DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

End Semester Examination – Winter 2018

Course: B. Tech in Chemical/Petrochemical Engineering **Sem: III**

Subject Name: Fluid Flow Operations **Subject Code: BTCHC 303**

Max Marks: 60 **Date: 5-12-2018** **Duration: 3 Hrs.**

Instructions to the Students:

1. *Solve **ANY FIVE** questions out of the following.*
2. *The level question/expected answer as per OBE or the Course Outcome (CO) on which the question is based is mentioned in front of the question.*
3. *Use of non-programmable scientific calculators is allowed.*
4. *Assume suitable data wherever necessary and mention it clearly.*

		(Level/CO)	Marks
Q. 1	**Solve <u>Any Two</u> of the following.**		**2x6=12**
A)	Calculate the pressure in kN/m^2 at the bottom of a spherical tank filled with oil having a diameter of 2.4 m. The top of the tank is vented to the atmosphere having a pressure of 101.325 kN/m^2. The density of the oil is 922 kg/m^3.	Apply	
B)	A U-tube manometer is being used to measure the pressure drop across a flow meter. The heavier fluid is mercury, with a density of 13,600 kg/m^3, and the top fluid is water, with a density of 1000 kg/m^3. The reading on the manometer is R_m = 32.7 cm. Calculate the pressure difference in N/m^2.	Apply	
C)	Given the pressure of 1 standard atmosphere as 101325 N/m^2, do as follows: (i) Convert this pressure to water head in meters (take density of water as 1000 kg/m^3) (ii) Convert this pressure to carbon tetrachloride head in meters (take density of carbon tetrachloride as 1,600 kg/m^3)	Apply	
Q.2	**Solve <u>Any Two</u> of the following.**		**2x6=12**
A)	Differentiate between Newtonian and non-Newtonian fluids and explain the rheological behavior of Newtonian and non-Newtonia fluids (time-independent) with examples for each type of fluid.	Analyze	
B)	Whole milk at 293 K having a density of 1030 kg/m^3 and viscosity 2.12 cP is flowing at the rate of 0.605 kg/s in a glass pipe having a diameter of 63.5 mm. (a) Calculate the Reynolds number. Is this turbulent flow? (b) Calculate the flow rate needed in m^3/s for a Reynolds number of 2100 and velocity in m/s.	Apply	
C)	A pump draws oil (specific gravity 0.8) from a storage tank and discharges it to an overhead tank. The mechanical energy delivered by the pump to the fluid is 50 J/kg. The velocities at the suction and the discharge points of the pump are 1 m/s and 7 m/s, respectively. Neglecting friction losses and assuming kinetic energy correction factor to be unity, what is the pressure developed by the pump?	Apply	

Q. 3 Solve Any One of the following. **1x12=12**

A) (i) Derive velocity profile for a Newtonian fluid flowing under laminar flow conditions in a circular pipe. Also derive equation for average velocity in the pipe. At what radial position is the fluid velocity equal the mean velocity in the pipe? Where does this occur for a pipe diameter of 25 mm? Apply

B) (i) Derive f = 16/Re for flow of Newtonian fluid in laminar flow through a circular pipe. Apply

(ii) A lubricating oil at a rate of 0.5 kg/s flows through a 25 mm diameter circular pipe. Pressure drop over a length of 2 m is measured with the help of an U-tube manometer. If the manometer reads 225 mm find the friction factor and compare it with the theoretical value. Take density = 900 kg/m^3, viscosity = 0.250 Pa.s, density of manometer fluid = 13600 kg/m^3. Apply

Q.4 Solve Any Two of the following. **2x6=12**

A) Ammonia at atmospheric pressure and 300 K with a bulk stream velocity of 10 m/s flows through a pipe of diameter 25 cm. Calculate the pressure drop per 100 m length of the pipe and the power consumed. Friction factor $f = 0.079\ Re^{-0.25}$ in the turbulent regime. Viscosity of ammonia may be taken as 10.2×10^{-6} kg/(m.s). Apply

B) A bacterium is moving in water at a velocity of 1 mm/s. The size of the bacterium may be taken as 1 micron meter. If the the kinematic viscosity of water is 10^{-6} m^2/s what will be the drag coefficient? Understand

C) Evaluate the sphericity of the following: Apply
(i) a solid particle of cubical shape
(ii) s solid particle of cylindrical shape with length equal to diameter.

Q. 5 Solve Any One of the following. **1x12=12**

A) (i) A bed of spherical particles (specific gravity 2.5) of uniform size 1500 micron meter is 0.5 m diameter and 0.5 m high. In the packed bed state, the porosity may be taken as 0.4. Ergun's equation for the above particle -fluid system (in SI units) is given below Apply

$\Delta P/L = 375 \times 10^3\ V_{OM} + 10.94 \times 10^6\ V^2_{OM}$ (in SI units)

If water is to be used as the fluidizing medium, what is the minimum fluidizing velocity, V_{OM}? In actual fluidization operation, the above bed has a height = 1m. What is the porosity of the fluidized bed?

(ii) Two spherical particles have the same outer diameter but are made of different materials. The first one (with material density ρ_1) is solid, whereas the second (with material density ρ_2) is a hollow sphere with the inner shell diameter equal to half the outer diameter. If both the spheres have the same terminal velocity in any fluid, then what will be the ratio of their material densities, ρ_2/ρ_1. Apply

B) (i) Explain the concept of NPSH and suction lift for a centrifugal pump. Understand

(ii) A storage vessel exposed to atmosphere (absolute pressure = 10.3 m of water) has a diameter of 3 m and is initially filled with water to a height of 2m. The pump draws water from the vessel and is located at an elevation of 5m above the bottom of the vessel. The frictional head loss in the suction pipe is 2 m of water. If the vapor pressure of the liquid at the temperature of operation is 3 m of water, then what will be the available NPSH? Apply

Q6 Answer any one of the following: **1x12=12**

A) (i) Explain, with neat sketches, the working principles of venturi meter and orifice meter. Give the merits and demerits of venturi and orifice meters. Understand

(ii) Water flowing at 1.5 L/s in a 0.05 m diameter tube is metered by means of a simple orifice of diameter 0.025 m. If coefficient of discharge is 0.62, what will be the reading on a mercury-under-water manometer connected to the meter? Density of water = 1000 kg/m^3; viscosity of water = 0.001 Pa.s; density of mercury = 13,600 kg/m^3. Apply

B (i) List out the purposes of agitation and explain, with example, how an agitator serves multiple purposes in a reaction vessel. Remember

(ii) What are the causes of swirling and vertex formation in an agitated vessel? Suggest suitable measures for reducing the swirling and vertex formation in an agitated vessel. Understand

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