B.TECH/CHE/5TH SEM/CHEN 3101/2016

CHEMICAL PROCESS TECHNOLOGY - I
(CHEN 3101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Raw materials for modified Solvay process for manufacturing soda ash are
(a) ammonia, salt, limestone
(b) ammonia, limestone, coke/coal
(c) salt, limestone, coke/coal
(d) none of these.

(ii) The ratio of P_2O_5 in SSP to that in TSP is
(a) 1:3 (b) 2:3 (c) 3:1 (d) 3:2.

(iii) Mercury cell process for caustic production compared to diaphragm cell process
(a) requires low initial investment
(b) requires more power
(c) produces lower concentrated
(d) none of these.

(iv) The composition of catalyst used for the oxidation of ammonia in a nitric acid plant is
(a) 100% Pt (b) 50% Pt +50% Rh
(c) 90% Pt + 10% Rh (d) 90% Rh + 10% Pt.

(v) Turbidity is expressed in
(a) Mg/s (b) NTU (c) MTS (d) TDS.

(vi) In the synthesis of ammonia from nitrogen & hydrogen by Haber's process, sulphur poisoning of catalyst (Fe) is inhibited by
(a) PbO (b) ZnO (c) CoO (d) MnO_2.

(vii) Ammonium sulphate manufacture uses
(a) Ammonia and gypsum
(b) Ammonium chloride and sulphuric acid
(c) Ammonia, carbon dioxide and gypsum
(d) Ammonium nitrate and sulphuric acid.

(viii) Sulphuric acid plant is operated at atmospheric pressure because
(a) increased pressure decreases equilibrium conversion,
(b) at atmospheric pressure, the equilibrium conversion is maximum
(c) increased yield does not compensate the cost of compression
(d) V_2O_5 catalyst cannot withstand high temperature.

(ix) Resistance to fusion of refractory under a steady rising temperature condition is called
(a) spalling (b) refractoriness
(c) both (a) & (b) (d) none of the above.

(x) During absorption of HCl gas in water (to produce HCl solution), the gas is kept above dew point to
(a) avoid corrosion
(b) increase the rate of absorption
(c) reduce cooling water rate
(d) reduce the strength of acid.

Group – B

2. (i) Describe the process of reverse-osmosis for purification of water.
(ii) What is the difference between demineralized and distilled water.
(iii) What are the major difference between Nano & Ultrafiltration processes in regard to the operation and purification of water?
(iv) Explain the reason that boiler-feed water is purified or otherwise the life of the boiler will be reduced?

(3 × 4) = 12

3. (a) (i) Show the construction of diaphragm cell with proper cell notation and respective cell reaction.
(ii) Make a comparative study of mercury cell and membrane cell process for NaOH and Cl_2 production with an eye to product purity and cost of production.

(b) Briefly discuss about the role of 'over voltage' in the electrolysis of brine solution.

(3 + 5) + 4 = 12

Group – C

4. (a) Critically examine the engineering problems associated with the manufacture of sulfuric acid by Contact and DCDA process.

   (b) Mention the steps and chemical reactions for the manufacture of nitric acid from synthesis gas.

6 + 6 = 12

5. (a) (i) Why oxidation of SO_2 to SO_3 in sulphuric aid plant is done in stages?

(ii) During synthesis of nitric acid by ammonia oxidation process, the first reaction is

$4\ NH_3 + 5\ O_2 \leftrightarrow 4\ NO\ (g) + 6\ H_2O\ (g) \quad \Delta H^0 = -227$ kJ/kg-mole

Under what conditions, this reaction is carried out in the nitric acid plant?

   (b) (i) In the light of the reaction $SO_2(g) + 1/2O_2(g) = SO_3(g)$; $\Delta H = -23$ Kcal at 25°C, Explain the statement: "In the two stage catalytic converter, it is advisable to run the reaction at higher temperature in the 1st stage and lower temperature in the 2nd stage".

(ii) How would you manufacture 30% commercial hydrochloric acid?

(3 + 3) + (3 + 3) = 12

Group – D

6. (a) (i) Explain the necessity of purging the recycle gas mixture after condensation of ammonia with the help of a thermodynamical expression.

(ii) How is the proportion of hydrogen in the synthesis gas improved for the manufacture of ammonia by Haber's process?

   (b) (i) Briefly discuss about the engineering problem associated in the urea manufacturing unit.

(ii) Explain the chance of ammonium carbonate formation instead of desired ammonium carbamate.

(4 + 2) + (4 + 2) = 12

7. (a) What is the definition of a fertiliser and what are the major & minor constituents presents in modern synthetic fertilisers? What are the different types of fertilisers available naturally and synthetically?

   (b) What are the chemical formulae of single super phosphate (SSP) & triple super phosphate (TSP) fertilisers? Why are they so called? Briefly describe the manufacturing principles of SSP & TSP.

6 + (2 + 1 + 3) = 12

Group – E

8. (a) What are the differences in properties between cement & concrete? Compare the manufacturing processes of cement by wet and dry methods.

   (b) What is refractoriness? Classify different types of refractory materials used in the industry and other areas. Define the terms RUL, PCE (seggar cone) & porosity with reference to refractory materials.

(2 + 4) + (1 + 2 + 3) = 12

9. (a) What are the thermodynamic considerations for the formation of glass? What is the glassy state of matter?

   (b) Describe the methods of manufacturing porcelain and state the requirement of their forming properties.

(4 + 2) + 6 = 12