Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech (FT)/SEM-4/CHE-414/2011

2011

UNIT OPERATION OF CHEMICAL ENGINEERING – I

Time Allotted : 3 Hours *Full Marks :* 70

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) The property of fluid by virtue of which it offers resistance to shear is known as

a) density b) surface tension

c) viscosity d) vapour pressure.

ii) A plate 0·6 mm distant from a fixed plate, moves at 0·24 m/s and requires a force per unit area of 1 N/m^2 to maintain the speed. The fluid viscosity of the substance between the plates in $N \cdot s/m^2$ is

a) 0·4 b) $2 \cdot 5 \times 10^{-3}$

c) 2·5 d) $0 \cdot 4 \times 10^{3}$.

iii) The dimensions of Kinematic viscosity is

a) $ML^{-2} T^{-1}$ b) $L^2 T^{-1}$

c) $ML^{-2} T^{-2}$ d) none of these.

iv) Which of the following is a fine Crusher ?

a) Black Jaw Crusher b) Gyratory Crusher

c) Toothhed Roll Crusher d) Dodge Jaw Crusher.

v) Centrifugal pressure of a fluid increases

a) with the decrease in angular velocity

b) with the increase in angular velocity

c) with the increase in viscosity of the fluid

d) with the decrease in viscosity of the fluid.

vi) Bernoulli's theorem can be applicable

a) under laminar flow condition

b) under plug flow condition

c) under turbulent flow condition

d) under steady flow condition.

vii) Hagen-Poiseuille equation is applicable for

a) Laminar flow for Non-Newtonian fluid

b) Laminar flow for Newtonian fluid

c) Plug flow

d) The flow of Newtonian and Non-Newtonian fluids.

viii) Which area is used in case of heat flow by conduction through a cylinder ?

a) Logarithmic mean area b) Arithmetic mean area

c) Geometric mean area d) None of these.

ix) Operating speed of ball mill is always

a) less then its critical speed

b) greater than its critical speed

c) equal to its critical speed

d) none of these.

x) The crushing energy required to create new surface is given by

a) Fick's law b) Rittinger's law

c) Fourier's law d) None of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What do you mean by net positive suction head (NPSH) in a pump ? What is meant by cavitation ? 3 + 2

3. Define drag and drag co-efficient. Which skin friction parameter is analogous to drag co-efficient ? What is the mathematical relation between drag co-efficient and Reynolds number according to Stokes' law ? 2 + 2 + 1

4. What is the significance of LMTD correction factor ? What is the necessity of baffles in a shell and tube heat exchanger ? Give an example of heat exchanger commonly used in dairy industries. 2 + 2 + 1

5. Classify different types of comminuting equipment. State the working principle of each. 2 + 3

6. Define potential flow, boundary layer and fully developed flow with a neat diagram. 5

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7\. a) What is called the discharge pressure of a pump ?

b) A centrifugal pump takes brine from the bottom of a supply tank and deliver it into the bottom of another tank. The brine level in the discharge tank is 50 m above the supply tank. The line between the tank is 200 m of 10 mm pipe. The flow rate is $100 \ m^3/h$. In this line there are two gate valves, three standard tees and four elbows. What is the energy cost for running the pump for 24 hrs day ?

Take $\rho = 1180 \ kg/m^3$,

$\mu = 1 \cdot 2$ mp-s

Energy cost Rs. 0·80 kW/h,

Overall efficiency of the pump is 60%

$F = 0 \cdot 079 \ (Re) - 0 \cdot 25$

L/D ratio of gate valve = 7

Standard tees = 90

Elbows = 32. 3 + 12

8. a) The frictional pressure drop, ΔP for a flow of a flowing fluid through a long straight, round pipe depends upon the length l, diameter d, roughness ε of the pipe, the average velocity of the fluid u, density ρ and viscosity μ of the fluid. Use Buckinghum method to make dimensional analysis of the system.

   b) Deduce Kozeny-Cerman equation in case of fluid flow through a packed bed.

   c) What is minimum fluidization velocity ? 6 + 6 + 3

9. Derive a relation between overall heat transfer coefficient & individual heat transfer coefficient. What is Dirt factor & how does it effect heat transfer coefficient ? A steam pipe line, 150/160 mm in diameter, is covered with a layer of insulating material of thickness 50 mm. The thermal conductivity of the pipe is 50 W/m-k & that of insulting material is 0·08 W/m-k. The temperature inside the pipe line is 120 °C & that of the outside surface of the insulation is 40 °C. Calculate the rate of heat transfer. 5 + 4 + 6

10. Discuss the mechanism of condensation heat transfer. Determine the heat transfer coefficient using the Dittus-Boelter equation for water flowing in a tube of 16 mm diameter at a velocity of 3 m/s. The temperature of the tube is 24 °C, the water enters at 80 °C & leaves at 36 °C.

    Where a = 0·3 and the properties of water at the arithmetic mean bulk temperature are P = $984{\cdot}1\ \mathrm{kg/m^3}$, $C_p = 4178$ J/kg K, $\mu = 485 \times 10^{-6}$ $P_a - S$, K = 0·657 W/m-k.

5 + 10

11. a) What is working index ? What is the relation between work index and bonds constant.

b) Calculate the energy required to crush 100 tonnes per hour of limestone if 80% of the feed passes through a screen with 3·75 cm aperture and 80% of the product passes through of screen with 0·03 cm aperture. The work index for limestone is 12·74, when capacity is expressed in tones per minute. Energy required is in HP and size of product and feed are in feet.

c) A roll mill is available with rolls of 400 mm dia and capable of milling to an average product particle dia of 0·05 mm. If the co-efficient of friction for the material on the roll is 0·12, what is the largest available diameter of the feed particle which could be fed to the mill ? 3 + 7 + 5

12. a) Sugar is ground from crystals of which it is acceptable that 80% pass a 500 mm sieve (US Standard Sieve No. 35), down to a size in which it is acceptable that 80% passes a 88 mm (No. 170) sieve, and a 5-horsepower motor is found just sufficient for the required throughput. If the requirements are changed such that the grinding is only down to 80% through a 125 mm (No. 120) sieve but the throughput is to be increased by 50% would the existing motor have sufficient power to operate the grinder ?

b) How many "*g*" can be obtained in a centrifuge which can spin a liquid at 2000 rev/min at a maximum radius of 10 cm ?

c) What is sedimentation coefficient and what is its unit ? Is it possible to separate different proteins according to their respective sedimentation coefficient ? How can you determine sedimentation co-efficient of a substance experimentally ? 7 + 2 + 6

13. a) State the following laws :

    i) Rittinger's law

    ii) Kick's law.

b) Differentiate between differential screen analysis and cumulative screen analysis.

c) Differentiate between classifier and clarifier ? Write the relation between thickness of cake and volume of filtrate. (2 + 2) + 5 + (3 + 3)