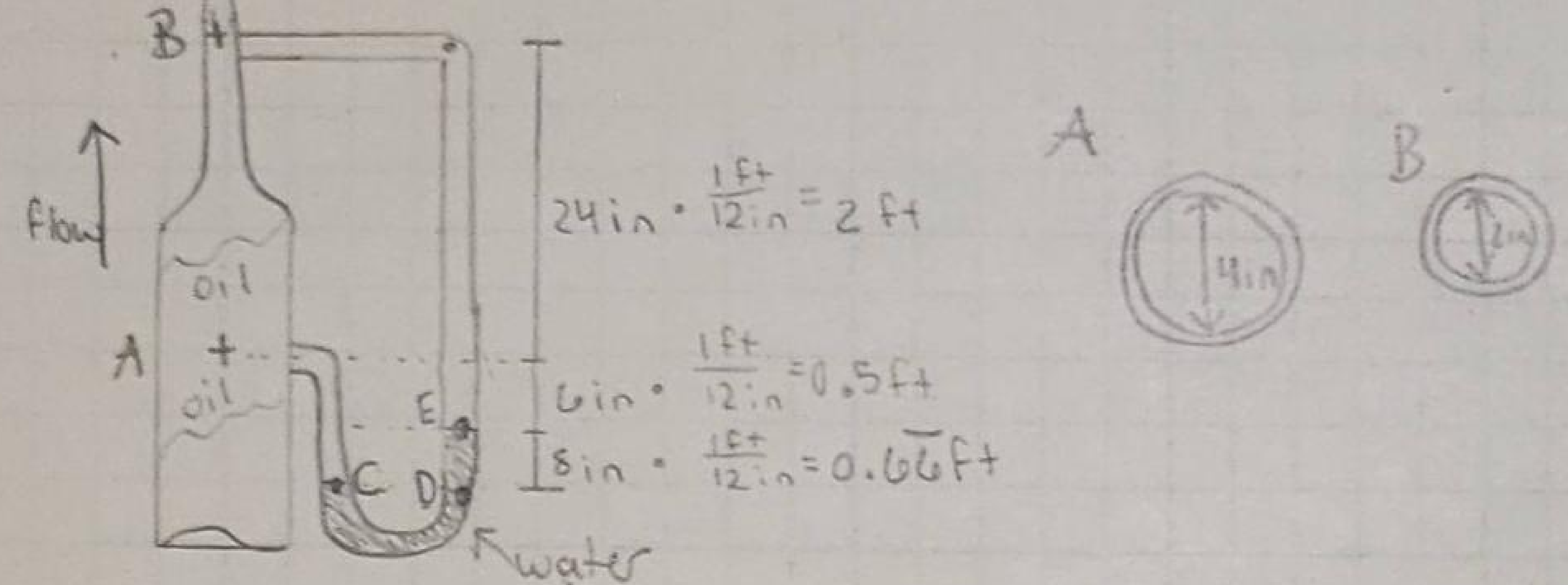
82



Given: $\gamma_{oil} = 55.0 \frac{lb}{ft^3}$, $\gamma_{water} = 62.4 \frac{lb}{ft^3}$, $d_A = 4in$, $d_B = 2in$, $sg_{oil} = 13.54$

Find: V_A

Solution: $\frac{P_A}{\gamma_{oil}} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma_{oil}} + \frac{V_B^2}{2g} + Z_B$

$Q_{in} = Q_{out} \Rightarrow Q_A = Q_B$

$V_A A_A = V_B A_B$

$A_A = \frac{\pi \cdot d_A^2}{4} = \frac{\pi (4)^2}{4} = 12.566 in^2$

$A_B = \frac{\pi \cdot d_B^2}{4} = \frac{\pi (2)^2}{4} = \pi in^2$

$\therefore V_B = \frac{V_A A_B}{A_A} = \frac{12.56 in^2 \cdot V_A}{\pi in^2}$

$V_B = 4V_A$

$\frac{P_A}{\gamma_{oil}} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma_{oil}} + \frac{(4V_A)^2}{2g} + Z_B$

$\left(\frac{P_A}{\gamma_{oil}} - \frac{P_B}{\gamma_{oil}}\right) + (Z_A - Z_B) = \frac{(4V_A)^2 - V_A^2}{2g}$

$\frac{16V_A^2 - V_A^2}{2g} = \frac{P_A - P_B}{\gamma_{oil}} + (Z_A - Z_B)$

$\frac{V_A^2(16-1)}{2g} = \frac{P_A - P_B}{\gamma_{oil}} + (Z_A - Z_B),$

$V_A^2 = \left(\frac{2g}{15}\right)\left(\left(\frac{P_A - P_B}{\gamma_{oil}}\right) + (Z_A - Z_B)\right)$

$V_A = \sqrt{\left(\frac{2g}{15}\right) \cdot \left(\left(\frac{P_A - P_B}{\gamma_{oil}}\right) + (Z_A - Z_B)\right)}$

$\cdot P_C = P_D$

$P_C = P_A + \gamma_{oil}(\Delta h) = P_A + (55 \frac{lb}{ft^3})(.66ft + 0.5ft)$

$P_C = P_A + 64.163 \frac{lb}{ft^2} = P_D$

$P_E = P_D - \gamma_w(\Delta h) = P_A + 64.163 - (62.4 \frac{lb}{ft^3})(.66 ft)$

$P_E = P_A + 22.563 \frac{lb}{ft^2}$

$P_B = P_E - \gamma_{oil}(\Delta h) = P_A + 22.563 \frac{lb}{ft^2} - (55 \frac{lb}{ft^3})(2 + 0.5ft)$

$P_B = P_A - 114.937 \frac{lb}{ft^2}$

$P_A - P_B = 114.937 \frac{lb}{ft^2}$

$V_A = \sqrt{\frac{2(32.2)}{15} \cdot \left(\frac{(114.937)}{55.0}\right) + (0-2)}$

$\left(\frac{ft}{s^2}\right)^{1/2} \cdot \left(\frac{lb/ft^3}{ft^2}\right)^{1/2} + \left(\frac{ft}{1}\right)^{1/2}$

$V_A = \sqrt{(4.293)(2.09018) - 2}$

$\boxed{V_A = 0.622 \frac{ft}{s}}$

Lecture review

Chris Betton

I was able to better utilize Bernoulli's equation by reviewing the solved problems on Blackboard. The manometer example helped me calculate pressures when moving between fluids. Manometers can be used to determine $(P_1 - P_2)$ which is also a part of Bernoulli's equation. The solutions also demonstrated how to use the energy balance equation in tandem with Bernoulli's, when certain characteristics of a system ar unknown.

Three key takeaways I had are:

1. Moving down in a manometer $=(+)$ increment of pressure, moving upward utilized a negative increment and moving w/ no change in height has no pressure change.
2. In a gravity driven system, most of the energy losses are due to loss of Potential energy at higher point.
3. To calculate the pressure difference across a pump we must start with reference points before & after the pump where we have known valus of elevation, velocities & pressures.

Tai Booker
MET 330
HW 1.3

Ch 6

79. Oil with a specific gravity of 0.90 is flowing downward through the venturi meter shown. If the manometer deflection h is 28 in, calculate the volume flow rate of oil.

$A_B V_B = A_A V_A$

$\frac{\pi D_B^2}{4} V_B = \frac{\pi D_A^2}{4} V_A$

$V_B = \left(\frac{D_A}{D_B}\right) V_A$

$V_B = \left(\frac{4}{2}\right)^2 V_A$

$V_B = 4 V_A$

$P_1 = P_2$

$P_A + \gamma_o z_A = P_B + \gamma_o \times (z_B - h) + \gamma_{Hg} \times h$

$P_A - P_B = \gamma_o (z_B - z_A - h) + \gamma_{Hg} h$

$\gamma_o = sg_{oil} \times \gamma_{water} = 0.9 \times 62.4$

$\gamma_o = 56.16 \text{ lb/ft}^3$

$\gamma_{Hg} = sg_{Hg} \times \gamma_{water} = 13.54 \times 62.4$

$\gamma_{Hg} = 844.896 \text{ lb/ft}^3$

$P_A - P_B = 56.16\left(z_B - z_A - 28 \times \left|\frac{1}{12}\right|\right) + 844.896 \times 28 \times \left|\frac{1}{12}\right|$

$P_A - P_B = 56.16(z_B - z_A) + 1840.38$

apply Bernoulli's equation b/w points A & B

$$\frac{P_A}{\gamma_o} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\gamma_o} + \frac{V_B^2}{2g} + z_B$$

$$\frac{P_A - P_B}{\gamma_o} + z_A - z_B = \frac{V_B^2 - V_A^2}{2g}$$

$$\frac{P_A - P_B + \gamma_o (z_A - z_B)}{\gamma_o} = \frac{V_B^2 - V_A^2}{2g}$$

$$\frac{[56.16(z_B - z_A) + 1840.38] + 56.16(z_A - z_B)}{56.16} = \frac{(4V_A)^2 - V_A^2}{2 \times 32.2}$$

$$\frac{1840.38}{56.16} = \frac{15 V_A^2}{64.4} \implies V_A = 11.86 \text{ ft/s}, \quad V_B = 47.44 \text{ ft/s}$$

volume flow rate

$Q = A_A V_A$

$$= \frac{\pi D_A^2}{4} \times V_A = \left[\frac{\pi \times \left(\frac{4}{12}\right)^2}{4}\right] \times 11.86 = 1.035 \text{ ft}^3/\text{s}$$

$\boxed{\text{The volume flow rate is } 1.035 \text{ ft}^3/\text{s}}$

m #2-I learned that the volumetric flow
al to gravity multiplied by the difference
uids specific gravity & the height differer
o fluids in the manometer divided by the
difference in the area of the pipe.

n #3-I learned the highest a jet of water su
essure differential of a tank will reach
height of the water in the tank

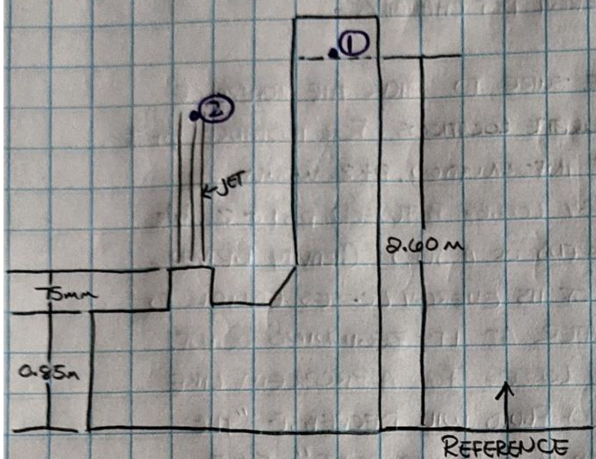
m #4-The power required by a pump is ec
c weight of a fluid multiplied by the volur
mes the height & length of the pipe all divi
mps efficiency.

HW 1.3
CH.6 #91

TEAM 7

MELANIE CRUZ CONTEE

91. TO WHAT HEIGHT WILL THE JET OF FLUID RISE FOR THE CONDITIONS SHOWN IN FIGURE 6.39?



GIVEN: $\gamma_w = 9.81\ kN/m^3$ (APPENDIX E)

PT 1

VELOCITY (v) AT PT 1 IS NEGLIGIBLE

PRESSURE AT AT PT 1 IS ATMOSPHERIC

PT 2

VELOCITY (v) AT PT 2 IS ZERO (HIGHEST POINT: AT REST)

PRESSURE AT PT 2 IS ATMOSPHERIC

$z_1 = 2.60M$

75mm = 0.075m

SOLUTION:

$$\frac{p_1}{\gamma} + z_1 + \frac{v_1^2}{2g} = \frac{p_2}{\gamma} + z_2 + \frac{v_2^2}{2g}$$

SOLVE FOR z_2

$$z_2 = \frac{p_1 - p_2}{\gamma} + \frac{v_1^2 - v_2^2}{2g} + z_1$$

$$= \frac{p_1 - p_2}{\gamma} + \frac{\cancel{v_1^2}^{\,0} - \cancel{v_2^2}^{\,0}}{2g} + z_1$$

$$z_2 = \frac{p_1 - p_2}{\gamma} + z_1$$

$$= \frac{\cancel{p_1}^{\,0psig} - \cancel{p_2}^{\,0psig}}{\gamma} + z_1$$

$$\boxed{z_2 = z_1}$$

THE HIGHEST POINT THE JET WILL REACH IS 2.60 M

WHAT I LEARNED:

WE HAVE TWO MAIN EQUATIONS THAT ARE ADDRESSED, BERNOULLI'S AND MASS FLOW RATE. BERNOULLI'S EQUATION IS DERIVED FROM NAVIER-STOKES EQUATION. BERNOULLI'S EQUATION IS NOT ONLY A BALANCE OF FLUID FORCES BUT ALSO AN ENERGY BALANCE EQUATION. THIS IS DUE TO DENSITY AND INTERNAL ENERGY NOT CHANGING.

WHEN WORKING OUT PROBLEMS, BE SURE TO PICK THE REFERENCE POINTS BEING USED AT THE MOST ACCURATE LOCATIONS. FOR INSTANCE, PT 1 IS WHERE WE WOULD KNOW THE MOST INFORMATION. PT 2 WOULD BE WHAT WE WANT TO KNOW. (EX. ENERGY LOSSES BETWEEN PTS 1 & 2. WE NEED TO HAVE PT 2 AT THE EXIT OR END OF A JET.) GRAVITY DRIVEN SYSTEMS WILL ALWAYS HAVE MOST OF ITS ENERGY LOSSES EQUAL TO THE POTENTIAL ENERGY OF THE WATER AT ITS BEGINNING POINT. IF WE WERE TO CONSIDER ENERGY LOSSES FOR A PROBLEM LIKE #91, THEN THE HEIGHT OF THE JET OF FLUID WILL DECREASE. "THE WATER WILL HAVE LESS ENERGY TO REACH A HIGHER POINT". IF WE WERE TO APPLY PRESSURE ABOVE THE WATER'S SURFACE, THEN THE JET WILL BE HIGHER. FOR DISTRIBUTION TANK PROBLEMS, THE POWER DELIVERED BY THE MOTOR TO THE PUMP WILL ALWAYS BE GREATER THAN THE REQUIRED HYDRAULIC POWER. ENERGY LOSSES EXIST INTERNALLY IN THE PUMP.