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B.Tech.
PCE3I101

3rd Semester Regular/Back Examination 2017-18
FLUID FLOW & FLOW MEASUREMENT
BRANCH : CHEM, PT
Time : 3 Hours
Max Marks : 100
Q.CODE : B968
Answer Question No.1 and 2 which are compulsory and any four from the
rest.
The figures in the right hand margin indicate marks.
Assume suitable notations and any missing data wherever necessary.
Answer all parts of a question at a place.

1.   Answer the following questions :   (2x10)

(a) Cornstarch,pastes, slurries of clay and titanium dioxide, sugar, etc.
are examples of:
    i. Shear thickening fluids
    ii. Shear thinning fluids
    iii. Bingham plastics
    iv. Newtonian fluids

(b) Values of high vacuum are generally expressed in terms of:
    i. Atm
    ii. mm Water column
    iii. kPa
    iv. Torr

(c) Skin friction is due to:
    i. Pressure distribution
    ii. Friction factor
    iii. Viscous drag
    iv. Surface tension

(d) Above what Reynolds numbers, for flow past a sphere,flow
separation takes place?
    i. $N_{Re}> 1$
    ii. $N_{Re}>20$
    iii. $N_{Re}>100$
    iv. $N_{Re}>2000$

(e) In laminar flow, friction factor is dependent onroughness factor.
    i. True
    ii. False

(f) What is beta ratio ?
    i. ratio of orifice plate bore and pipe outer diameter
    ii. ratio of orifice plate bore and pipe internal diameter
    iii. ratio of pipe outer diameter and orifice plate bore
    iv. ratio of pipe internal diameter and orifice plate bore

(g) The average values of orifice and venturicoefficients are:
    i. 0.5 and 0.8
    ii. 0.8 and 1.0
    iii. 0.6 and 0.9
    iv. 0.9 and 1.2

(h) NPSH for hot/boiling liquids is high.
    i. True

ii.   False
(i) Positive displacement pumps generally operate at lowinlet velocities.
    i.   True
    ii.   False
(j) Ratio of volumetric flow rate and cross-sectional area for flow is known as:
    i.   Mass velocity
    ii.   Average velocity
    iii.   Instantaneous velocity
    iv.   Superficial velocity

2. **Answer the following questions :** (2x10)
(a) Why dimensional analysis method is chosen over formal mathematical development and a completely empirical study ?
(b) Explain dilatant and rheopectic fluids with examples.
(c) A plate of area 0.15 m^2 is pulled at 0.3 m/s with respect to another stationary parallel plate 1.5 mm distant from it. If the space between the plates containing a liquid of viscosity 0.001 $N.s/m^2$, find the forces necessary to maintain this velocity.
(d) Mention the utility of Hagen-Poiseulli's equation.
(e) Differentiate between isotropic and anisotropic turbulence.
(f) The pressure loss in orificemeters is more than venturimeters. Explain.
(g) What is creeping flow ?
(h) Mention the values of $\dfrac{\bar{V}}{u_{max}}$ for different values of N_{Re}.
(i) Mention the use of notches and weirs.
(j) What is cavitation ?

3. **(a)** In a compressor, the frictional torque T in the impeller depends on diameter of the impeller D, rotational speed N, fluid density ρ, and viscosity μ. Using Buckingham's π-theorem, show that the frictional torque T can be expressed as: **(10)**

$$T = \rho N^2 D^5 \, f\left(\frac{\mu}{\rho N D^2}\right)$$

(b) Derive the Barometric equation. Mention its use. **(5)**

4. **(a)** A submarine is designed to operate 3 KM below the sea surface. If the interior pressure is 1.2atm, what is the total pressure on a 20 cm diameter window ? The average density of seawater is 1025 kg/m^3. **(4)**

(b) The temperature of the earth's atmosphere falls about 5^0C for every 1000 m of elevation above the earth's surface. At ground level the air temperature is 25^0C and the pressure is 760 mm Hg. Assuming air to be an ideal gas, calculate the elevation at which the pressure is 400 mm Hg. How much error would be introduced in the answer, if hydrostatic equilibrium equation is used with the density calculated at 0^0C and an arithmetic average pressure ? **(6)**

(c) Discuss with a neat sketch the development of turbulent boundary layer on a flat plate. **(5)**

5. **(a)** An oil of specific gravity 0.9 flows through the piping as shown in the figure. Pipe A is 52 mm, pipe B is 74 mm, and each of pipes C is 40 mm in internal diameter. An equal quantity of liquid flows through each of the pipes C. The flow through pipe A is 6.7 m^3/h. Calculate: (i) mass flow rate in each pipe, (ii) average linear velocity in each pipe, and (iii) mass velocity in each pipe. **(6)**
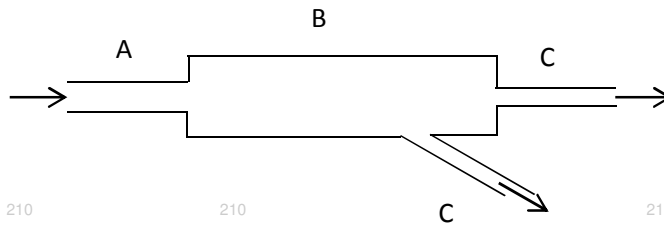
(b) The velocity profile for laminar flow in a circular pipe is given by: **(9)**

$$u = u_{max}\left(1-\left(\frac{r}{R}\right)^2\right),$$ where, u_{max} = constant = velocity at the center

line of the pipe, r = radial distance from the center line of pipe, and R = radius of pipe.
What is average velocity,
Show that the velocity gradient varies linearly with radius, and
Find the velocity gradient at the wall and also at the center line.

6. (a) Derive the Bernoulli equation without friction with a suitable diagram. **(10)**

(b) A laptop is cooled by a fan whoseflow rate is 0.4 m^3/min. Determine the mass flow rate of airthrough the fan at an elevation of 3500 m where the air densityis 0.8 kg/m^3. Also, if the average velocity of air is not toexceed 100 m/min, determine the diameter of the casing ofthe fan. **(5)**

7. (a) A bed of ion-exchange beads 2.5 m deep is to be backwashed with water to remove dirt. The particles have a density of 1.2 g/cm^3 and have an average size of 1.1 mm. What is the minimum fluidization velocity using water at 25^0C and what velocity is required to expand the bed by 25% ? Take Φ_S = 1.0 and $\square_M$ = 0.40. **(8)**

(b) Discuss in detail the mechanism of fluidization. With a suitable plot explain the variation of pressure drop and bed height with respect to the superficial velocity. **(7)**

8. (a) Explain in detail the characteristic curves of the centrifugal pump. **(10)**

(b) Briefly discuss about the operation of a rotameter. **(5)**

9. **Write short notes on :**

(a) Friction factor **(5)**

(b) Net positive suction head **(5)**

(c) Slip of reciprocating pumps **(5)**