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MET 330

Dr. Ayala

October 28, 2021

HW #2.3

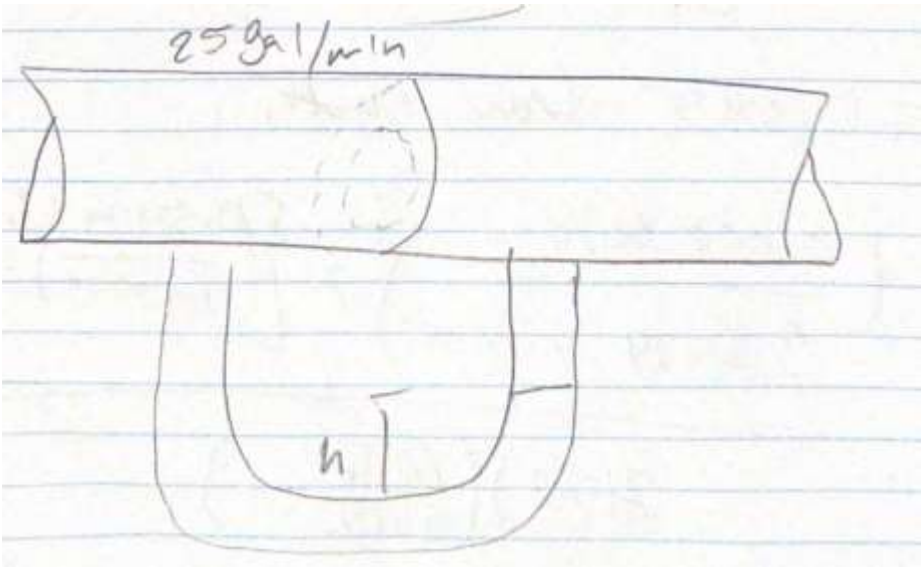
Devon Moore: Looking at this week's slides, they were similar to the Orifice Plate Coefficients experiment done in the lab recently. The slides help emphasize how a change pipe diameter due to an orifice plate or a nozzle relates to flow rate, showing the decrease in diameter causes an increase in flow rate and vice versa. The forces due to a fluid in motion slides show how objects respond to fluids in motion and the importance of bracing piping systems to counteract this force. This is further explored in the second part of the test this week.

Dave Buonconsiglio: This week's lessons were enjoyable, as we learned about velocity, and how to calculate it. I had a slight understanding of pitot tubes before from my aviation experience, but this gave me a whole new view into their world and how they work. I always wondered how a tube sticking off the side of an airplane can tell the airspeed… Now I know. This also gave me more of an insight into the calculations that are involved in HVAC work, another field where I have some experience. I helped the pro work on repairing the systems at a school that I used to do maintenance at. In fact, HVAC was the biggest part of the job there.

Richard Harrell:

Traveon Williams:

15.4



4. Pipe D_i = 10" sch 40 = 0.833H Fluid = Ammonia
$Q = 25$ gal/min $sg = 0.43$
$= 0.0557$ ft³/s $\mu = 2.5 \times 10^{-6}$ lb/ft s

a. Orifice = 1 in/12 = 0.0833H

$$h = \frac{\left(\frac{Q}{A_1 \times C}\right)^2 \times \left[\left(\frac{A_1}{A_2}\right)^2 - 1\right]}{2g\left(\frac{\gamma_m}{\gamma_w} - 1\right)}$$

$sg = \frac{\rho_s}{\rho_w}$

$Re = \frac{\rho V D}{\mu} = \frac{1.41(0.102)0.835}{2.5 \times 10^{-6}}$

$0.43 = \frac{\rho_s}{1.94}$

$Re = 54849.48$

$\rho_s = 1.61$ slug/ft³

$V = \frac{Q}{A} = \frac{0.0557}{0.5479} = 0.102$

C = 0.595 from chart.

$$h = \frac{\left(\frac{0.0557 \text{ ft}^3/\text{s}}{0.5479 \text{ in} \times 0.595}\right)^2 \times \left[\left(\frac{0.5479}{0.00545}\right)^2 - 1\right]}{2(32.2)\left(\frac{62.4}{51.792} - 1\right)}$$

$$\frac{(0.029)(16105.705)}{13.19}$$

$h = 22.2$ ft

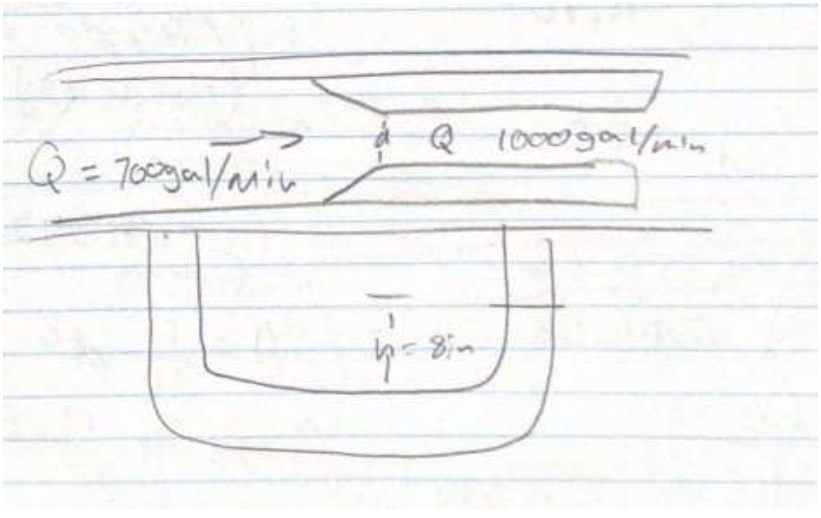
b. $\text{Orifice} = 7\text{in} \; \frac{d}{D} = \frac{7}{10} = 0.7$

from chart $C = 0.618$

$$h = \frac{0.027(3.2)}{13.19}$$

$h = 0.00655$ ft

15.9



9. Sim typ k copper tube Liquid 0.1 @ 77°F

Mercury meter Q = 700 gal/min - 1000 gal/min

0 - 8.0 in

$A_1 = 1.259 \times 10^{-1}$ ft

$A_2 = \frac{A_1}{\sqrt{\frac{2gh\left(\frac{\gamma_m}{\gamma_L} - 1\right)}{\left(\frac{Q}{A_1 C}\right)^2 + 1}}}$ Assuming 1 for C

$= \frac{.1259}{\sqrt{\frac{2(32.2)(.66)\left(\frac{8814.9}{58} - 1\right)}{\left(\left(\frac{2.225}{.1259(1)}\right)^2 + 1\right)}}}$

$= \frac{.1259}{\sqrt{\frac{570.64}{314.169}}}$ $= A_2 = 0.0929$

$A = \frac{\pi}{4} d^2$

$0.0929 = \frac{\pi}{4} d^2$

$d = 0.34 \text{ ft} \times 12 \text{ in}$

$d = 4.12$

Check

$\frac{d}{D} = \frac{4.12}{5} = 0.824$ $C = 0.968$

$Re = \frac{1.8(23.94)(.416)}{0.91 \times 10^{-4}} = 25,948.85$

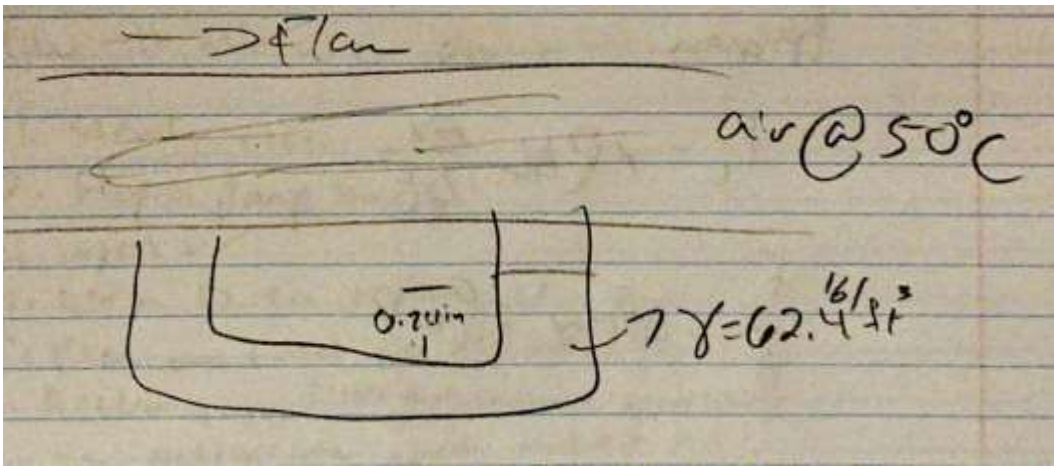
$V = \frac{Q}{A} = \frac{2.225}{0.0929} = 23.94$

$$A = \frac{.1259}{\sqrt{\frac{2(32.2)(.66)\left(\frac{844.9}{76}+1\right)}{\left(\frac{2.224}{.1259(.968)}\right)^2 - 1}}} = \frac{.1259}{\sqrt{\frac{576.64}{333.217}}}$$

$$A = 0.0957 = \frac{\pi}{4} d^2$$

$$d = 0.349\,ft \times 12\,in = 4.188$$

15.15



15. air at atm and 50°C

$h = 0.24_{i,y}$

$$V = \sqrt{2gh(\gamma_s - \gamma)/\gamma}$$

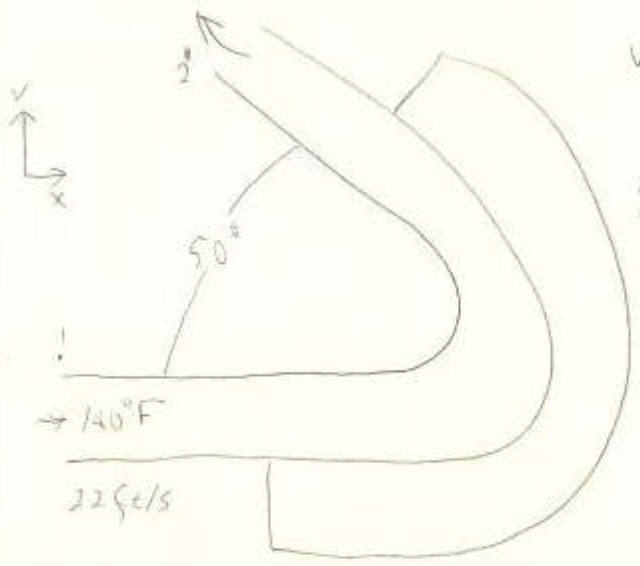
$$V = \sqrt{2(32.2\ ft/s^2)(.02\ ft)(4.24 - 0.069\ lb/ft^3)}$$

$$0.069\ lb/ft^3$$

$$V = 34.36\ ft/s$$

16.6

16-6



Water @ 180°F

$\nu = 60.6\ lb/ft^2$

$\rho = 1.88\ slug/ft^3 = 60.48712$

$\eta = 7.23 \times 10^{-6}\ lb\text{-}s/ft^2$

$\nu = 3.84 \times 10^{-4}\ ft^2/s$

130° Angle

$A = 2.95\ in^2 = .0209\ ft^2$

$F_x = \rho Q (V_{2x} - V_{1x}) = 60.48712\ \frac{lb}{ft^3} \cdot .4507\ \frac{ft^3}{s} \cdot (22 + 14.14\ ft/s) = 985.4\ lbs$

$F_y = \rho Q (V_{2y} - V_{1y}) \quad 60.48712 \cdot .4507 (16.85) = 459.4\ lbs$

$V_{2x} = -\cos 50 (V) = -14.14\ ft/s$

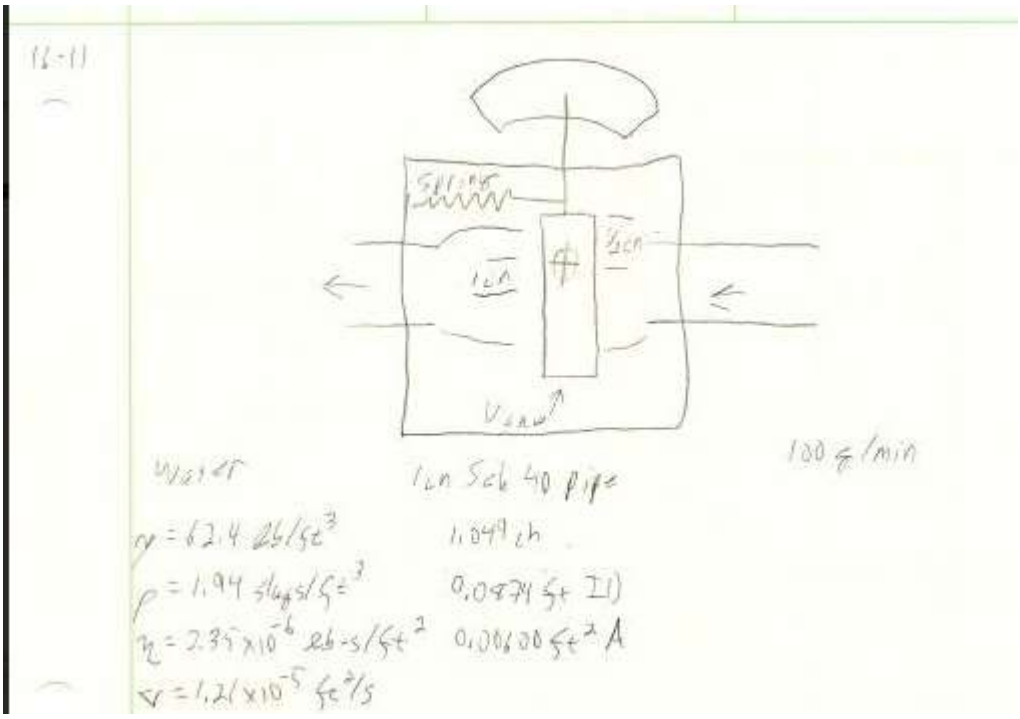
$V_{2y} = \sin 50 (V) = 16.85\ ft/s$

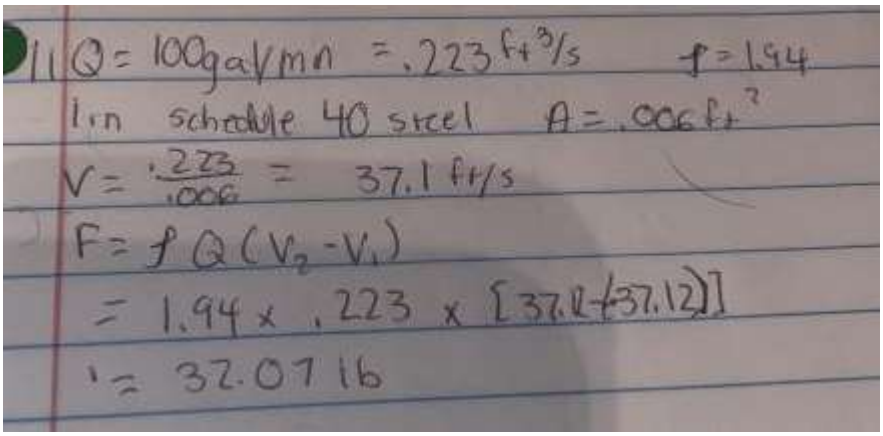
$V = 22\ ft/s$

$Q = Av$

$= .0209\ ft^2 \cdot 22\ ft/s = .4\,038\ ft^3/s$

16.11


16-11
1in
1in
Water
1in Sch 40 pipe
100 gal/min
ρ = 62.4 lb/ft³
ρ = 1.94 slug/ft³
μ = 2.35 x 10⁻⁵ lb-s/ft²
ν = 1.21 x 10⁻⁵ ft²/s
1.049 in
0.0874 ft ID
0.00600 ft² A


11 Q = 100 gal/min = .223 ft³/s ρ = 1.94
1 in schedule 40 steel A = .006 ft²
V = .223/.006 = 37.1 ft/s
F = ρ Q (V₂ - V₁)
= 1.94 x .223 x [37.12 - 37.12]
= 32.07 lb

16.20

16-20

water

$\rho = 1000 \frac{kg}{m^3}$

$F = \rho Q (V_2 - V_1) = \frac{kg}{m^3} \cdot \frac{m^3}{s} \cdot \frac{m}{s} = \frac{kg \cdot m}{s^2} = N$

$A = \frac{\pi D^2}{4} = \frac{\pi \cdot .2^2}{4} = \frac{\pi \cdot .04}{4} = 0.0314\ m^2$

$Q = A_1 = .0314\ m^2 \cdot 30 \frac{m}{s} = .924 \frac{m^3}{s}$

$V_{1x} = \cos 15 (V_1) = 30 \cos 15 = 28.98\ m/s$

$V_{1y} = \sin 15 (V_1) = 30 \sin 15 = 7.764$

$V_{2x} = 30$

$V_{2y} = 0$

$R_x = \rho Q (V_2 - (-V_1 \cos\theta)) \rightarrow R_x = \rho Q (V_2 + V_1 \cos\theta) \rightarrow R_x = \rho Q V (1 + \cos\theta) \rightarrow 1000 \cdot .924 \cdot 30 (1 + \cos 15)$

$R_x = 57495.46\ N$

$R_y = \rho Q (V_2 - (-V_1 \sin\theta)) \xrightarrow{\text{as above}} R_y = \rho Q V (0 + \sin\theta \rightarrow 1000 \cdot .924 \cdot 30 (\sin 15) = 7174.46\ N$

Car moving @ 12 m/s

$V_x = V\cos 15 = 30\cos 15 = 28.98\ m/s$

$V_y = V\sin 15 = 30\sin 15 = 7.764\ m/s$

$V_{1x} = V_x - V_{car} = 29.98 - 12 = 16.98\ m/s$

$V_f = \sqrt{V_{1x}^2 + V_y^2} = \sqrt{16.98^2 + 7.764^2} = 18.671\ m/s$

$M = \rho Q$

$Q = A V_f = \frac{\pi D^2}{4} \cdot V_f$

$M = \frac{kg}{m^3} \cdot m^2 \cdot \frac{m}{s} = \frac{kg}{s}$

$M = 1000 \cdot 0.0314 \cdot 18.671 = 586.2694\ \frac{kg}{s}$

$\alpha = \tan^{-1}\left(\frac{V_y}{V_x}\right) = \tan^{-1}\left(\frac{7.764}{16.98}\right) = 24.57^\circ$

$\beta = \alpha - \theta = 24.57 - 15 = 9.57^\circ$

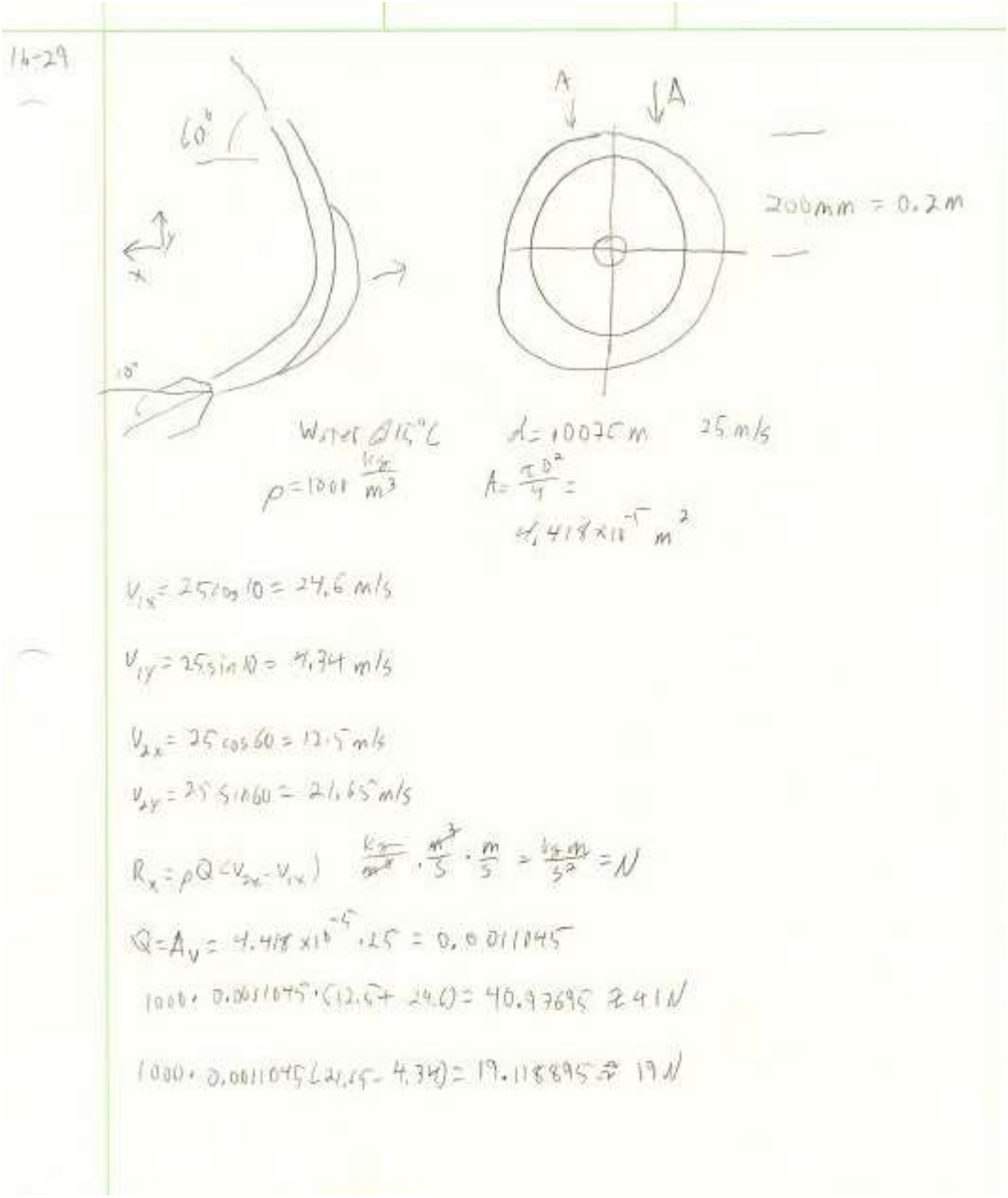
$V_{wall} = V_f \cos\beta = 18.67\cos 9.57 = 18.4\ m/s$

$R_x = \overset{(\rho Q)}{M}(V_2 - V_1) = M(V_{wall} - V_{1x}) = 586.2694 \cdot (18.4 - 16.98) = 832.5\ N$

$\frac{kg}{s} \cdot \frac{m}{s} = \frac{kg\ m}{s^2} = N$

$R_y = M(V_2 - V_1) = M(V_{wall} - V_y) = 586.2694 \cdot (0 - (-7.764)) = 4551.8\ N$

16.29


16-29
60°
y
x
10°
A
A
200mm = 0.2m
Water @ 15°C
ρ = 1001 kg/m³
d = 1007cm
25 m/s
A = πD²/4 =
4.418 x 10⁻⁵ m²
V1x = 25 cos 10 = 24.6 m/s
V1y = 25 sin 10 = 4.34 m/s
V2x = 25 cos 60 = 12.5 m/s
V2y = 25 sin 60 = 21.65 m/s
Rx = ρQ(V2x - V1x)
Q = AV = 4.418 x 10⁻⁵ · 25 = 0.0011045
1000 · 0.0011045 · (12.5 + 24.6) = 40.97695 ≈ 41 N
1000 · 0.0011045 (21.65 - 4.34) = 19.118895 ≈ 19 N