جامعة بيرزيت

BIRZEIT UNIVERSITY
Faculty of Engineering
Department of Mechanical Engineering

Fluid Second Exam
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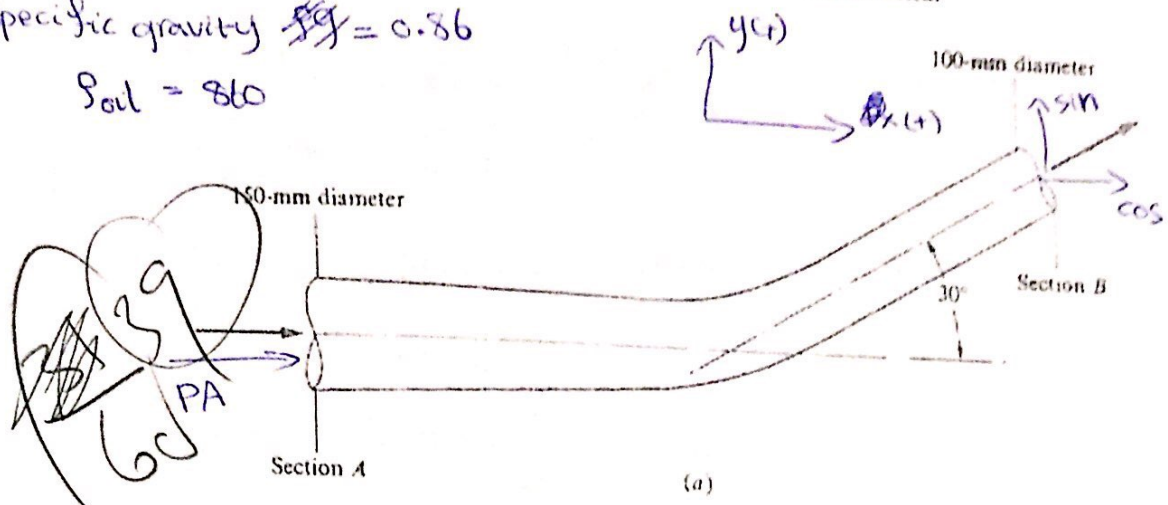
Problem 1(30 Points): (e)

The pipe bend shown in the figure below is in a horizontal plane. Oil with a specific gravity of 0.86 enters the reducing bend at section A with a velocity of 3.2 m/s and a pressure of 150 kPa.
Determine the force required to hold the bend in place assuming no energy is lost in the bend.

Specific gravity = 0.86

$\rho_{oil} = 860$



$V_A = 3.2$

$d_A = \frac{150}{1000} = 0.15m$

$A_A = \frac{\pi}{4}(0.15)^2$

$P = 150\ kPa$

no energ lost on the bend $Q_1 = Q_2$

$Q_1 = V_1 A_1 = 3.2\left(\frac{\pi}{4}\right)(0.15)^2 = 0.05655\ m^3/s$

$Q_2 = Q_1 = V_2 A_2$

$= 0.05655 = V_2 \frac{\pi}{4}(0.1)^2 = 7.2\ m/s$

$\Sigma F_x = (\dot{m}V)_{out} - (\dot{m}V)_{in}$

$\Sigma F_x = \dot{m}V_2\cos 30 - \dot{m}V_1$

$\Sigma F_x = \dot{m}(7.2\cos 30 - 3.2)$

$\Sigma F_x = \rho Q(7.2\cos 30 - 7.2)$

$\Sigma F_x = 860(0.05655)(-4.43)$

$\Sigma F_y = (\dot{m}V)_{out} - (\dot{m}V)_{in}$ (zero)

$\Sigma F_y = \dot{m}V_2\sin 30$

$F_y = \rho Q V_2 \sin 30$

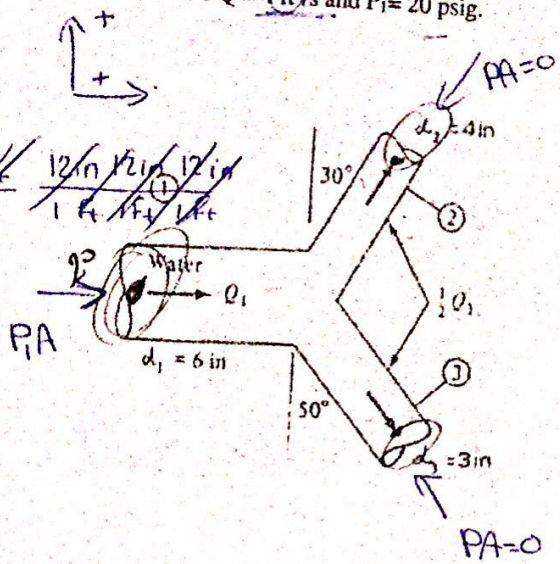
$F_y = (860)(0.05655)(7.2)(0.5)$

$= 175.1$

62.4 lb/ft² (32.2) 12in = 1 ft

oblem 2(30 Points): (e)

horizontal Y fitting in the figure below splits Q into two equal flow rates. At section 1 Q = 4 ft³/s and P₁ = 20 psig.



$A_1 = \frac{\pi}{4}(6)^2$

$= 28.3\ in^2$

$Q = 4\ ft^3/s = \frac{4\ ft^3}{s} \times \frac{12in}{1\ ft} \frac{12in}{1\ ft} \frac{12in}{1\ ft}$

$A_2 = \frac{\pi}{4}(4)^2$

$= 12.6\ in^2$

$Q = V_1 A_1$

$V_2 = V_1$

$A_3 = \frac{\pi}{4}(3)^2$

$= 7.1\ in^2$

$V_2 = V_3$

$20\ \frac{lb}{in^2} \times \frac{12in}{ft} \frac{12in}{ft}$

$= 2880\ lb/ft^2$

$Q_1 = Q_2 + Q_3$ $\quad Q_2 = Q_3 = \frac{1}{2}Q_1$

$V_1A_1 = V_2A_2 + V_3A_3$

$Q_1 = Q_2 + Q_3$

$Q_1 = \frac{1}{2}Q_1 + \frac{1}{2}Q_1$

$Q_2 = \frac{1}{2}V_1A_1$

$Q_2 = 14.15V_1$

$V_2A_1 = 14.15V_1$

$V_2 = 1.12V_1$

$Q_3 = \frac{1}{2}V_1A_1$

$\frac{V_3A_3}{7.1} = \frac{\frac{1}{2}V_1(28.3)}{7.1}$

$V_3 = 1.99\ V_1$

$Q = \frac{4ft^3}{s} \times \frac{12in}{1ft} \frac{12in}{1ft} \frac{12in}{1ft}$

$Q = 6912\ in^3/s$

$6912 = V_1(28.3)$

$V_1 = 244.24\ in/s$

$V_2 = 273.55\ in/s$

Good Luck!!!!!!

$V_3 =$

$\Sigma F_x = (\dot{m}V_2 \sin 30 + \dot{m}V_3) - (\dot{m}V_1)$

$\Sigma F = \dot{m}V_2 \cos 30 + \dot{m}V_3 \sin 50$