

Process Calculations

QP Code :14710

(3 Hours)

[ Total Marks : 80

- N. B. : (1) Question No. 1 is compulsory.  
(2) Attempt any three of remaining five questions.  
(3) Assume suitable data wherever necessary.

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1. (a) Define the following :-  
(i) Stoichiometry  
(ii) Dalton's law  
(iii) Raoult's law  
(iv) Ideal gas law 10  
(b) What is dimensional homogeneity? Explain with an example. 5  
(c) Explain Hess' law of constant Heat summation. 5
2. (a) Benzene and toluene are to be separated 50,000 kmol/hr of feed is fed to the rectifier. Feed has 45% by wt benzene. Overhead stream has 98% benzene by wt and 8% benzene by wt was found in bottom product. Calculate overhead product rate & % recovery of benzene. 10  
(b) 1000 kg of mixed acid needs to be prepared containing 65% sulfuric acid, 30% nitric acid and remaining water by blending the following 10  
- 11.3% HNO<sub>3</sub>, 44.4% H<sub>2</sub>SO<sub>4</sub> & remaining H<sub>2</sub>O  
- Aq 90% HNO<sub>3</sub>  
- Aq 98% H<sub>2</sub>SO<sub>4</sub>  
Calculate the quantity of each acid required for blending.
3. (a) Explain step by step procedure of Buckingham π theorem. 10  
(b) A gas mixture has the following composition by volume : 10  
Ethylene - 30.6%, Benzene - 24.5%, Oxygen - 1.3%, Methane - 15.5%, Ethane - 25%, Nitrogen - 3.1%.  
Find out (i) The avg molecular weight of gas mixture (ii) The composition by wt. 20
4. A catalytic reactor is used to produce formaldehyde from methanol by the reaction CH<sub>3</sub>OH → HCHO + H<sub>2</sub>. A single pass conversion of 70% is achieved in the reactor. The methanol is separated and recycled to the reactor. Calculate the required feed rate of methanol in kmol/hr for 500 kg/hr of formaldehyde produced. 10
5. (a) In production of SO<sub>3</sub>, 100 kmol of SO<sub>2</sub> and 100 kmol of O<sub>2</sub> are fed to a reactor. The % conversion of SO<sub>2</sub> is 80. Calculate the composition of the product stream on mole basis.

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(b) In the production of chlorine gas by oxidation of hydrochloric acid gas, air is used 30% excess of that theoretically required. Based on 4 kmol HCl. Calculate (i) the weight ratio of air to hydrochloric acid gas in feed (ii) if the oxidation is 80% complete, find the composition of the product stream on mole basis. 10

6. Write a short notes on :-

- (a) Heat of reaction
- (b) Heat of formation
- (c) mole % = vol % = pressure %
- (d) Specific gravity
- (e) Distillation & its applications.

GN-Con.:11997-14.

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