Roll No.

Total No. of Questions : **03**

No. of Printed Pages : **7**

M-SFS-I-2017 (12)

CHEMICAL ENGINEERING

(Optional Subject)

First Paper

Time : **3 Hours**]

[Total Marks : **200**

Instructions to the candidates :

1. This question paper consists of **three** questions and all questions are compulsory.

2. Marks for each question have been indicated on the right hand margin.

3. There is no internal choice in Question No. 1, remaining questions carry internal choice.

4. The first question is of very short-answer type consisting of **15** compulsory questions. Each one is to be answered in one or two lines. Question No. 2 is short answer type, word limit is **100**. Question No. 3 is long answer/Essay type, word limit is **300**.

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5. Wherever word limit has been given, it must be followed to.

6. Question should be answered exactly in the order same as mentioned in the question paper. Answer to the various parts of the same question should be written together compulsorily and no answer of the other question should be inserted between them.

1. Give answer of the following in **one** or **two** lines.   15 × 4 = 60

   (A) Define Excess Reactants.   4

   (B) Define what is fuel.   4

   (C) Define what is an Anti-biotic.   4

   (D) Which products we obtain after saponification of a fat ?   4

   (E) Define Reynolds Number.   4

   (F) Classify Pumps.   4

   (G) What is the role of filter aids in filteration ?   4

   (H) State the third law of thermodynamics.   4

(I) State phase rule applicable to non-reacting systems.   **4**

(J) Define Relative Volatility.   **4**

(K) How you will determine the Dry-bulb temperature of a vapour-gas mixture ?   **4**

(L) Name the 3 modes of heat transfer.   **4**

(M) Define Evaporator Capacity.   **4**

(N) Name 2 types of reflection when radiation strikes a material surface.   **4**

(O) Explain what is meant by hindered settling.   **4**

2. Write the answer of any **10** questions. Each question should be limited to **100** words.   **10 × 8 = 80**

(A) The analysis of gas entering the secondary converter in a contact sulphuric acid plant is 4% SO_2, 13% O_2 and 83% N_2 (Volume %). In the converter SO_2 is oxidized to SO_3. The gases leaving the converter contains 0.45% SO_2 on an SO_3 – tree basis (volume %). Calculate the percent conversion of SO_2.   **8**

       P.T.O.

(B) Limestone mixed with coke is being burnt in a kiln. An average analysis of the limestone is $CaCO_3$: 84.5%, $MgCO_3$: 11.5% and the rest inerts. The coke contains 76% carbon, 21% ash and 3% moisture. The calcination of $CaCO_3$ is only 95% complete and that of $MgCO_3$ is 90%. The carbon in the coke is completely burnt to CO_2. The kiln is fed with 1 kg of coke per 5 kg of limestone. Calculate the weight percent CaO in the product leaving the kiln.   **8**

(C) Describe the atmospheric distillation process of crude oil.   **8**

(D) Derive the equation of terminal velocity for gravitational settling of spherical particles.   **8**

(E) Show that in ball mill   **8**

$$\eta_c = \frac{1}{2\pi} \sqrt{g/(R-r)}$$

where η_c = critical rotational speed of the ball mill.

r = radius of ball

R = radius of mill

(F) Describe the phenomena of retrograde condensation and differentiate between Refrigerator and Heat Pump.   **.8**

(G) The model for excess Gibbs energy (G^E) of a binary solution is given by

$$\frac{G^E}{x_1 x_2 RT} = A,$$ where A is a constant for a given temperature. Obtain the

expressions for $ln\, Y_1$ and $ln\, Y_2$. **8**

(H) Derive an expression to show the effect of temperature on the Equilibrium

Constant. **8**

(Assume heat of reaction to be independent of temperature)

(I) By taking 4 examples explain the usefulness of liquid-liquid extraction over

distillation. **8**

(J) Derive a relation between the Relative Saturation and Percentage

Saturation. **8**

(K) Define and show the various types of moisture used in drying. **8**

(L) Explain with diagram the pool boiling of saturated liquid. **8**

(M) Show that the relative volatility of an ideal binary system is equal to the

ratio of vapour pressures of two components and explain film theory of

mass transfer. **8**

3. Write the answer of any **three** questions. Each question should be limited to **300** words.

$3 \times 20 = 60$

(A) Draw a neat flow sheet and explain the production process of poly vinyl chloride (suspension polymerization). **20**

(B) (i) Exhaust gases (Cp = 1.12 kJ/kg °C) flowing through a tubular heat exchanger at the rate of 1200 kg/hr are cooled from 400 °C to 120 °C. The cooling is affected by water (Cp = 4.18 kJ/kg °C) that enters the system at 10 °C at the rate of 1500 kg/hr. If the overall heat transfer co-efficient is 500 kJ/(m².hr °C) what heat exchanger area is required to handle the load for (i) Parallel flow (ii) Counter flow arrangement ? **10**

(ii) A liquid mixture of 60 mol % benzene and remaining toluene is charged to a still pot where the mixture is differentially distilled at 1.2 atm total pressure. How much percentage of the charge must be boiled away to leave a liquid mixture containing 80 mol% toluene. The relative volatility of the mixture may be assumed to remain constant at 2.41. **10**

(C) (i) Derive the expression of Gibbs energy change of mixing for ideal gases. **10**

(ii) Water flowing at 1.5 l/sec in a 0.05 m diameter tube is metered by means of a simple orifice of diameter 0.025 m. If the co-efficient of discharge is 0.62, what will be the reading on a mercury under water manometer connected to the meter ? Density of water = 1000 kg/m^3, viscosity of water = 0.001 N/m^2. Density of mercury = 13600 kg/m^3. **10**

(D) (i) Differentiate between physisorption and chemisorption. (any 4) **5**

(ii) Write short note on fluidization. **5**

(iii) Derive clapeyron equation for two phase system. **5**

(iv) Differentiate between Recycle, By Pass and Purge. **5.**

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