RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

SECOND YEAR [BATCH 2014-17]

B.A./B.Sc. FOURTH SEMESTER (January – June) 2016

Mid-Semester Examination, March 2016

Date : 17/03/2016 **INDUSTRIAL CHEMISTRY (Honours)**

Time : 11 am – 1 pm Paper : IV Full Marks : 50

[Use a separate Answer Book for each group]

Group – A

Answer any six questions : [6×5]

1. a) Show that the following empirical equation for a heat transfer coefficient is dimensionally homogeneous. $h_i = 0{\cdot}023G^{0.8}K^{0.67}C_p^{0.33}D^{-0.2}\mu^{-0.47}$ [1]

   b) Air at a temperature of 20°C is blown along a flat plate at a velocity of 6m/sec. Find the heat transfer per unit width per minute for both sides of the plate over the first 0·2m of the plate when surface temp is 580°C. Use the following equation $Nu = 0{\cdot}664(Pr)^{1/3}(Re)^{1/2}\left(\frac{Tw}{T\alpha}\right)^{0.117}$

   where Tw and $T\alpha$ are the absolute temperature of the plate and free stream of the air respectively.

   Properties at mean temperature of 300°C

   Pr = 0·674, C_P = 0·25 Kcal/kg°C, K = $3{\cdot}96\times10^{-3}$ KCal/m hr°C, ρ = 0·615 kg/m^3,

   $\mu = 3{\cdot}03\times10^{-6}$ kgf sec/m^2. [2]

   c) i) Dimension of kinematic viscosity is

   a) MLT^{-1} b) L^2T^{-1} c) L^2T d) L^2T^{-2}

   ii) Froude Number is the ratio of

   a) shear stress to gravitational stress b) drag stress to shear stress

   c) inertial stress to shear stress d) inertial stress to gravitational stress [2]

2. a) Fuels for motor vehicles other than gasoline are being eyed because they generate lower levels of pollutants than does gasoline. Compressed propane has been suggested as a source of economic power for vehicles. Suppose that in a test 20kg of C_3H_8 is turned with 400kg of air. What was the present excess air? $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ [2]

   b) The microstructure of nanosized particles has proved to be important in nanotechnology in developing economic magnetic performance of nanocomposites. In a ternery allow such as $Nd_{4\cdot5}\ Fe_{77}\ B_{18\cdot5}$ the avg. grain size is about 30nm. By replacing 0·3 atoms of Fe with atoms of Cu, the grain size can be reduced (improved) to 17 nm. [3]

   i) What is the molecules formula of the allow after adding the Cu to replace the Fe?

   ii) What is the mass fraction of each atomic species in the improved alloy?

   N_d (Neodymium) : At. No. 60, At.wt 144·24.

3. a) Use Buckingham π theorem to find the frictional head loss in the pipe through which fluid is flowing. Frictional head loss depends on the following factors : [3]

   i) $\frac{\Delta p}{L}$ = pressure drop per unit length ($ML^{-2}T^{-2}$)

   ii) ρ = density of the fluid (ML^{-3})

   iii) D = diameter of the pipe (L)

   iv) v = velocity of the pipe (LT^{-1})

   v) μ = dynamic viscosity of the fluid ($ML^{-1}T^{-1}$)

vi) $\in$ = roughness of the pipe wall (L)

b) Air is flowing with 150km/hr on a plate which is maintained at 100°C. If the temperature of the air is 20°C, find the heat lost per hour from the plate assuming the plate is 50 cm long along the flow and 30 cm wide. [2]

Properties of air at mean temperature of 60°C, $\rho = 1{\cdot}06\ kg/m^3$; C_P = 0·24 Kcal/kg°C; K = 0·02 KCal/m hr°C; $\mu = 2{\cdot}05\times10^{-6}$ kgf sec/m^2; $\nu = 18{\cdot}97\times10^{-6} m^2$ /sec.

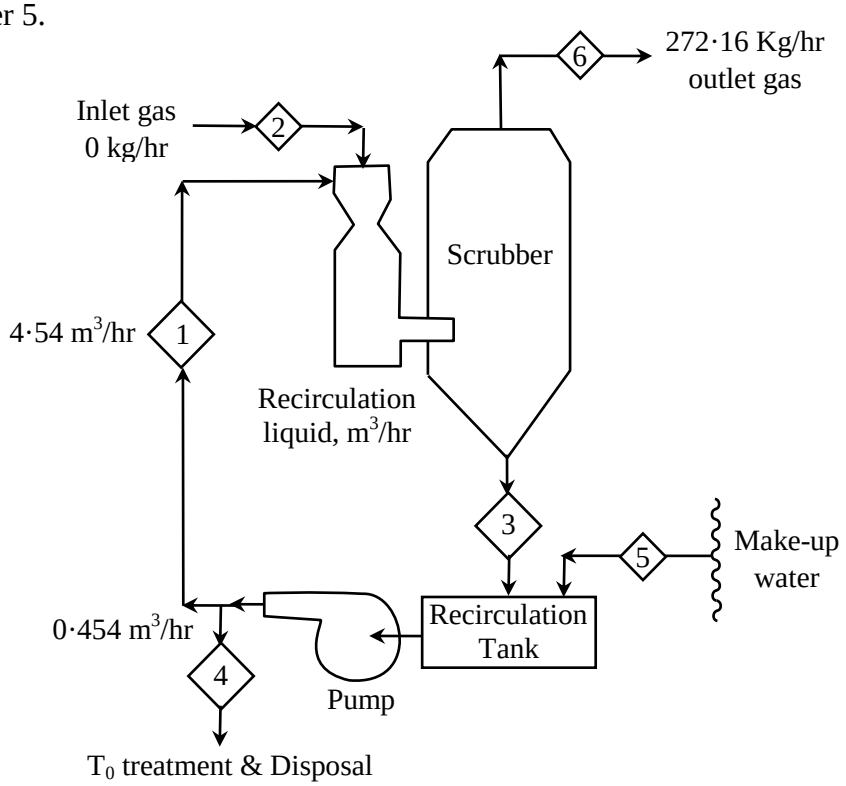
Expression for local heat transfer coefficient $Nu_x = \frac{h_x x}{K} = 0{\cdot}0288(Rc_x)^{4/5}(Pr)^{1/3}$,

$$h_x = 0{\cdot}0288K\left(\frac{V}{\nu}\right)^{4/5}(Pr)^{1/3}(x)^{-1/5}.$$

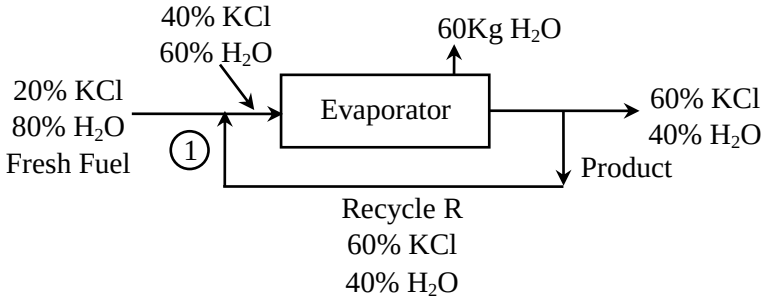
4. a) A scrubber is used to remove the fine material or dust from the inlet gas stream with a spray of liquid (typically water) so that outlet gas stream meets the requirement process or emission standards.

How much water must be continually added to wet scrubber shown in figure below in order to keep the unit running? Each of the streams is identified by a number located in a diamond symbol. Stream 1 is the recirculation liquid flow streams back to the scrubber and it is 4·54 m^3/hr. The liquid being withdrawn for treatment and disposal (stream 4) is 0·454 kgm^3hr.

Assume that inlet gas stream (number 2) is completely dry and the outlet stream (number 6) has 272·16 kg/hr of moisture evaporated in the scrubber. The water being added to the scrubber is stream number 5. [3]



b) Find the kilogram of R per 100 kg of fresh feed. [2]



5. a) A horizontal pipeline of length L and diameter D, used for transporting a liquid in a plant has a frictional pressure loss ΔH_f and a flow rate Q. It is proposed to replace the line with another pipe of diameter 2D, and reduce the frictional loss to half its present value. Assume flow to be in the region where friction factor is virtually constant. What will be the linear velocity and volumetric flow rate in the new pipeline. [2·5]

   b) It is proposed to replace the circular duct of diameter D for air in an air conditioning unit by a rectangular duct of dimension a×b such that linear velocity, volumetric flow rate and fraction factor remain same. Both the ducts can be assumed to be smooth and air may be treated in this case as an incompressible fluid as the pressure difference is small and flow is virtually isothermal. Find the values of a and b in terms of D. [2·5]

6. There is a clear water lake on top of a hill near a small village. A pipeline of 10cm dia is used to bring water from this lake to the village. The length of the pipeline may be taken as equivalent to 1km. The line does not require a pump, water flows by gravity. The flow rate is 25l/s. Make an estimate of the height of the hill. Use the normal values for properties of water. [5]

7. Water is flowing through a pipeline of dia 4cm at a rate of about 2·5 l/s. It is proposed to measure the exact flow rate by installing a venturimeter. What should be the throat diameter if the reading in a differential manometer be 20 cm for the above flow rate. The differential manometer uses water and another immiscible liquid with density 1·2 g/ml. Assume venturi coefficient to be 0·98. [5]

Group – B

Answer <u>any four</u> questions : [4×5]

8. What are major disadvantages in bulk polymerization? Name one polymer which can be prepared in emulsion polymerization. What is critical micelle concentration? Name a product made of PVC. [2+1+1+1]

9. In what aspect LLDPE is superior than LDPE? Write two differences between suspension and emulsion polymerization. What are the major drawbacks in solution polymerization? [1+2+2]

10. For a polymer,

Number of Molecules	Mass of each Molecule
1	800,000
3	750,000
5	700,000
8	650,000
10	600,000
13	550,000
20	500,000
13	450,000
10	400,000
8	350,000
5	300,000
3	250,000
1	200,000

Calculate (a) no. avg. MW. (b) wt. avg. MW (c) PDI. [2+2+1]

11. Write the steps related to polymerization. What do you mean by thermal initiator? Name one thermal initiator. [3+1+1]

12. Which polymer shows 'hot tack' property? What are the major differences between the properties of polymer made from suspension and emulsion? What are the possibilities in the termination process of a polymer? What is auto-acceleration? [1+2+1+1]

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