

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

SECOND YEAR [2016-19]

B.A. /B.Sc. FOURTH SEMESTER (January – June) 2018

Mid-Semester Examination, March 2018

Date : 14/03/2018

Time : 2pm – 4pm

INDUSTRIAL CHEMISTRY (Honours)

Paper: IV

Full Marks: 50

(Use a separate Answer Book for each group)

Group A

(20 marks)

Answer **any two** questions **from question nos. 1 to 4:**

(2 × 5)

1. a) Surface temperature of the sun is 6000 K. At what wave length does it radiate highest energy?
b) A submarine has a maximum cruising speed under water of 20 knots (nautical miles per hour). It is proposed to increase its maximum speed to 25 knots by installing a more powerful engine. The current engine has a rating of 12000 hp. What should be the rating of the new engine? Assume power is consumed only for overcoming the drag force. Assume constant drag coefficient.
2. a) Why Grashof number in natural thermal convection is considered similar to Reynolds number in ordinary flow situation.
b) Glycerine is flowing through a capillary of diameter 1 mm with a velocity of 3cm/s. What will be the pressure drop over a length of 10cm of capillary? Glycerine has a density of 1.228 g/cc and viscosity of 600 cP.
3. a) What is the value of heat transfer coefficient as per film theory if thermal conductivity be k and film thickness be δ ?

A fluid with Prandtl number 5.8 is flowing through a tube with diameter 2 cm at a Reynolds number 24000. What will be the hypothetical film thickness according to film theory?

b) Why is rotameter called a "variable area flow meter"?
4. a) Write down Bernoulli's equation for an ideal fluid and explain the terms.
b) In heat transfer, LMTD is often used as the driving force. What is LMTD and what is its definition/ expression.

Answer **any one** question **from question nos. 5 & 6:**

(1 × 10)

5. a) In a power plant, it is proposed that a cold water stream be preheated from 30° C to 50° C in a double pipe heat exchanger. Cold stream flows in the annular region. Physical properties of this stream may be taken as $\rho = 1.0\text{g/cc}$, $C_p = 4.180\text{ J/g K}$, $\mu = 0.67\text{ cP}$, thermal conductivity = 0.63W/mK and flow rate is 1000 kg/hr. Inner pipe diameter is 2.5 cm, outer tube od is 3.5 cm (neglect tube wall thickness). This is to be heated by another stream of hot water flowing inside the inner tube entering at 90° C and leaving at 70° C in a counter arrangement. Properties of this stream are virtually same as those of the cold stream, except viscosity, which may be taken as 0.32 cP.

Calculate the length of the double pipe exchanger needed in meter.

- b) Calculate the pressure drop in the annular tube (cold stream). Effective length of the pipe, for frictional pressure loss calculation, should be taken as 1.5 times the length found in part a to take into account the pipe bends and fittings.

6. a) Water is being pumped from an underground tank to an overhead tank – a height difference of 12 m, at the rate of 1.5 l/s through a pipeline of dia 3.5 cm. Total length of pipeline may be taken as 85 m. Calculate the frictional pressure drop and pressure head created by the pump.
- b) The entire pipeline mentioned lies exposed to sun and on a hot day surface temperature of the pipe reaches 40° C. Water reservoir temperature is 25° C. What will be the temperature of water when it reaches the overhead tank? Assume resistance of pipe wall to heat transfer to be negligible.

Properties of water may be taken as $\rho = 1.0 \text{ g/cc}$, $C_p = 4.180 \text{ J/g K}$, $\mu = 0.67 \text{ cP}$, thermal conductivity = 0.63 W/mK

Wiens law constant 2.897 mmK

Blausius expression for friction factor $f = 0.079 \text{ Re}^{-0.25}$

Sieder – Tate correlation

$$\text{Nu} = 1.86 (\text{Re Pr D/L})^{0.333}$$

Dittus Boelter Correlation

$$\text{Nu} = 0.023 \text{ Re}^{0.8} \text{ Pr}^{0.4}$$

Group B

(15 marks)

Answer **any three** questions of the following:

(3 × 5)

7. a) A gas mixture has the following composition by volume –

SO₂ -8.5%; O₂ -10% and N₂ -81.5%

Find (i) the density of mixture at a temperature of 200°C and 2 atm and (ii) composition by weight.

- b) The nitrogen content NH₄NO₃ sample is 54.5% by weight. Find actual content of ammonium nitrate in sample.
8. a) A sample of coal is found to contain 63% carbon and 24% ash on weight basis. The analysis of refuse after combustion shows 7% carbon and ash. Calculate the percentage of the original carbon unburnt in the refuse.
- b) 2000 kg of wet solids containing 70% solids by weight are fed to tray dryer where it is dried by hot air. The product finally contained is found to contain 1% moisture by weight, calculate
- kg of water removed from wet solids
 - kg of product obtained.
9. a) In manufacture chlorine, feed containing hydrochloric acid gas and air are fed to oxidise. The product gases leaving the oxidiser is found contain 13.2% HCl, 6.3% O₂, 42.9% N₂, 30% Cl₂ and 7.6 % H₂O (by weight). Calculate
- Percentage excess air used
 - Composition by weight of gases entering the oxidiser
 - Degree of completion of oxidation

10. A gas analysing CO_2 – 5.5%, CO – 25%, H_2 – 14%, CH_4 – 0.5% and N_2 – 55% (by volume) is burnt in furnace with air which is 10% excess over that required to burn CO , H_2 and CH_4 completely. Give the analysis of the product gas mixture assuming all reactions proceed to completion.
11. A stream flowing at a rate of 250 gmole./min contains 25% by mole N_2 and 75% by mole H_2 is to be heated from 25°C to 200°C . Calculate the heat must be transferred using the following data

$$C_p = a + bT + cT^2$$

Gas	a	$b \times 10^3$	$c \times 10^6$
H_2	6.946	-0.196	0.4757
N_2	6.457	1.389	-0.069

Group C

(15 marks)

Answer **any three** questions of the following:

(3 × 5)

12. Draw the heating and cooling curve for pure iron on heating from room temperature to 1540°C & on cooling from 1540°C to room temperature. (2.5 + 2.5)
13. Show the relationship between total number of variables & degree of freedom for a binary phase system where temperature & pressure are two external parameters. Find out the degree of freedom at three phases equilibrium & two phase equilibrium points of a single component system. (2.5 + 2.5)
14. Find out the relative amount of proeutectoid cementite & pearlite in a steel containing 1.2% carbon. What are denoted by the symbols A_{c_m} & A_{r_4} (3 + 2)
15. Why bath temperature is important in Hall- Herault process of aluminium extraction. Give a brief discussion of ALCOA process for AL extraction. (2 + 3)
16. Write down the electrolytic redefine process for the recovery of precious metals from anode slime in copper extraction process. Write down the advantages of WORCA process? (3 + 2)

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