers. **(10 Marks)**
b. Show how to use heat transfer formulae in theory to calculate tube-side velocity **(5 Marks)**
c. Name and briefly explain the three types of reboilers **(5 Marks)**

2. Design (in theory) a horizontal condenser for the condensation of 45,000lb/h of almost pure normal propyl alcohol available at 15Psi_g. At this pressure, the boiling point of n-propyl alcohol is 244⁰F. Water available in the temperature range of 95⁰ to 120⁰ Can be as the coolant. The maximum pressure drop of 2Psi and 10Psi is permissible for the vapor phase and water respectively. Show your working **(20 Marks)**

3. Evaporators consists of heat exchangers for boiling solutions with special provisions for separation of liquid and vapor phases having tubular heating surfaces. The tubes may be horizontal or vertical, long or short and liquids may be inside or outside the tubes. Having this in

mind, name and explain five evaporator types. Discuss some of the methods of feeding evaporators **(20 Marks)**

4. In thermal design calculation, there is single effect calculations and multiple effect calculations. Discuss **(20 Marks)**

5. A triple-effect forward feed evaporator of the long-tube vertical type is used to concentrate 4,000 kg/h of 9.5% solution of caustic soda available at 40^o C to 50% solution. Saturated steam at 3.5kg.cm⁻² is available. A vacuum of 700 mm Hg is maintained in the last effect. The overall heat transfer coefficients are 5800, 3300 and 2400 Wm⁻² °C⁻¹, corrected for BPEs may be used for the 1st, 2nd and 3rd effects respectively. Calculate the heat transfer area required (assume equal areas in all three effects), steam economy and rate of steam consumption. **(20 Marks)**

6. a. State and explain Six different types of Dryers. **(6 Marks)**
b. What is a scrubber in chemical design? **(6 Marks)**
c. Name four different types of scrubbers **(8 Marks)**