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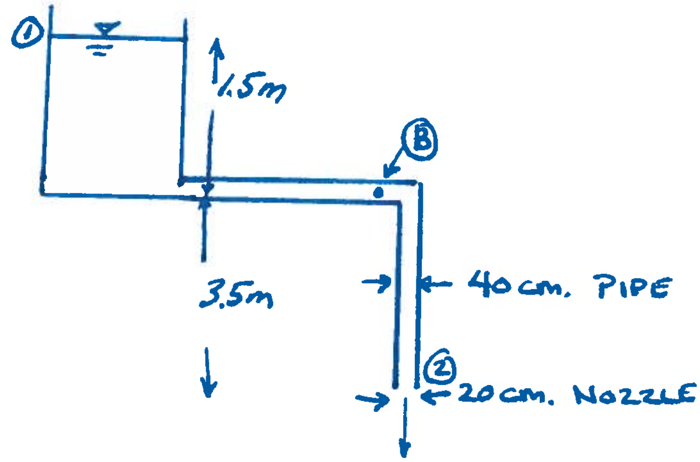
AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852
TEXAS TECH UNIVERSITY
J.H. MURDOUGH
ASCE STUDENT CHAPTER

NAME SOLUTION DATE 27MAR14
COURSE CE3305 SHEET 1 OF 8

7.25 FIND Q IN PIPE & PRESSURE AT (B). NEGLECT HEAD LOSS
$\alpha = 1.0$ EVERYWHERE



GOVERNING EQUATIONS

ENERGY EQUATION, CONTINUITY (FOR Q)

SOLUTION

RESERVOIR TO NOZZLE

NEGLECT FRICTION

$$\underbrace{\cancel{\frac{p_1}{\gamma}}}_{0\ gage} + \underbrace{\cancel{\frac{\alpha V_1^2}{2g}}}_{\sim 0} + z_1 + \cancel{h_p}^{0} = \underbrace{\cancel{\frac{p_2}{\gamma}}}_{0\ gage\ (in\ jet)} + \frac{\alpha V_2^2}{2g} + \cancel{z_2}^{0} + \cancel{h_L}^{0} + \cancel{h_T}^{0}$$

$$z_1 = \frac{V_2^2}{2g} \qquad z_1 = 1.5m + 3.5m = 5m.$$

$$V_2 = \sqrt{2g\, z_1} = \sqrt{2(9.8 m/s^2)(5m)} = 9.9 m/s$$

CONTINUITY FOR Q

$$Q = VA = (9.9 m/s)\left(\frac{\pi (0.2m)^2}{4}\right) = \underline{\underline{0.311\ m^3/s}} \leftarrow Q$$

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7.25 (CONTINUED)

RESERVOIR TO POINT (B)

$$\cancelto{0}{\frac{p_1}{\gamma}} + \cancelto{0}{\frac{V_1^2}{2g}} + z_1 + \cancelto{0}{h_p} = \frac{p_B}{\gamma} + \frac{V_B^2}{2g} + z_B + \cancelto{0}{h_L} + \cancelto{0}{h_T}$$

$$z_1 = \frac{p_B}{\gamma} + \frac{V_B^2}{2g} + z_B$$

$z_1 = 5m$
$z_B = 3.5m$

$$V_B = \frac{Q}{A_B} = \frac{0.311 m^3/s}{\frac{\pi (0.4m)^2}{4}} = 2.48 m/s$$

$$\frac{p_B}{\gamma} = (z_1 - z_B) - \frac{V_B^2}{2g}$$

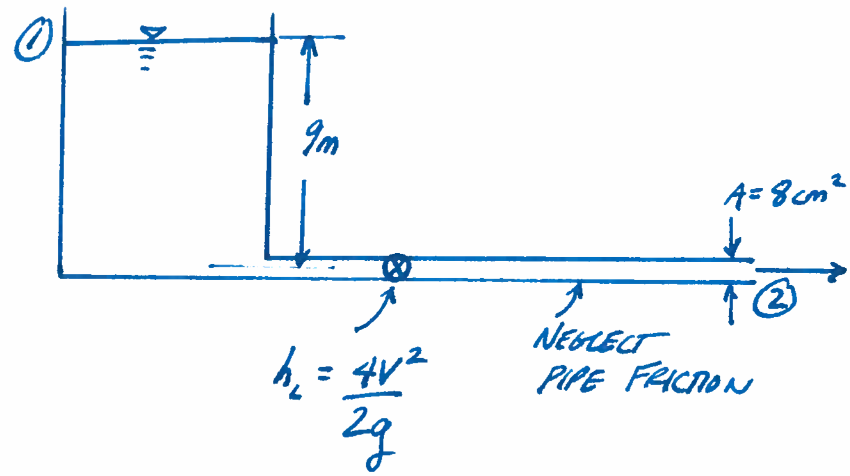
$$\frac{V_B^2}{2g} = \frac{(2.48 m/s)^2}{2(9.8 m/s^2)} = 0.312m$$

$$p_B = \gamma\left[(z_1 - z_B) - \frac{V_B^2}{2g}\right]$$

$$= 9800 N/m^3 \left[(5m - 3.5m) - 0.312m\right] = 11,642 N/m^2$$

$$= \underline{\underline{11.6 kPa}} \leftarrow p_B$$

7.34 FIND Q. $K = 1.0$ EVERYWHERE. NEGLECT PIPE FRICTION, BUT INCLUDE VALVE LOSS



EQUATIONS

ENERGY, CONTINUNITY.

SOLUTION

ENERGY FROM 1 TO 2

$$\cancel{\frac{p_1}{\gamma}} + \cancel{\frac{V_1^2}{2g}} + z_1 + \cancel{h_p}^{\,0} = \cancel{\frac{p_2}{\gamma}} + \frac{V_2^2}{2g} + \cancel{z_2} + h_L + \cancel{h_T}^{\,0}$$

0 gage $\quad \approx 0 \quad$ 0 gage $\quad$ 0 – DATUM

$$z_1 = \frac{V_2^2}{2g} + h_L = \frac{V_2^2}{2g} + \frac{4V_2^2}{2g} = \frac{5V_2^2}{2g}$$

SOLVE FOR V_2

$$\sqrt{\frac{2g\,z_1}{5}} = V_2$$

$$\therefore \sqrt{\frac{2(9.8\,m/s^2)(9\,m)}{5}} = 5.94\,m/s$$

CONTINUNITY TO RECOVER Q

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7.34 (CONTINUED)

$Q = V \cdot A$

$$= (5.94 \, m/s)(8 \, cm^2)\left(\frac{1m}{100cm}\right)\left(\frac{1m}{100cm}\right)$$

$$= \underline{\underline{0.00475 \, m^3/s}} \longleftarrow Q$$

7.40 FOR SIPHON SYSTEM, $h_{AB} = \frac{1.1V^2}{2g}$

PIPE AREA IS $8 \cdot 10^{-4} m^2$

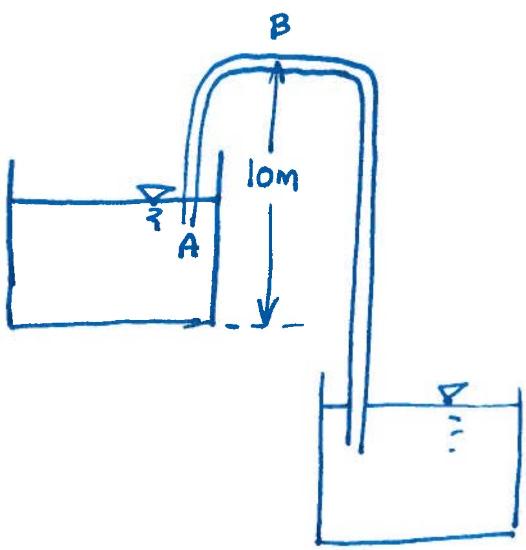
Q IS $8 \cdot 10^{-4} m^3/s$

WHAT IS ELEVATION OF UPPER RESERVOIR FOR CAVITATION AT POINT B

$p_{vap} = 1.23 kPa$

$p_{atm} = 100 kPa$

$\alpha = 1.0$ ALL LOCATIONS



EQUATION(S)

ENERGY; DEFN. CAVITATION
CONTINUITY

SOLUTION

$Q = VA$ CONTINUITY, SOLVE FOR V

$$V = \frac{Q}{A} = \frac{8 \cdot 10^{-4} m^3/s}{8 \cdot 10^{-4} m^2} = 1 m/sec$$

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COURSE CE3305 SHEET 6 OF 8

ENERGY FROM A TO B

$$\frac{p_A}{\gamma} + \frac{V_A^2}{2g} + z_A = \frac{p_B}{\gamma} + \frac{V_B^2}{2g} + z_B + h_L$$

$\frac{V_A^2}{2g} \to 0$

$$\frac{100 kPa}{9800 N/m^3} + 0 + z_A = \frac{1.23 kPa}{9800 N/m^3} + \frac{V_B^2}{2g} + \frac{1.1 V_B^2}{2g} + 10m$$

$$z_A = \frac{1.23 \cdot 10^3 Pa - 100 \cdot 10^3 Pa}{9800 N/m^3} + \frac{(1 m/s)^2}{2(9.8 m/s^2)} + \frac{1.1 (1 m/s)^2}{2(9.8 m/s^2)} + 10m$$

$$= -10.078m + 0.1071 + 10.0$$

$$= \underline{\underline{0.029 m}}$$

z_A (ALMOST EMPTY

— ABOUT 1-INCH!

7.48

PUMP AS SHOWN

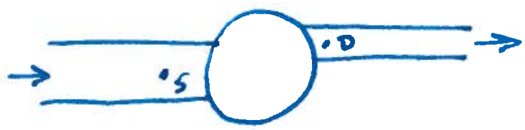
- SUCTION PIPE 12in.
- DISCHARGE PIPE 6in.

$Q = 3.0\,cfs$

$p_s = 5\,psi$

$p_d = 55\,psi$

WHAT IS POWER SUPPLIED ?



EQUATIONS

ENERGY ACROSS PUMP, ASSUME NEGLIGIBLE Δz

$$\frac{p_s}{\gamma} + \frac{V_s^2}{2g} + \cancel{z_s} + h_p = \frac{p_d}{\gamma} + \frac{V_d^2}{2g} + \cancel{z_d} + \underbrace{\cancel{h_F}}_{0}$$

$$z_s \approx z_d$$

$$V_s = \frac{Q}{A_s} = \frac{3.0\,cfs}{\frac{\pi(1ft^2)}{4}} = 3.82\,ft/s$$

$$V_d = \frac{Q}{A_d} = \frac{3.0\,cfs}{\frac{\pi(0.5ft)^2}{4}} = 15.27\,ft/s$$

$$\frac{V_s^2}{2g} = \frac{(3.82\,ft/s)^2}{2(32.2\,ft/s^2)} = 0.226\,ft$$

$$\frac{V_d^2}{2g} = \frac{(15.27\,ft/s)^2}{2(32.2\,ft/s^2)} = 3.62\,ft$$

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7.48 (CONTINUED)

$$\frac{p_s}{\gamma} = \frac{\frac{5\,lbf}{in^2} \cdot \frac{144\,in^2}{1\,ft^2}}{62.4\,lbf/ft^3} = 11.54\,ft \qquad \frac{p_d}{\gamma} = \frac{\frac{55\,lbf}{in^2} \cdot \frac{144\,in^2}{1\,ft^2}}{62.4\,lbf/ft^3} = 126.9\,ft$$

SUBSTITUTE SOLVE FOR h_p

$$h_p = \frac{p_d}{\gamma} - \frac{p_s}{\gamma} + \frac{V_d^2}{2g} - \frac{V_s^2}{2g}$$

$$= 126.9\,ft - 11.54\,ft + 3.62\,ft - 0.226\,ft = 118.77\,ft$$

$$P = Q\gamma h = \left(\frac{3\,ft^3}{s}\right)\left(\frac{62.4\,lbf}{ft^3}\right)(118.77\,ft)$$

$$= 22235.06\,\frac{lbf-ft}{sec} \times \frac{1\,hp}{550\,\frac{lbf-ft}{sec}}$$

$$= \underline{\underline{40.43\,hp}} \longleftarrow \text{POWER}$$