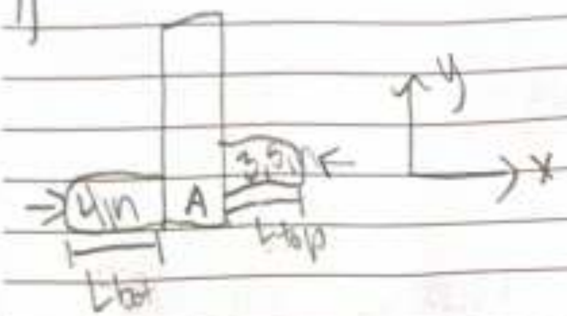
MET 330 Test 3 Micah Ferguson UIN 01184025

1)



design
incompressible
isothermal
steady state

data
4in sch 40 Lbot
3.5 in sch 40 Ltop
$T = 71°F$, $\rho = .0747\ lb/ft^3$
$V = 80 mi/h = 117.3\ ft/s$
UIN 01184025 1st from right
$L_{bot} = 3ft$
$L_{top} = 6ft$

purpose
compute the moment of the pole compressed by 2 cylinders at point A.

calculations

$$\Sigma F_x = \rho Q (V_{x2} - V_{x1})$$

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + h$$

$$R_x = \rho Q (v_2 + v_1)$$

$$V_2 = \sqrt{v_1^2 + 2g(z_1 - z_2)}$$

$$V_2 = 108.6\ ft/s$$

$$R_x = \rho Q \sqrt{v_1^2 + 2g(z_1 - z_2)} + v_1$$

$$Q = V\left(\frac{\frac{\pi}{4} D^2}{2}\right) = 117.3 \frac{\pi}{8}\left(\frac{4.5}{12}\right)^2 = 6.48\ ft^3/s$$

$$R_x = .0747\ lb/ft^3 (6.48\ ft^3/s)\left(\sqrt{117.3\ ft/s^2 + 2(9.81)\left(\frac{4}{12}\right)} + 117.3\right)$$

$$R_x = 57.0\ lb$$

$\Sigma m = 0$

$R_x(d_{rx}) + \rho Q V_2(d_2) - \rho Q V(d_1) = 0$

$$d_{rx} = \frac{-\rho Q V_2(d_2) + \rho Q V_1 d_1}{R_x}$$

$$= \frac{-.0749(6.48)108.6(3.5) + .0747(6.48)117.5(4)}{57.03}$$

$$d_{rx} = 0.761 \text{ in}$$

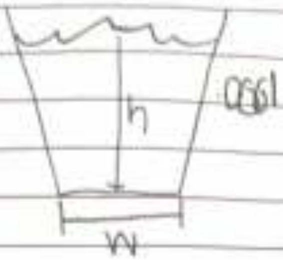
$$m = R_x(d_{rx}) = 57.03\left(\frac{0.761}{12}\right) = 3.617 \text{ ft/lb}$$

Summary
The reaction forced is 57.03 lb and the produced moment is 3.617 ft/lb.

material
air
4in Schedule 40 steel pipe
3.5 in schedule steel pipe

Source
Mott, R, Untener, JA, "Applied Fluid Mechanics," 7th edition, Pearson Education Inc (2015)

2)



material
water

design considerations
incompressible fluid
open channel

data
UIN 01184625 2nd from right
W = 18 ft
Q = 356 ft^3/s
S = 0.6001
n cement = 0.017 table 14.1

purpose
Calculate the height of the open channel with the are provided. Using mannings equation and area we can get h

calculations

$$AR^{2/3} = \frac{nQ}{1.49S^{1/2}}$$

$$A = 12(h) + X(h/2) = 12h + h^2$$

$$R = \frac{A}{WP} = \frac{A}{2\sqrt{2}h^2 + 12}$$

$$12h + h^2\left(\frac{(12h + h^2)}{(2\sqrt{2}h + 12)}\right)^{2/3} = \frac{nQ}{1.49(S)^{1/2}}$$

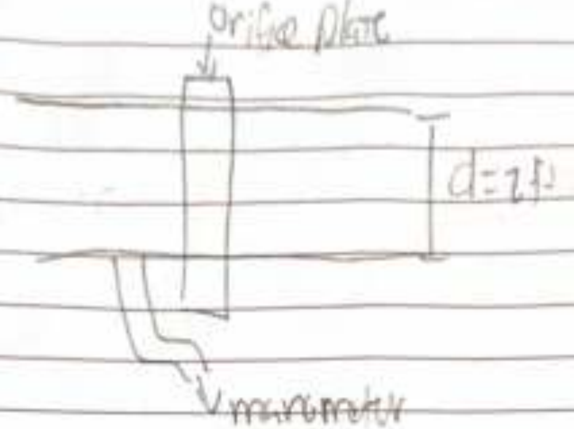
$$\frac{(12h_1 + h_1^2)^{5/3}}{(2\sqrt{2}h_1 + 12)^{2/3}} = \frac{0.017(350)(1^{2/3})}{1.49(0.0001)^{1/2}} = 399.3$$

Using excel h = 0.56785 ft

Summary
By using mannings equation getting both sides solved for and using excel for the percentage difference the height is calculated to 0.56785 ft for a 0.061% difference.

Source
Mott R, Untener JA, "Applied Fluid Mechanics, 7th edition Pearson

3)



procedure

compute the reading of the mercury manometer

$$V_1 = C\sqrt{\frac{2gh(\gamma_m - \gamma_w) - 1}{(A_1 - A_2)^2 - 1}}$$

$$h = \left(\frac{V_1}{C}\right)^2 \left(\frac{(D/d)^4 - 1}{2g((\gamma_m/\gamma_w) - 1)}\right)$$

$$= \left(\frac{9.57}{.9965}\right)^2 \left(\frac{(2/1)^4 - 1}{2(32.2)\left(\frac{844.9}{62.4} - 1\right)}\right)$$

$$h = 92.229(15/807.58)$$

$$h = 1.713 \text{ ft}$$

design

incompressible

isothermal

steady state

data

$\beta = 0.5$

UIN 3rd from right

D184D25

$Q = 12000 \text{ gpm} = 26.74 \text{ ft}^3/\text{s}$

$D = 24''$ Sch 40 = 2 ft

$A = 2.792 \text{ ft}^2$

$\gamma_m = 844.9 \text{ lb/ft}^3$

$\gamma_w = 62.4 \text{ lb/ft}^3$

$g = 32.2 \text{ ft/s}^2$

$$C = .9975 - 6.53\sqrt{\beta/Re}$$

$$= .9975 - 6.53\sqrt{.5/2.14\times10^7}$$

$$= .9965$$

$$Re = \frac{VD}{\nu} = \frac{9.57(2\text{ft})}{8.94\times10^{-7}}$$

$$= 2.14\times10^7$$

$$V = \frac{Q}{A} = \frac{26.74}{2.792} = 9.57 \text{ ft/s}$$

$\beta = d/D$

$d = \beta(D) = .5(2\text{ft})$

$= 1 \text{ ft}$

Summary

The mercury manometer rang was found by using the equation to solve for hight. The rang is 0-1.713 ft.

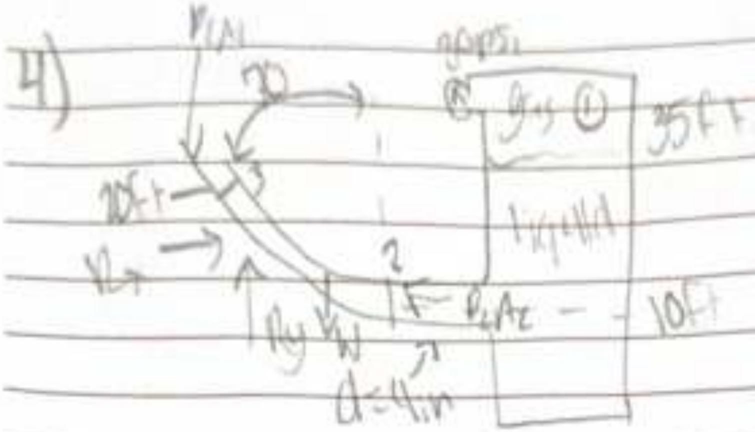
Material

Mercury

Source

Mott R., Untener, J.A., "Applied Fluid Mechanics", 7th edition
Pearson Education 2015

4)



design
incompressible
isothermal
steady state

data
$\gamma = 55\,lb/ft^3$
4 in 0.1184025 4in
from right
$L_{curved} = 40\,ft$
$p_1 = 30\,psi = 4320\,lb/ft^2$
$\rho = 1.7\,slugs/ft^3$

procedure
compute the force on the curved pipe and provide the magnitude and direction.

solutions

$F_x = \rho Q(v_2 - v_1)$

$R_x = p_1A_1 - p_2A_2\cos 70 - \rho Q v_2 \cos 70 + \rho Q v_1$

$F_y = \rho Q(v_{2y} - v_{1y})$

$R_y = p_2A_2\sin 70 - \rho Q v_2 \sin 70$

$A_1 = \frac{\pi}{4} 4in^2 = 0.0218$ $A_2 = \frac{\pi}{4} 3in^2 = 0.049\,ft^2$

$p_2 = p_1 + \gamma(v_1^2 - v_2^2)/2g$

$p_1 A_1 = 4320(.0218)$

$p_2 A_2 = 90.24(.049)$

$\rho Q v_1 = 55(1.129)51.8$

$\rho Q v_2 = 55(1.129)23.05$

$$V = \sqrt{\frac{R_x}{\rho A(\cos 70+1)}} = \frac{\sqrt{4320}}{\sqrt{55(.0218)(\cos 70+1)}} = 51.8 \text{ ft/s}$$

$$V_2 = V_1\left(\frac{A_1}{A_2}\right) = 51.8\left(\frac{.0218}{.049}\right) = 23.05 \text{ ft/s}$$

$$p_2 = p_1 + \gamma(v_1^2 - v_2^2)/2g$$

$$= 4320 + 55(51.8 - 23.05)/2(32.2) = 90.24$$

$$Q = AV = 51.8(.0218) = 1.129$$

$R_x = 4320(.0218)\sin 70 - 55(1.129)(23.05)\cos 70 + 55(1.129)51.8$

$R_x = 281.548$ lb/ft positive right

$R_y = 90.24(.049)\sin 70 - 55(1.129)(23.05)\sin 70$

$R_y = 1340.81$ lb/ft down negative

Material
Curved pipe

Source
Mott R, Untener, JA, "Applied Fluid Mechanics," 7th edition Pearson Education Inc (2015)

Summary
The force on the length of the curved pipe in the x direction is 2815.48 lb/ft in the positive direction. The force in the y direction is negative 1340.8 lb/ft

design
incompressible
isothermal
steady state

data
UIN 01134835 5th from right
$D = 305mm$
$V = 1.0m/s$
$\sigma = 10mm$
$E = 2\times10^{7}\ N/cm^{2}$
$E_0 = 2.03\times10^{5}\ N/cm^{2}$
$\rho = 1000\ kg/m^{3}$

purpose
Calculate the pressure increment when the valve suddenly closes

Calculations

$$\Delta p = \rho v c$$

$$c = \frac{\sqrt{E_0/\rho}}{\sqrt{1+\frac{E_0(D)}{E(\sigma)}}} = \frac{\sqrt{2.03\times10^{9}/1000}}{\sqrt{1+\frac{2.03\times10^{9}(305mm)}{2\times10^{7}(10mm)}}} = 1639.52 m/s$$

$$\Delta p = 1000 kg/m^3 (1639.52)1.0m/s = 1.64\times10^6 Pa$$

material
steel pipe

source
Mott, R., Untener, JA, Applied Fluid Mechanics, 7th edition Pearson education 2015)

Summary
The pressure increment before the valve closes is 1.64×10^6 Pa.

Honor Code: Meda Aerguson