M. TECH. –I (CHEMICAL) (2011COURSE) CHOICE BASED CREDIT SYSTEM : SUMMER - 2018

SUBJECT: ADVANCED TRANSPORT PHENOMENA

Day : **Wednesday** Time : **11.00 AM TO 02.00 PM**
Date : **30/05/2018** **S-2018-3211** Max. Marks: 60

N.B.

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Answers to both the sections should be written in **SEPARATE** answer book.

SECTION – I

Q.1 Two immiscible, incompressible liquids are flowing in z-direction in a horizontal thin slit of length L and width W under the influence of a pressure gradient $(P_0 - P_L)/L$. Make a differential momentum balance and obtain an expression for momentum flux and velocity distribution. **(10)**

OR

Discuss various types of Non-Newtonian fluids and describe the two parameter rheological models in detail.

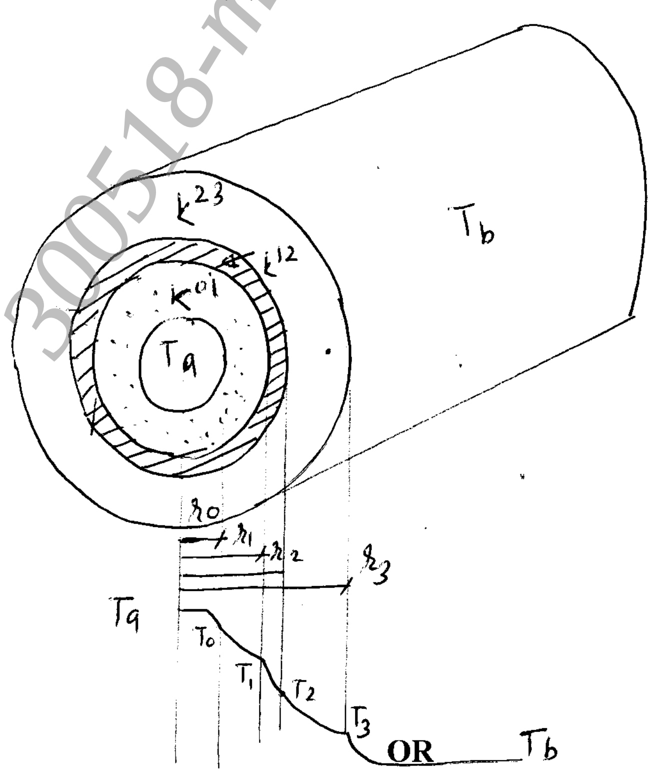
Q.2 What pressure drop is required for pumping water at 20^0C through a pipe of 25 cm diameter and 1234 m length at a rate of 1.97 m/sec. The pipe is at the same elevation throughout and contains four standard radius 90^0 elbows and two 45^0 elbows. [Le/D for 90^0elbow is 82 diameters and Le/D for 45^0 elbow is 15 diameters] **(10)**

OR

Discuss friction factors for packed column and derive the following equations:

i) Blake-Kozeny equation
ii) Burke-Plummer equation
iii) Ergun equation

Q.3 Develop a formula for the overall heat transfer coefficient for the composite cylindrical pipe wall shown in figure. **(10)**



OR

Derive an expression for the effectiveness of a cooling fin

$$\eta = \frac{\tanh N}{N}.$$

P.T.O.

SECTION – II

Q.4 A solid body occupying the space from $y = 0$ to $y = \infty$ is initially at temperature T_0. Beginning at time $t = 0$, a periodic heat flux given by. **(10)**

$q_y = q_0 \cos \omega t = q_0 R(e^{i\omega t})$

is imposed at $y = 0$. Here q_0 is the amplitude of the heat flux oscillations and 'ω' is the (circular) frequency. It is desired to find the temperature in this system, T(y, t) in the periodic steady state.

OR

Define heat transfer coefficients and discuss heat transfer coefficients for forced convection through packed beds.

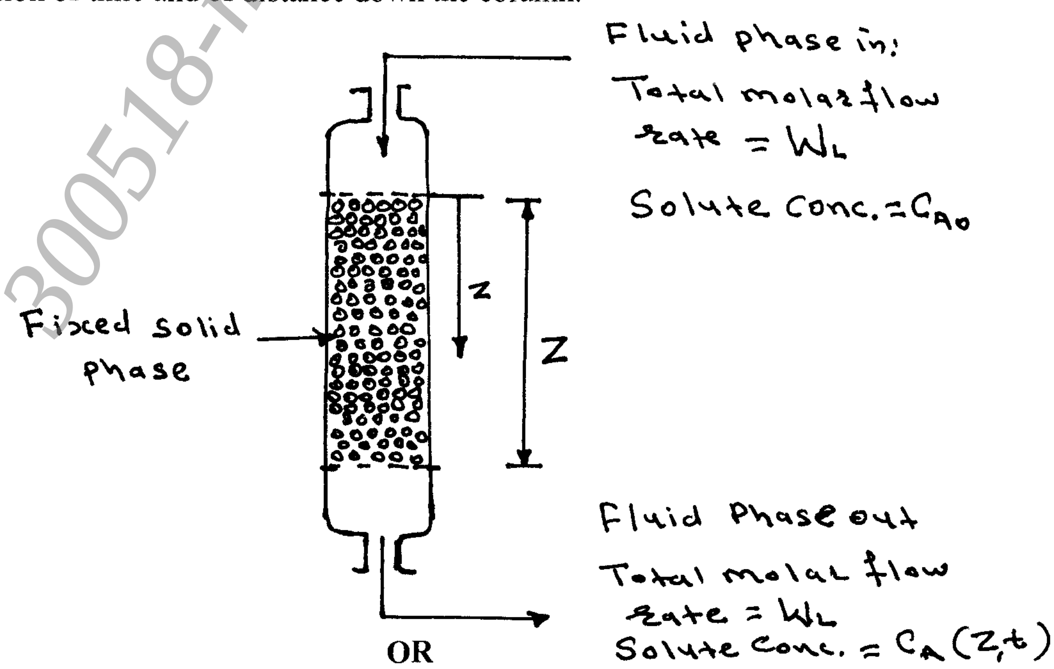
Q.5 Derive an expression for concentration profile and prove that the molar flux of reactant through the film is **(10)**

$$N_{Az} = \frac{2C\,D_{AB}}{\delta} \ln\left(\frac{1}{1 - \frac{x_{A0}}{2}}\right)$$

OR

Write in detail about diffusion and chemical reaction inside a porous catalyst.

Q.6 Consider an unsteady operation of a packed column in which a solution containing a single solute A at mole fraction x_{A1} in a solvent B is passed at a constant volumetric flow rate w/ρ through a packed tower. The tower packing consists of a granular solid capable of adsorbing A from the solution. At the start of the percolation, the interstices of the bed are filled with pure liquid B, and the solid is free of A. The percolating fluid displaces this solvent evenly so that the solution concentration of A is always uniform over any cross section. For simplicity, it is assumed that the equilibrium concentration of A adsorbed on the solid is proportional to the local concentration of A in the solution. It is also assumed that the concentration of A in the percolating solution is always small and that the resistance of the porous solid to intra-particle mass transport is negligible. Develop an expression for the concentration of A in the column as a function of time and of distance down the column. **(10)**



OR

Discuss in detail about enhancement of mass transfer by first order reaction in turbulent flow.

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