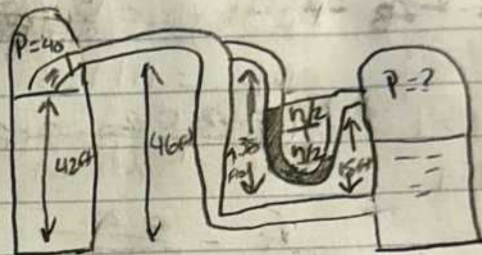
Aaliyah Ashley 3/15/24

Part A:

Purpose: 1) Determine the force magnitude and location on a blind flange to be installed on the oppsite side of the pipeline inlet in the tank on the right.
2) Determine the total horizontal and vertical forces in the whole pipe-elbows-value system.
3) Find the pressure drop across the nozzle.
4) Determine the pressure increment after closing the pipe suddenly.

Drawings and diagrams:



Sources: Mott Robert, Untener Joseph, Applied Fluid mechanics 8th edition, Pearson Education

Design considerations: Incompressible fluids, Isothermal process

Data and variables: $T = 77F$, $P = 40$ psig, $h = 36$ ft, $D = 2$ in, $Q = 150$ gpm $= 0.33\ ft^3/s$, $r = 0.5$, $E = 200$ gpa

Procedure: 1) set a refence point than use the equation for force to find force magnitude.
2) I will use the vertical force equation and horizontal force equation to find vertical and horizonatal force. Also use Bernoulli's equation to find the different pres
3) I would use bernoullis equation to find the pressure drop.
4) First I would calculate the thickness of the pipe in equation 11-9. than using the thickness to find the pressure of the pipe if suddenly closed and verify there is no cavitation.

1) $F_x = \rho Q(v_2 - v_1)$ $\quad \rho = 1.53\ \text{slugs/ft}^3$ $\quad 2\text{in} = 0.1667$

$A = \frac{\pi}{4}(2)^2 = 3.14\ \text{in}^2 = 0.261\ \text{ft}^2$

$V = \frac{0.33}{0.26} = 1.27\ \text{ft/s}$ $\quad V_2 = \frac{4(0.33)}{\pi(0.1667)^2} = 15.12\ \text{ft/s}$

$$\frac{P_1}{\gamma_{air}} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma_{air}} + \frac{V_2^2}{2g} + Z_2 + h_L$$

$$P_1 = P_2 + \gamma_{air}\left[(Z_2 - Z_1) + \frac{V_2^2}{2g} + h_L\right]$$

$h_{L\,pipe} = f\frac{L}{D_1}\frac{V_2^2}{2g}$ $\quad Re = \frac{VD}{\nu} = \frac{15.12(0.1667)}{1.37\times10^{-5}} = 1.846\times10^5$

$D/\varepsilon = 1111.3$

$f = 0.03939$

$f_T = 0.01914$

$$f = \frac{0.25}{\left[\log\left(\frac{1}{3.7(D/\varepsilon)} + \frac{5.74}{Re^{0.9}}\right)\right]^2}$$

$$f_T = \frac{0.25}{\left[\log\left(\frac{1}{3.7(D/\varepsilon)}\right)\right]^2}$$

$= 0.6393 \times \frac{110}{0.1667}\frac{(15.12)^2}{2\times32.2}$

$= 92.06\ \text{ft}$

$K_{valve} = 8f_T$

$K_{elbow} = 30f_T$

$K_{ent} = 0.5$

$h_{L\,ent} = 0.5 \times \frac{(15.12)^2}{2\times32.2} = 1.77\ \text{ft}$

$h_{L\,elbows} = 2\times30\times0.01914\times\frac{(15.12)^2}{2\times32.2} = 4.08\ \text{ft}$

$h_{L\,valve} = 8\times0.01914\ \frac{(15.12)^2}{2\times32.2} = 0.544\ \text{ft}$

$h_{total} = 98.45\ \text{ft}$

$P_1 = 40\frac{\text{lb}}{\text{ft}^2} + 49.01\frac{\text{lb}}{\text{ft}^3}\left[20 + \frac{(15.12)^2}{2\times32.2} + 98.45\right]\frac{1\ \text{ft}^2}{144\ \text{in}^2}$

81.51 psig

$F_x = \rho Q(v_2 - v_1) = 1.53\ \text{slugs/ft}^3 \times 0.33(15.12\ \text{ft/s} - 1.27)$

$\boxed{F_x = 6.99\ \text{lb}}$

2) $Q = 150\,gpm = 0.33\,ft^3/s$ $R = 1.840 \times 10^5$

$f = 0.03939$

$h_{L\,horizontal} = 0.03939\left(\frac{36}{0.1667}\right)\left(\frac{15.12^2}{2 \times 32.2}\right) = 30.26\ ft$

$h_{L\,vertical} = 0.03939\left(\frac{38}{0.1667}\right)\left(\frac{15.12^2}{2 \times 32.2}\right) = 31.88\ ft$

$h_{L\,ent} = 1.77\ ft$

$h_{L\,elbows} = 4.08\ ft$

$h_{L\,valve} = 0.544\ ft$

$h_{L\,total} = 68.474\ ft$

$P_1 = 46\frac{lb}{in^2} + 49.01\frac{lb}{ft^3}\left[20 + \frac{(15.12)^2}{2 \times 32.2} + 68.474\right] = 4549.17\ lb/ft$

$R_x = \rho Q v_1 + P_1 A_1$

$R_y = \rho Q v_2 + P_2 A_2$

$R_x = 1.53(0.33)(15.12) + (4549.17)(0.261) = \boxed{1194.95\ lb}$

$4549.12 = P_2 + 49.01\left(20 + \frac{15.12^2}{2 \times 32.2} + 6.424\right) = 151.789\ lb/ft$

$R_y = 1.53(0.33)(15.12) + (151.789)(0.261) = \boxed{47.25\ lb}$

3) Re $= 1.804 \times 10^5$ Flow of Nozzle $= 0.5$

$C = 0.9975 - 6.53\sqrt{\beta / N_R}$ $C = 0.9975 - 6.53\sqrt{0.5 / 1.804\times10^5}$

$B = d/D$ $= 0.9866$

back of book

$V_1 = C\sqrt{\dfrac{2g(P_1-P_2)/\gamma}{(A_1/A_2)^2-1}}$ $P_1 - P_2 = \dfrac{\left(\frac{V_1}{C}\right)^2 \cdot \gamma\,[(A_1/A_2)^2-1]}{2g}$ $= \left(\dfrac{15.12}{0.9866}\right)^2 \cdot \dfrac{49.6\,[(0.1723)/(0.0233)]^2 - 1}{2\times32.2}$

$P_1 - P_2 = 8970\ \text{lb/ft} = \boxed{62.29\ \text{psig}}$

4) Equation 11-9) $t = \dfrac{PD}{2(SE+PY)}$

$\Delta P = \rho C V$ $C = \dfrac{\sqrt{E_0/\rho}}{\sqrt{1 + \frac{E_0 D}{E\delta}}}$

$P_{max} = P_{op} + \Delta P$

$C = \dfrac{\sqrt{18270000/1.53}}{\sqrt{1 + \frac{18270000\,(0.1723)}{(1200)(0.0108)}}} = 3341$

$\Delta P = 1.53(3341)(15.12) = 77289.36$

$P_{max} = 4549.17 + 77289.36 = 81838.53\ \text{lb/ft}^3$

568.32 psig

$t = \dfrac{PD}{2(SE+PY)}$ $= \dfrac{568.32(2)}{2(\ldots(0.8) + 568.32(0.70))}$ $= \boxed{0.0317}$

Thickness in book: 0.154

the pipe won't fail

Summary: 1) the blind flange is located in the center. The force magnitude is 16 441lb
2) The horizontal and vertical forces were found as well as pressures
3) for the drop in pressure it dropped to 62.29 psig
4) what was found showed the pipe would not fail.

Materials: Ethal alchol

Analysis: 1) blind flange located was found and the force magnitude
2) The multiple pressures and analysis were found
3) The pressure drop of the nozzle was found and drop around 20psig.
4) The pipe won't fail found out by using equations from notes and the notebook

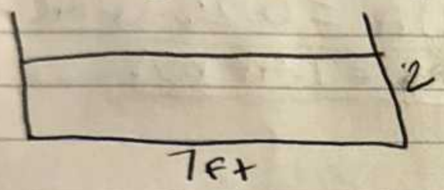
Part B:

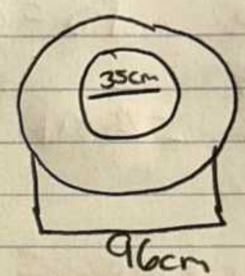
Purpose: 5) Determine the flow rate required

6) Determine the Drag force a four yearold Child would experience

7) Determine how deep into the water the lazy river would go for someone who 220lb Find if the lazy river tube is Stable with the Person on it.

Drawings and Design:





Sources: Mott Robert, Untenier Joseph, Applied Fluid mecahnics 8th edition

Design considersations: steady State, Isothermal Process, Incompressible Fluid

Data and Variable: External diameter: 96, Inside diametr 35

$w = 220lbs$

Procedure; 5) To Find the flow rate I will use the $Q = \frac{1.49}{n} A S^{1/2} R^{2/3}$

6) For this question I will use the drag force equation $F_D = C_D\left(\frac{\rho v^2}{2}\right)A$ to find the drag force a 4-year old would expreience

7) I will use $MB = I/V_d$ to see if the person is Stable. Also $V_d = \frac{w}{\gamma}$ for the Volume displacement

$T = 70°F$

5) $Q = \frac{1.49}{n} A S^{1/2} R^{2/3}$

$A = b \cdot y = 8 \times 1 = 8 ft$

$R = \frac{by}{b+2y} = \frac{8 \times 1}{8 + 2(1)} = 0.8 ft$

$Q = \left(\frac{1.49}{0.013}\right) \cdot 8 \cdot 0.8^{2/3} \cdot 0.001^{1/2} = \boxed{24.99 \ ft^3/s}$

6) D of kid $= 2$ ft

$V = \frac{Q}{A} = \frac{24.99}{8} = 3.12 \ ft/s$

$T = 70°F$

$N_R = \frac{VD}{\nu} = \frac{3.12 \ ft/s \cdot 2}{1.05 \times 10^{-5}} = 5.942 \times 10^{5}$

$C_D = \frac{2}{8} \cong 0.25$

$F_D = C_D \cdot (\rho V^2/2) A = 0.25 \cdot (1.94(3.12)^2/2) 3.14$

$\boxed{F_D = 7.41 \ lb}$

A of kid $= \frac{\pi (2)^2}{4} = 3.14$

7) $w = 220 lb + 4.019 lb = 224.019 lb$

$2 \times q = 4.019 lb$

$F_b = \gamma_f V_d = V_d = \frac{F_b}{\gamma_f} = V_d = \frac{w}{\gamma_f} = \frac{224.019}{62.3} = 3.597 \ ft$

$V = \frac{\pi H (3.15^2 - 1.15^2)}{4}$

$3.597 = \frac{\pi H (3.15^2 - 1.15^2)}{4}$

$14.388 = 27.018 H$

$H = 0.5325 \ ft$

$C_D = \frac{1}{2} = 0.5$

$MC = I/V_D$

$I = \frac{\pi (3.15^4 - 1.15^4)}{64}$

$MB = \frac{4.75}{3.597} = 1.321$

$I = 4.75$

$MC = 0.5 + 1.321 = \boxed{1.821 \ ft}$

Summary: 5) The water flow rate required is
24.99 ft^3/s
(6) The drag force a 4-yearo ld
would experience is 7.41 lb
7) The lazy river goes 0.5325 ft
in to the water for somonone who
ways 220lbs.

matrials: water

Analysis. 5) Depending on the height and
width that was chosen. with
find the area and R which helps
determine the flow rate of water.
(6) The kid was assume to be a
cylinder and had to find the diameter
of the kid and area. to find the
force the 4-yearold would experience.
7) The lazy river tube with the person
would be stable because metacenter
is above the water.