
PROGRAM : B-ENG TECH
EXTRACTION METALLURGY

SUBJECT : **PROCESS ENGINEERING 2**

CODE : **PREMTB2**

DATE : SUMMER EXAMINATION
NOVEMBER 2019

DURATION : (SESSION 1) 09H00 - 12H00

WEIGHT : 40 : 60

TOTAL MARKS : 100

ASSESSOR : MISS M MADIBA

MODERATOR : MR M KALEMBA 5119

NUMBER OF PAGES : 4 PAGES AND 2 ANNEXURES

INSTRUCTIONS : ANSWER ALL QUESTIONS.
ONE CALCULATOR ALLOWED PER STUDENT
START ANSWERING NEW QUESTION ON A NEW PAGE

REQUIREMENTS : 2 SHEETS OF GRAPH PAPER PER STUDENT

QUESTION 1

1.1 Water is moving through a pipe. The velocity profile at some section is shown in Figure 1.a below and is given mathematically as $V = (\beta/4\mu) (d^2/4 - r^2)$, where V = the velocity of water at any position r , β = a constant, μ = viscosity of water, d = pipe diameter and r = radial distance from center line. specific weight and relative density.

1.1.1 What is the shear stress at the wall of the pipe due to water? (5)

1.1.2 What is the shear stress at a position $r = d/4$? (5)

1.1.3 If the given profile persists a distance L along the pipe, what force is induced on the pipe by the water in the direction of the flow over this distance? (5)

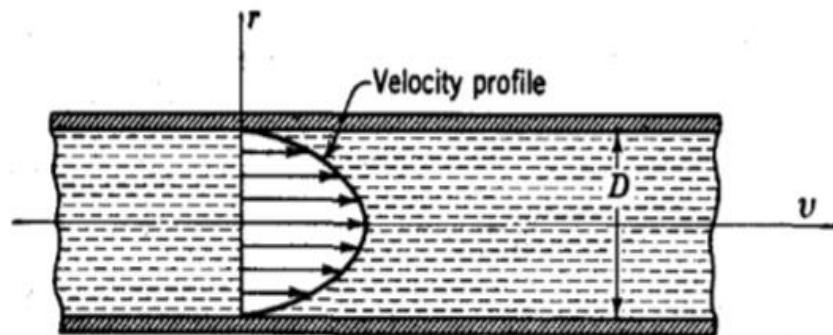


Figure 1.a

1.2 In Figure 1.b, if the fluid is SAE 30 oil at 20°C and $D = 7\text{mm}$, what shear stress is required to move the upper plate at 3.5 m/s? Calculate the Reynolds number based on D .

(6)

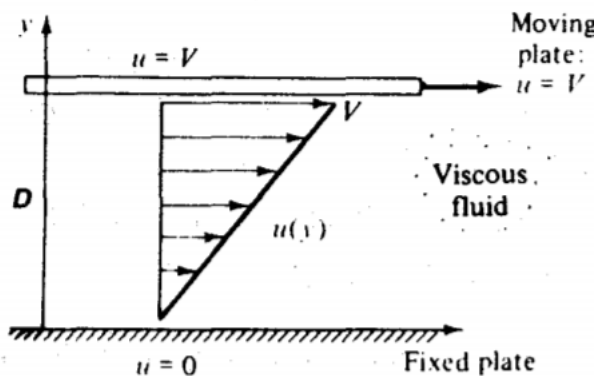


Figure 1.b

[21]

QUESTION 2

- 2.1 A monometer is attached to a tank containing three different fluids, as shown in Figure 2.a. What will be the difference in elevation of the mercury column in the manometer (i.e., y in Figure 2.a)? (5)

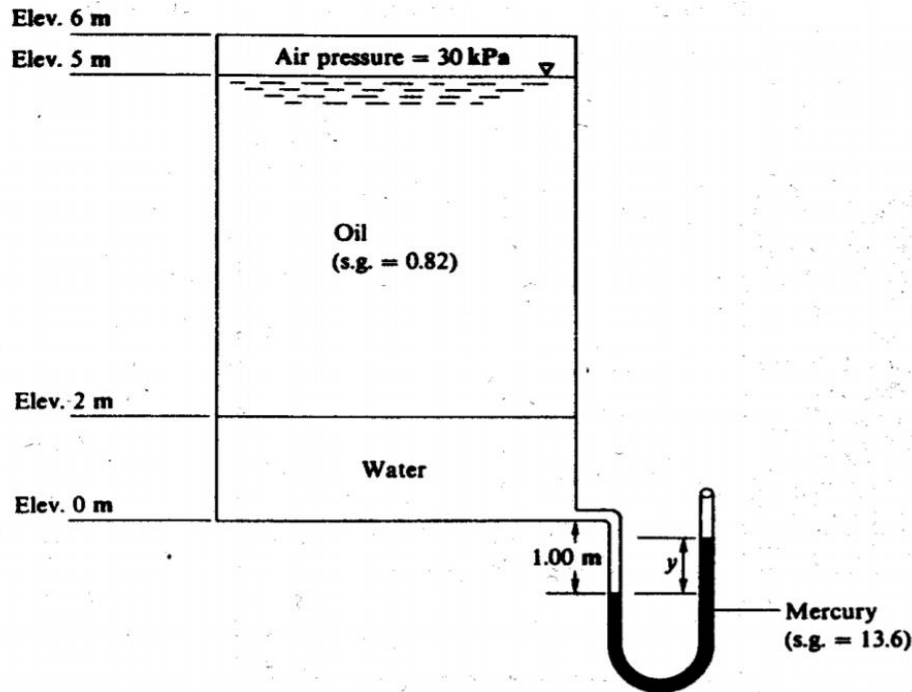


Figure 2.a

- 2.2 Very small pressure differences $p_A - p_B$ can be measured accurately by the two-fluid differential manometer shown in Figure 2.2. Density ρ_2 is only slightly larger than the upper fluid ρ_1 . Derive an expression for the proportionality between h and $p_A - p_B$ if the reservoirs are very large. (5)

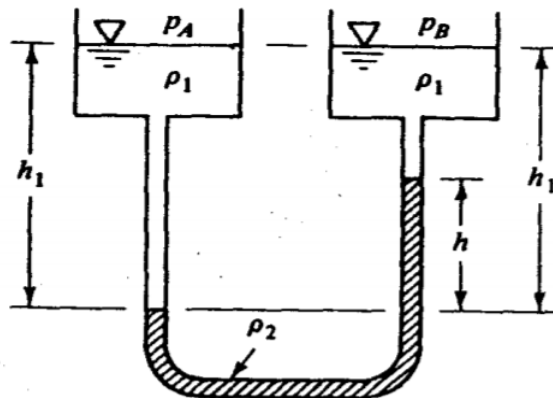


Figure 2.b

[10]

QUESTION 3

3.1 Benzene flows through a 100-mm-diameter pipe at a mean velocity of 3 m/s. Find the

(a) volume flow rate in m^3/s and L/min, (5)

(b) weight flow rate, and (3)

(c) mass flow rate. (3)

3.2 A 150-mm diameter jet of water is discharging from a nozzle into the air at a velocity of 36 m/s. Find the power in the jet with respect to a datum at the jet. (9)

3.3 Water at 10°C flows in a 150-mm-diameter pipe at a velocity of 5.5 m/s. Is this flow laminar or turbulent? (4)

[24]

QUESTION 4

4.1 Water at 20°C flows through a new cast iron pipe at a velocity of 4.2 m/s. The pipe is 400 m long and has a diameter of 150 mm. Determine the head loss due to friction. (Hint. Use Moody chart). (20)

4.2 You have been asked by a customer to correctly size the centrifugal pump and conduct pump cavitation check for his typical dairy process. Pump 'A' in the figure below is a Raw Milk pump in connection with a pasteuriser. The raw milk is pumped from a Balance tank to a Separator via the preheating stage in the plate heat exchanger.

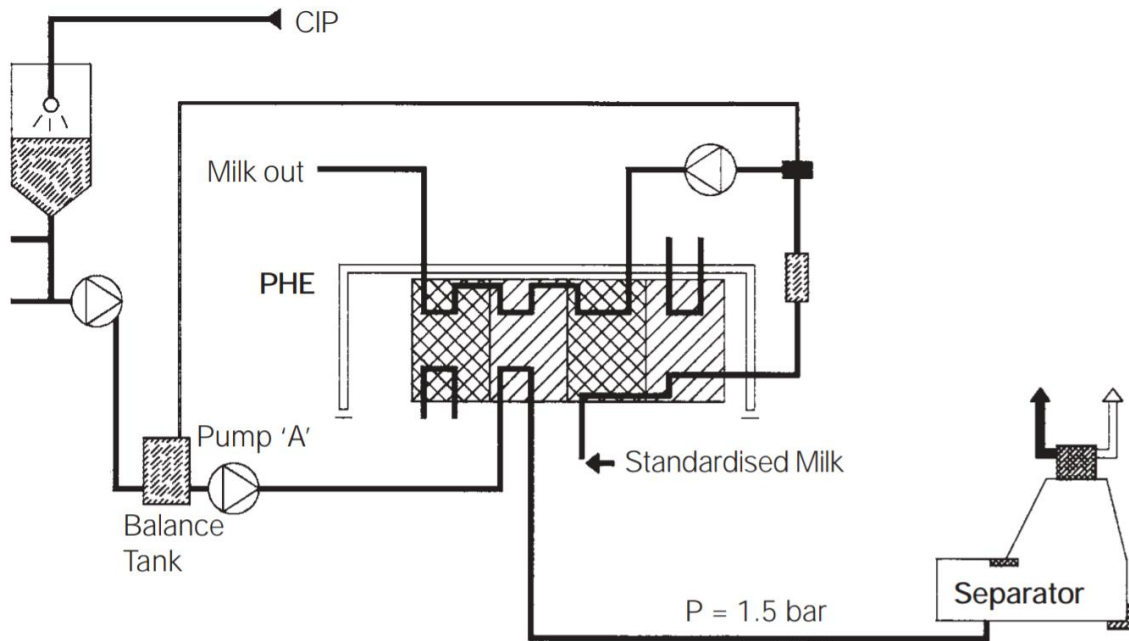


Figure 4

The following data has been given:

Product/Fluid data:

Fluid to be pumped - : Raw Milk.

Viscosity : 5 cP.

Pumping temperature : 5°C.

Performance data:

Capacity : 30 m³/h.

Discharge : via 5 m of horizontal 76 mm dia. tube, plus a given number of bends, valves and a plate heat exchanger with Δp_{PHE} 1 bar.

Inlet pressure for the separator = 1.5 bar. Suction : 0.1 m head, plus a given number of bends and valves.

Site Services data:

Electrical supply : 220/380v, 50 Hz.

(25)

[45]

TOTAL

[100]