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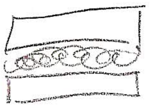
ENCE 3318
PRINCIPLES OF HYDRAULICS

TEST 1

1. Two large flat plates are separated by a thin fluid layer that is 1 mm thick and at a temperature of 20°C. The dynamic viscosity is 0.06 N-s/m^2. A force is applied to the top plate such that a shear stress $\tau = 30.0$ N/m^2 is generated. How fast will the top plate move (in m/s) relative to the bottom plate after a constant velocity is attained? Assume that the velocity profile between the plates is linear.

25



↕ 1mm @ 20°C

$\mu = .06 \frac{N \cdot s}{m^2}$

$\tau = 30 \ N/m^2$

$\tau = \mu \frac{V}{b}$ b/c linear

$30 \ N/m^2 = \left(.06 \frac{N \cdot s}{m^2}\right) \frac{V}{.001 m}$

$V = .5 m/s$ ✓

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2. What pressure increase must be applied to water at 70 °F to reduce its volume by ½ %? Give your answer in lbf/in^2. What depth (in feet) in sea water (γ=64.2 lbf/ft^3) is this equivalent to?

$$E = -\frac{\Delta p}{\frac{\Delta V}{V_{original}}} \qquad 3.20 \times 10^5 psi = E$$

$$3.2 \times 10^5 psi = \frac{-\Delta p}{\left(\frac{-.5}{100}\right)}$$

$$\Delta p = 1.6 \times 10^3 \ lb_f/in^2$$ ✓

$$P_2 - P_1 = \gamma d$$

$$\frac{1.6 \times 10^3 \frac{lb_f}{in^2} \cdot \frac{144 \ in^2}{ft^2} - 0}{64.2 \frac{lb_f}{ft^3} ft} = \frac{64.2 \frac{lb_f}{ft^3} (d)}{64.2 \frac{lb_f}{ft^3}}$$

$$d = 3588.79 \ ft$$ ✓

water

20°

3. The capillary rise in medium sand is approximately 25 cm. If the medium sand can be modeled by a capillary tube (glass tube), what is its equivalent diameter? Assume that $\theta = 0$ degrees.

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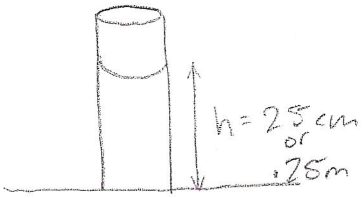

$\gamma_w = 9789\ N/m^3$ @ 20°C

$\sigma = .0728\ N/m$

$$h = \frac{4\sigma\cos\theta}{\gamma d} \Rightarrow .25m = \frac{4(.0728\frac{N}{m})(\cos 0)}{(9789\frac{N}{m^3})\, d}$$

$d = 1.1899 \times 10^{-4}\ m$

✓

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4. Mercury has a S.G. of 13.57..

■ Problem Statement

What is the absolute and gage pressure in drum *A* in Fig. 2.4 at position *a*?

$\gamma_w = 9789\ N/m^3$ @ 20°C

$\gamma_{oil} =$

$\gamma_{Hg} = 132836.7\ N/m^3$ @ 20°C

14.7 = 101.3 kPa

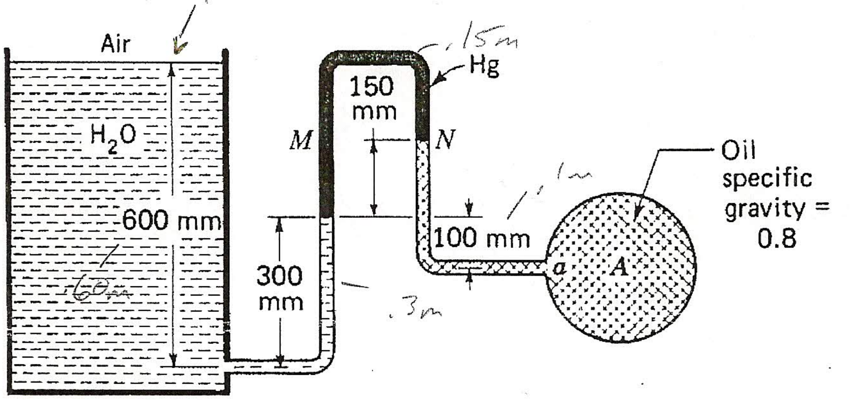

Figure 2.4
Inverted U-tube.

gage pressure

$P_2 = P_1^{\,0} + (.60)(9789) = 5873.4\ Pa$

$P_3 = (.60)(9789) - (.3)(9789) = 2936.7\ Pa$

$P_4 = P_3 - (.15)(132836.7) = -16988.8\ Pa$ ✓

$P_5 = P_4$ → same depth + fluid

$P_A = -16988.8 + (.25)(.8)(9789) = \boxed{-15031.005\ Pa}$ - gage

Absolute

$P_2 = 101300 + 5873.4 = 107173.4$

$P_3 = 107173.4 - (.3)(9789) = 104236.7$

$P_4 = 104236.7 - (.15)(132836.7) = 84311.195$ ✓

$P_5 = P_4$

$P_A = 84311.195 + (.25)(.8)(9789) = \boxed{86268.995\ Pa}$ - absolute