HW 2.3

15.4 $D = 10\text{in}$, $Q = 25\ 89\text{l/min}$, $SG_{\text{ammonia}} = 0.83$

$\mu = 2.5 \times 10^{-6}\ \text{lb-s/ft}^2$ $d_1 = 1.0\text{in}$, $d_2 = 7.0\text{in}$

a) $A_1 = \pi(0.83)^2/4 = 0.541\ \text{ft}^2$

$A_2 = \pi(0.043)^2/4 = 0.00541\ \text{ft}^2$

$\gamma_A = (0.83)(62.4\ \text{lb/ft}^3) = 51.79\ \text{lb/ft}^3$

$v_1 = 0.056\ \text{ft}^3\text{/s} / 0.541\ \text{ft}^2 = 0.104\ \text{ft/s}$

$\nu = \mu/\rho \rightarrow \rho = SG_A \times \text{density}_W = 0.83 \times 1.94 = 1.61\ \text{slug/ft}^3$

$\hookrightarrow \nu = 2.5 \times 10^{-6}\ \text{lb-s/ft}^2 / 1.61\ \text{slug/ft}^3 = 1.55 \times 10^{-6}\ \text{ft}^2\text{/s}$

$N_R = (0.104\ \text{ft/s})(0.83) / 1.55 \times 10^{-6}\ \text{ft}^2\text{/s} = 55690.3$

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

$\hookrightarrow h = (V_1/C)^2\left((A_1/A_2)^2 - 1 / 2g((\gamma_m/\gamma_f) - 1)\right)$

$h = \left(0.104\ \text{ft/s} / 0.594\right)^2\left((0.541\ \text{ft}^2/0.00541\ \text{ft}^2)^2 - 1 / 2(32.2\ \text{ft/s}^2)((62.4/51.79) - 1)\right)$

$\boxed{h = 23.23\ \text{ft}}$

b) $A_2 = \pi(0.58\text{ft})^2/4 = 0.264\ \text{ft}^2$

$h = \left(0.104/0.618\right)^2\left((0.541/0.264)^2 - 1 / 2(32.2)((62.4/51.79) - 1)\right)$

$\boxed{h = 0.0069\ \text{ft}}$

15.9 From Appendix H: $A = 0.1259\ \text{ft}^2$, $D = 4.805\text{in}$

$v_{\text{max}} = 1.558\ \text{ft}^3\text{/s} / 0.1259\ \text{ft}^2 = 12.38\ \text{ft/s}$

From Appendix B: $\nu = 3.84 \times 10^{-4}\ \text{ft}^2\text{/s}$ $\gamma = 98\ \text{lb/ft}^3$

$N_R = (12.38\ \text{ft/s})(0.4\text{ft}) / 3.84 \times 10^{-4}\ \text{ft}^2\text{/s} = 12,895.83$

$V_{\text{max}} = 2.227\ \text{ft}^3\text{/s} / 0.1259\ \text{ft}^2 = 17.686\ \text{ft/s}$

$N_R = (17.686\ \text{ft/s})(0.4\text{ft}) / 3.89 \times 10^{-4}\ \text{ft}^2\text{/s} = 18422.92$

$A_1 = A / \sqrt{2gh(\gamma_m/\gamma)(C)^2/v_{\text{max}}^2 + 1} = 0.0746\ \text{ft}^2$

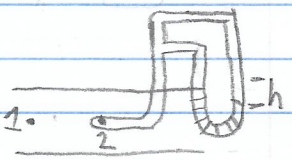
$d = \sqrt{0.0746\ \text{ft}^2 \times 4/\pi} = 0.3082\text{ft} = \boxed{3.70\text{in}}$

15.15 $\gamma_a = 0.0685 \frac{lb}{ft^3}$ $\gamma_w = 61.7 \frac{lb}{ft^3}$ $h = 0.24$ in Find V_1.

$P_1 + \gamma_w \cdot h - \gamma_a \cdot h = P_2$ $P_2 - P_1 = h(\gamma_w - \gamma_a)$

$P_1 = 0$ psig $\frac{P_1}{\gamma_a} + \frac{V_1^2}{2g} = \frac{P_2}{\gamma_a}$ $V_1 = \sqrt{2 \cdot g \cdot \frac{P_2 - P_1}{\gamma_a}}$

$V_1 = \sqrt{2 \cdot g \cdot \frac{h(\gamma_w - \gamma_a)}{\gamma_a}} = 34.03 \frac{ft}{s}$



16.6 $\theta = 50°$ $V_1 = 22 \frac{ft}{s}$ $A = 2.95 in^2 = 0.021 ft^2$ Find Fx and Fy.

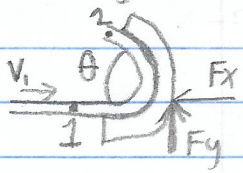
$\rho = 1.88 \frac{Slug}{ft^3}$ $Q = V_1 \cdot A = 0.451 \frac{ft^3}{s}$

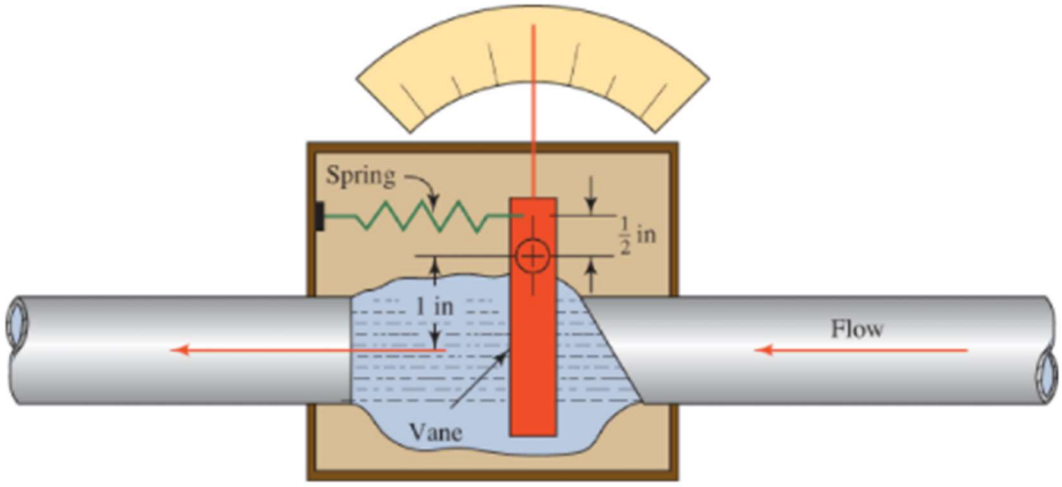
$Fx = \rho \cdot Q \cdot (V_{2x} - V_{1x})$ $V_{1x} = 22 \frac{ft}{s}$ $V_{2x} = V_1 \cdot \cos(180 - \theta)$

$V_{2x} = -19.14 \frac{ft}{s}$ $Fx = -30.69$ lb

$Fy = \rho \cdot Q \cdot (V_{2y} - V_{1y})$ $V_{1y} = 0 \frac{ft}{s}$ $V_{2y} = V_1 \cdot \sin(180 - \theta)$

$V_{2y} = 16.85 \frac{ft}{s}$ $Fy = 14.29$ lb





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Flow rate = 0.2228 ft^3/s

area 1in pipe = 0.006 ft^2

water density = 1.94 lb/ft^3

Velocity = 37.1 ft/s

Force = 1.94 · 0.2228 · (37.1 − (−37.1))

F = 32.07 lb

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How fast water

$Q = Av$

$Q = \frac{\pi}{4} \times 0.2^2 \times 30$

$Q = 0.943 m^3/s$

force water y

$R_y = \rho Q v(0 + \sin\theta)$

$R_y = 0.25 \times 1000 \times 0.943 \times 30$

$R_y = 7072.5N$

Force water x

$R_x = \rho Q v(0 + \cos\theta)$

$R_x = 1.966 \times 1000 \times 0.943 \times 30$

$R_x = 55618.14N$

Velocity X

$V_x = V\cos\theta$

$V_x = 30\cos 15$

$V_x = 28.98 m/s$

Velocity y

$V_y = V\sin\theta$

$V_y = 30\sin 15$

$V_y = 7.76 m/s$

Velocity X car

$28.98 m/s - 12 m/s = 16.98 m/s$

Velocity

$V = \sqrt{16.98^2 + 7.76^2}$

$V = 18.67 m/s$

Mass

$m = 1000 \cdot \frac{\pi}{4} \cdot 0.2^2 \times 18.67$

$m = 586.6 kg/s$

Angle Velocity

$\alpha = \tan^{-1}\left(\frac{7.76}{16.98}\right)$

$\alpha = 24.56^\circ$

Vane angle

$24.56 - 15 = 9.56^\circ$

Vane Velocity

$18.67 \cos 9.56^\circ = 18.4 m/s$

force X car

$= 586.6 \cdot (18.4 - 16.98)$

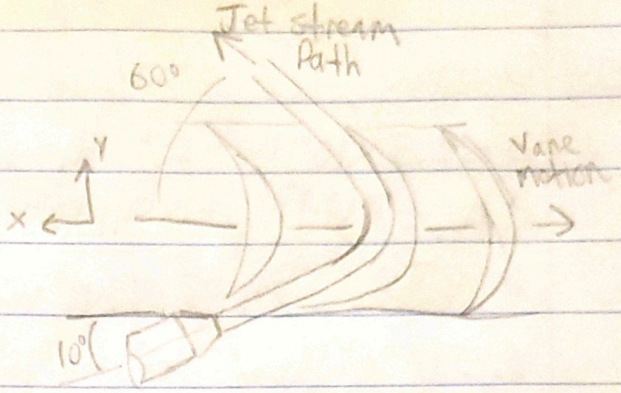
832.97N

force Y car

$= 586.6 \cdot 7.76$

4552N

16.29 Water @ 15°C



$D = 7.50\ mm = 0.0075\ m$

$v = 25\ m/s$

$A = \pi(0.0075)/4 = 4.418 \times 10^{-5}\ m^2$

$Q = (4.418 \times 10^{-5}\ m^2)(25\ m/s)$

$Q = 0.0011\ m^3/s$

$R_x = \rho Q((v_2 \cos 60) + (v_1 \cos 10))$

$R_x = 1000 \times 0.0011\ m^3/s\ ((25\ m/s \cos 60) + (25\ m/s \cos 10)) = \boxed{40.83\ N}$

$R_y = 1000 \times 0.0011\ ((25 \sin 60) - (25 \sin 10)) = \boxed{19.04\ N}$