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TEXAS TECH UNIVERSITY
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ASCE STUDENT CHAPTER

NAME SOLUTIONS DATE 31 Jan
COURSE CE 3305 SHEET ____ OF ____

Exercise 3 Solutions

PROBlems

2.31

2.37

2.61 ⟹ GRADED PROBlEM

2.31) Velocity distribution of crude oils between two walls.

$\mu = 3.83 \times 10^{-3}\ N \cdot s/m^2$
$B = 0.03m$
$u = 100y(0.1-y)\ m/s$
$T = 37.8°C$

UNKNOWN:

Shear stress @ walls

GOVERNING EQs:

velocity distribution

$\Rightarrow u = 100y(0.1-y) = 10y - 100y^2$

SOLUTION:

Rate of strain:

$$\frac{du}{dy} = 10 - 200y$$

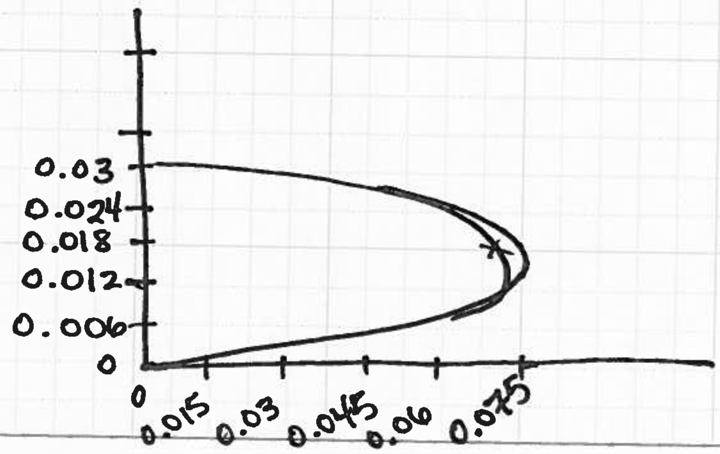
$(du/dy)_{y=0} = 10s^{-1}$ and $(du/dy)_{y=0.1} = -10s^{-1}$

Shear stress:

$\tau_0 = \mu \frac{du}{dy} \Rightarrow (3.83 \times 10^{-2}\ N/m^2) = (3.83 \times 10^{-3}) \times 10$

$$\boxed{\begin{array}{l} \tau_{0.1} = -3.83 \times 10^{-2}\ N/m^2 \\ \tau_0 = 3.83 \times 10^{-2}\ N/m^2 \end{array}}$$

Plot, where distance is in meters, and velocity in m/s.

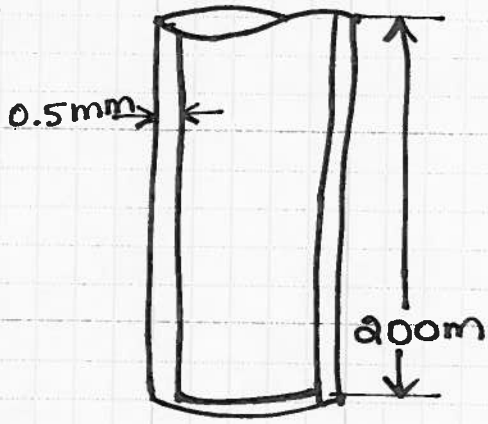


2.37) A cylinder falls inside a pipe filled with oi

$d = 100 mm$; $D = 100.5 mm$; $l = 200 mm$

$W = 15 N$

SKETCH:



UNKNOWN:

speed @ which the cylinder slides down the pipe.

KNOWN:

$T_{oil} = 10°C$

From Fig. A2: $\mu = 0.35 \, N s/m^2$

assume buoyant forces can be neglected

GOVERNING EQS:

$$\tau = \mu \frac{dV}{dy} \quad ; \quad \frac{W}{\pi d l} = \frac{\mu V_{fall}}{(D-d)/2}$$

SOLUTION:

$$V_{fall} = \frac{W(D-d)}{2\pi d l \mu}$$

$$V_{fall} = \frac{15N(0.5 \times 10^{-3} m)}{(2\pi \times 0.1m \times 0.2m \times 3.5 \times 10^{-1} Ns/m^2)}$$

$$\boxed{V_{fall} = 0.17 \, m/s}$$

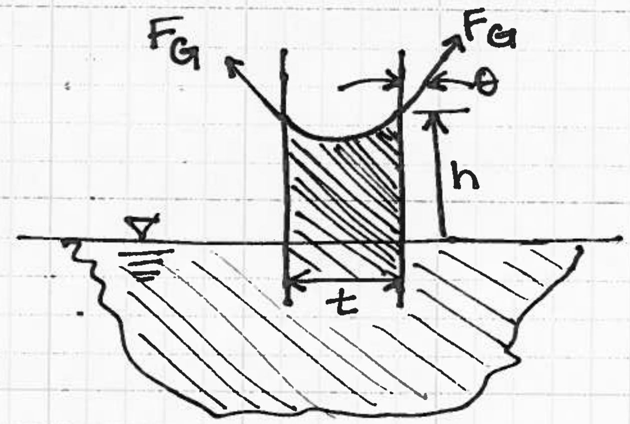
2.61) Two vertical glass plates with a thickness of 1m

KNOWN:

$t = 1mm$

From table A.4, surface water tension, $\sigma = 7.3\times10^{-2}\ \frac{N}{m}$

SKETCH:



UNKNOWN:

h = capillary rise between the plates.

GOVERNING EQS:

$$h = \frac{2\sigma}{\gamma t}$$

SOLUTION:

Force due to surface tension = weight of fluid that has been pulled upward

Equilibrium $(2l)\sigma = (hlt)\gamma$

$\Sigma F_y = 0$

$$\therefore \quad 2\sigma l - hlt\gamma = 0$$

$$h = \frac{2\sigma}{\gamma t}$$

$$h = \frac{2\times(7.3\times10^{-2} N/m)}{9810 N/m^3 \times 0.001 m}$$

$$= 0.0149\ m$$

$$\boxed{h = 14.9 mm}$$