

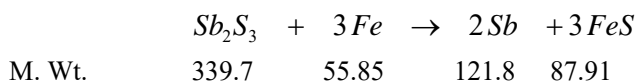
Note : Answer four questions only

Q1/ A storage tank contains 24 °API gas oil. A hole of 1.5 mm diameter at the bottom of the tank discharges the oil. Assuming that the level of the gas oil in the tank is kept constant at 14 ft above the bottom, and the rate of leakage can be estimated by the following equation $\{ Q = 0.61 S \sqrt{\frac{2 g_c P}{\rho}} \}$ **where:** (Q) volumetric flow rate ft³/sec (S) cross-sectional area ft² of hole (P) pressure exerted by the oil on the hole lbf/ft² (ρ) density of the gas oil lbfm/ft³.

- (1) Prove that the above equation is dimensionally consistent.
- (2) Calculate the loss from the tank in gal/day.

25 marks

Q2/ Antimony is obtained by heating pulverized stibnite (Sb₂S₃) with scrap iron and drawing off the molten antimony from the bottom of the reaction vessel



Suppose that 0.600 kg of stibnite and 0.250 kg of iron turning are heated together to give 0.200 kg of Sb metal. Determine:

- (a) The limiting reactant and the percent of excess reactant.
- (b) The degree of completion of the reaction.
- (c) The percent conversion based on Sb₂S₃.
- (d) The yield in kg produced/kg Sb₂S₃ fed to the reactor.

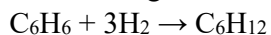
25 marks

Q3/ A tank holds 10,000 kg of a saturated solution of Na₂CO₃ at 30°C. You want to crystallize from this solution 3000 kg of Na₂CO₃.10H₂O without any accompanying water. To what temperature must the solution be cooled? The solubility data of Na₂CO₃ as a function of the temperature is given as below:

Temp. (°C)	Solubility (g Na ₂ CO ₃ / 100 g H ₂ O)
0	7
10	12.5
20	21.5
30	38.8

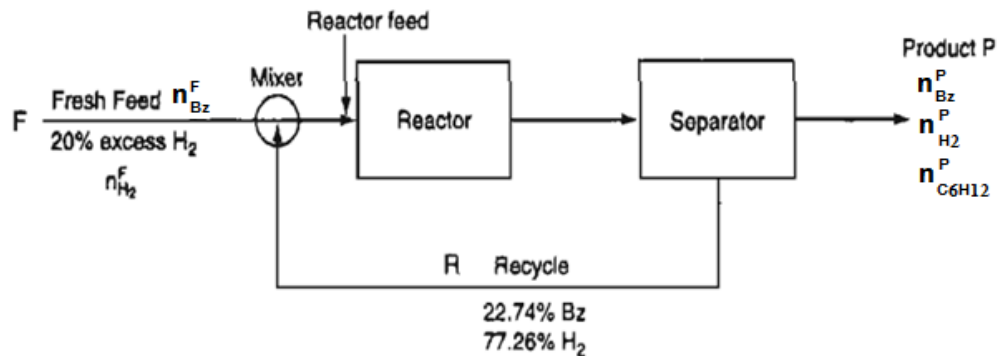
25 marks

Q4/ Cyclohexane (C₆H₁₂) can be made by the reaction of benzene (Bz) (C₆H₆) with hydrogen according to the following reaction:



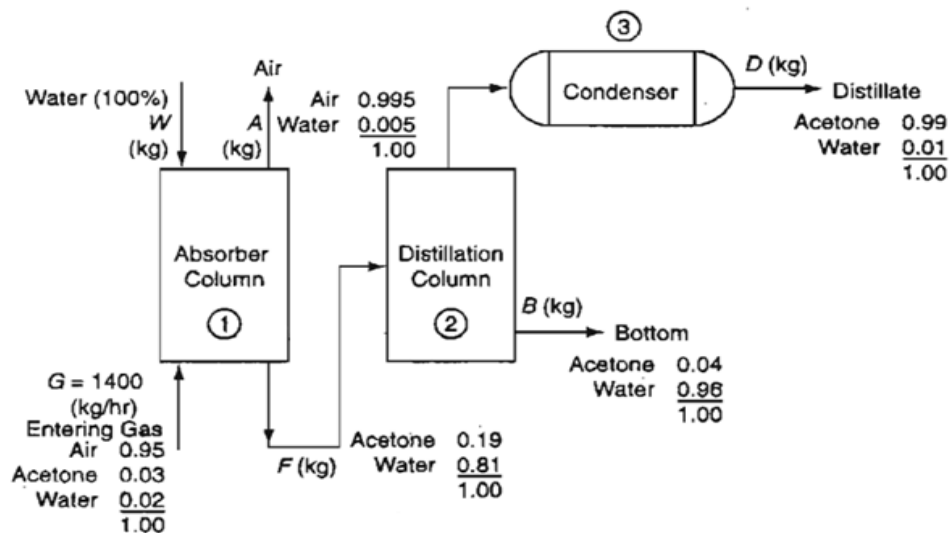
For the process shown below, determine the ratio of the recycle stream to the fresh feed stream if the overall conversion of benzene is 95%, and the single-pass conversion is 20%. Assume that 20% excess

hydrogen is used in the fresh feed, and that the composition of the recycle stream is 22.74 mol % benzene and 77.26 mol % hydrogen.



25 marks

Q5/ Acetone is used in the manufacture of many chemicals and also as a solvent. In its later role, many restrictions are placed on the release of acetone vapor to the environment. You are asked to design an acetone recovery system having the flowsheet illustrated in Figure below. All the concentrations shown in Figure of both gases and liquids are specified in weight percent to make the calculations simpler. Calculate A, F, W, B and D per hour. $G = 1400$ kg/hr.



25 marks

Good Luck

Assistant Professor
Dr. Ahmed Daham

Assistant Professor
Dr. Burhan S. Abdullrazzak

Head of the Department
Dr. Aysar T. Jarullah