Minor-2 Examination: CLL-331 : Fluid Particle Mechanics

Time:1 hour ; Full Marks:20.

Guidelines (i) **Use two different Answer booklets for two different sections** (ii) State necessary assumptions clearly if required . (iii) Indicate your answer with proper nomenclature, direction and units .if any (iv) **Negative marking** (-1) for wrong statement or answer for Question 2 a to 2d. (v) Do not ask questions to invigilators.

Part-1

1. Find out the **number** frequency distribution and **Sauter mean diameter** of a powder sample (true density 2gm/cc) from the data given below. Assume particles are non porous particle.

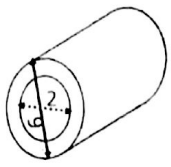
Marks: 2+2

Size range (μm)	100-150	150-200	200-250	250-300
Mass of powder (gm) in the size range	0.3	1.0	0.5	0.2

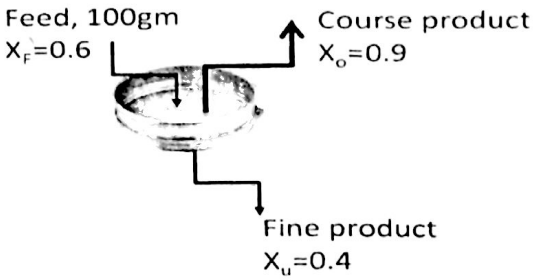
2. (a) In a test sieve, the French AFNOR series, which is based on a sieve aperture of 1mm in a tenth root of ten progression, is used. What may be basis of the used progression?

(b) Prove that the capacity of a screen , in mass per unit time, divided by the mesh size should be constant for any specified conditions of operation.

(c) Find out the sphericity and d_a of an open hollow cylinder of dimension ID 2mm and OD 6mm and length 60mm.



(d) Find out the efficiency of the screen from the data shown in figur. x_i is the fraction of particle with dia greater than d_A in i(F for feed, u for underflow and o for overflow).



Marks : 1+1+2+2

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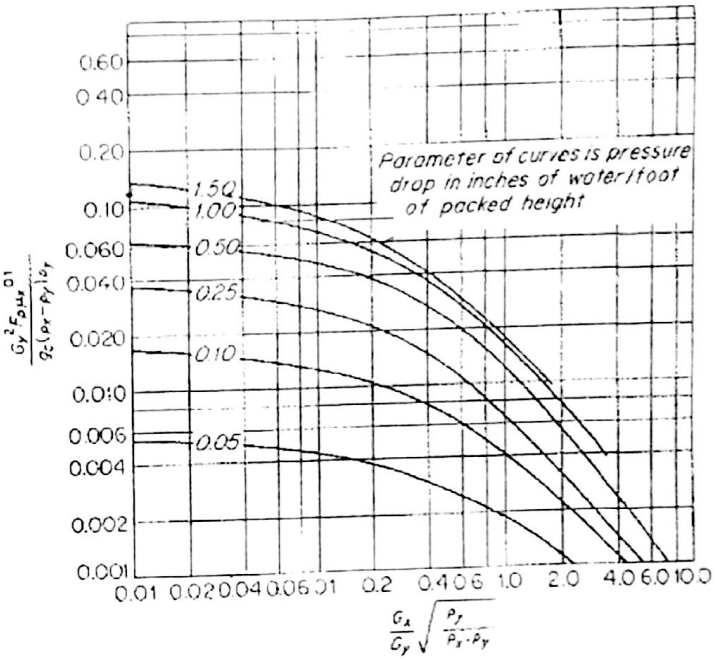
Part-2

Use Separate Answer Sheet

- **Drag force on a stationary rigid spherical particle of diameter, d in uniform flow of velocity, U in a fluid of viscosity, μ is $3\pi\mu dU$.**
- **Viscosity of water is 10^{-3} Pa.s=1cp**
- **Ergun equation-** $$\frac{-\Delta p}{L} = 150\frac{\mu U(1-\varepsilon)^2}{d^2\,\varepsilon^3} + 1.75\frac{\rho_f U^2(1-\varepsilon)}{d\,\varepsilon^3}$$

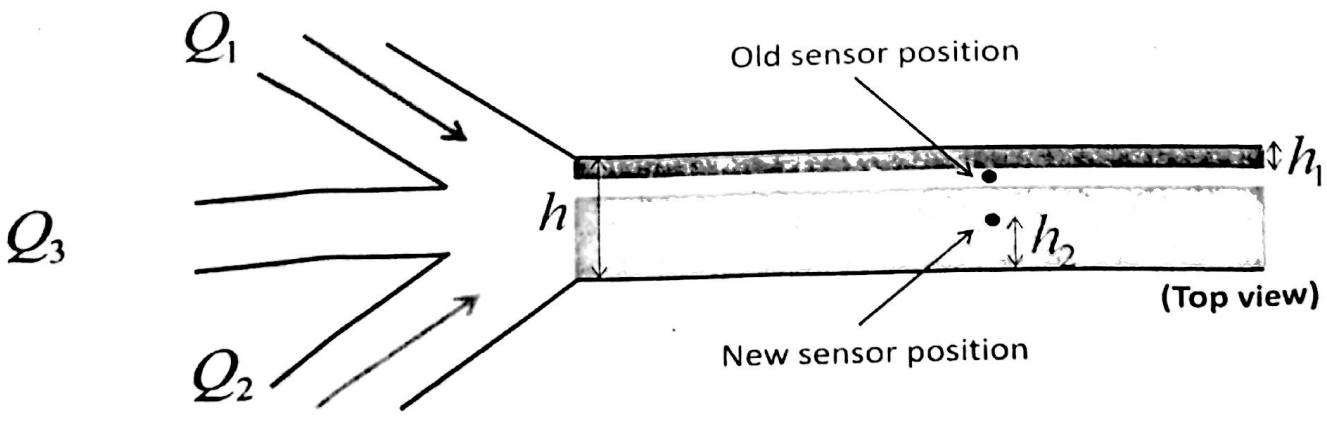
3. A packed tower using 1" of Pall rings (Packing factor, F_p=56) is to be designed to treat 1000 ft^3/s of air containing small amount of ammonia. Water containing a small amount of acid is used to completely remove ammonia from air. The ratio of the gas flow (G_y) to the liquid flow (G_x) to be used is 1 pounds of air per pound of liquid. Determine the minimum diameter of the tower that can be used if the tower starts flooding at a pressure drop of 1.5" of water per feet of the packing. The temperature inside the column is uniform and equal to 300K and the column is working at 1 atm. (Viscosity of water = 1 cP, 1 lb= 0.45kg, 1 feet= 0.31 m, density of water = 62 lb/ft^3)

Marks: 6



Generalized correlation for pressure drop in packed column (G_y, G_y are in lb/ft^2s, μ_x is in cP, ρ_x and ρ_y are in lb/ft^3, g_c = 32.174 ft/lb.s)

4. In a microfluidic channel (figure below), three streams of fluid are flowing. In the beginning, the flow rates are such that the cell stream (Q_3) is flowing at a distance of 20 μm (h_1) from the top wall. Q_1 is 1 ml/s. The sensor position is then shifted to the center (h_2 =50 μm) of the channel. At what new flow rate Q_1 will the cells now pass through this new sensor position. Assume Stokes flow, $Q_3 << Q_1, Q_2$, h =100 μm, h<< width of the channel. Assume flow rate, Q_2 and Q_3 remain same. (4)



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