Dims / Units

May 13 2020

(1.1) $F = \frac{C_D \rho V^2 A}{2}$, V: wind speed, ρ density, air A: projection area building, C_D: drag coeff

FLT: $F = \frac{C_D F T^2 L L^2}{L^4 T}$, $F = \frac{C_D F T}{L}$, $C_D = F/F$

(1.8) a) $\frac{M}{LT^2} \div \frac{M}{L^3}$, $\frac{L^2}{T^2}$ b) $\frac{M L M}{L T^2 T L^3} = \frac{M^2}{L^3 T^3}$ c) $\frac{M}{LT^2} \div \left[\frac{M}{L^3}\left[\frac{L}{T}\right]^2\right]$, $\frac{M}{LT^2} \cdot \frac{LT}{M} = \frac{1}{T}$

(1.10) V velocity, ℓ L, ν fluid prop viscosity $\left[\frac{L^2}{T}\right]$

$\frac{L}{T}$ L

$\therefore \frac{V\ell}{\nu}$ (6)

(1.15) $\Delta p = K_v \cdot \frac{\mu V}{D} + K_u \left(\frac{A_0}{A_1} - 1\right)^2 \rho V^2$

$\frac{F}{L^2} = K_v \cdot \left[\frac{\frac{FT}{L^2} \cdot \frac{L}{T}}{L}\right] + K_u \left[\frac{FT^2}{L^4}\right]\left[\frac{L}{T}\right]^2$

$\frac{F}{L^2} = K_v \left[\frac{F}{L^2}\right] + K_u \left[\frac{F}{L^2}\right]$, $\therefore K_v$ & K_u are dimensionless

Fluid Homework - Fluid Mass + Ideal Gases

May 18 2020

(1.30) a) $(1\,km^3)\cdot(0.621371)^3 =$

$= 0.24\ mi^3$

b) $(1\,km^3)\cdot(1000)^3\cdot(0.2)\cdot(0.00220462)$

$= 440924\ lb$

(1.31) a) $25\ slug = 25(32.2\ lb),\ 805\ lb = 25(14.59)\cdot 9.81,\ 3578\ N$

(1.35) $1.15 = \frac{\rho}{1000} = 1150\ kg/m^3\ \rho$.

$1.15 = \frac{\gamma}{9.807},\ \gamma = 11.28\ kN/m^3$

(1.41) $\rho = 1005\ kg/m^3$

$\rho_h = 1005\ kg/m^3 \cdot 1/3,\ 335\ kg/m^3$

$SG = \frac{335}{1000} = 0.335$

$\gamma = 335 * 9.81\ \frac{kg\cdot m}{s^2}$

$= 3286.35\ \frac{kg^2 m^2}{s^2}$

(1.44) $pV = nRT$

$p = 24\ lb/in^2 = 24\left(\frac{1}{0.0254}\right)^2(4.448) = 165465.9309\ Pa$

$70°F = \frac{70-32}{1.8} + 273\ K$

$T = 294.1\ K$

$R = 8.312$

$V = \frac{4}{3}\cdot\pi\cdot(4.67\cdot 0.0254)^3$

$= 0.00699\,1017$

$n = \frac{165465.9309\cdot 0.00699\,1017}{8.312\cdot 294.1}$

$n = 0.4732$

$nM = m,\ m = 0.4732\cdot 28.9628$

$= 13.7\ g$

(1.46) $pV = mRT$

$T = -50 + 273$
$= 223\ K$

a) $R = 188.9\ \frac{m^3 Pa}{kg \cdot K}$ $\quad \frac{\rho}{RT} = \frac{m}{V}, \frac{900}{188.9 \cdot 223} = 0.02137\ kg/m^3$

$m = kg$

$\rho = 900\ Pa$

b) $R = 287.05$

$T = 18 + 273$
$= 291$

$P = 101600\ Pa$ $\quad \frac{\rho}{RT} = \frac{m}{V}, \frac{101600}{287.05 \cdot 291} = 1.21630692\ kg/m^3$

(1.50) $\left[\frac{60-32}{1.8} + 273\right] = 288.\overline{55}$

$\left[\frac{110-32}{1.8} + 273\right] = 316.\overline{3}$, $\Delta p = \frac{316.3}{288.\overline{5}}(90) = 98.67\ P_{in^2}$

Viscosity

May 19 2020

(1.55)

$\mu = 1.002E-3$

$\tau = \frac{dv}{dy} \cdot \mu, \quad \frac{1}{1.002E-3} = \frac{dv}{dy} = 998\ s^{-1}$

(1.57)

$t = 1430\ s$

~~KR^4~~ $\frac{v_6}{t} = \frac{1.19E-3}{1430} = 8.32E-7\ m^2/s^2$

$V = 8.32E-7 \cdot 900$

$= 0.0007488\ m^2/s$

$\mu = 0.0007488 \cdot 900\ kg/m^3$

$\mu = 0.67392\ kg/m \cdot s$

(1.59)

$5E-4\ poise = 5E-4(0.1)\ Pa \cdot s = 5E-4(0.067196a)$

$= 5E-5\ Pa \cdot s \qquad = 0.0000335\ 98\ \frac{lb}{ft \cdot s}$

(1.67)

$C = 1.458E-6$

$S = 110.4K$

$T_1 = 10 + 273$

$T_2 = 90 + 273$

$\mu_1 = \frac{1.458E-6 \cdot 283^{3/2}}{283 + 110.4} = 0.00001764$

$\mu_2 = \frac{1.458E-6\ (363)^{3/2}}{363 + 110.4} = 0.0000213$

(1.71) $\mu = De^{B/T}$

$7.1E-5 = De^{B/40}$

$1.9E-5 = De^{B/150}$

$7.1E-5 = De^{\frac{71.904}{40}}$

$D = \frac{7.1E-5}{e^{\frac{71.904}{40}}}$

$\ln(7.1E-5) = \ln D + B/40$

$-\ln(1.9E-5) = \ln D + B/150$

$D = 11.76 \times 10^{-6}$

$\mu^{80} = 11.76E-6\, e^{71.9/80}$

$= 28.9E-6$

$\ln\left(\frac{7.1E-5}{1.9E-5}\right) = \frac{B}{40} - B/150$

$1.31824 = \frac{11B}{600} \rightarrow B = 71.9$

(1.72)

$\tau = 150\ Pa = 150\ N/m^2$

$d = 2mm = 0.002\ m$

$v = 1\ m/s$

$150 = \mu \cdot \frac{1}{0.002}$

$\mu = 0.3\ \frac{N \cdot s}{m^2}$

(1.73) $F_T = F_b$, $\therefore \tau_t \cdot A = \tau_b \cdot A$, $\tau_t = \tau_b$

Since $\tau_t = \tau_b$

$\mu_t \frac{dv}{dy} = \mu_b \frac{dv}{dy}$

$2\mu \frac{(V - V_1)}{b - cb} = \mu \frac{V_1}{cb}$

$\frac{2cb}{b - cb} = \frac{V_1}{V - V_1}$

$\frac{2c}{1 - c} = \frac{V_1}{V - V_1}$

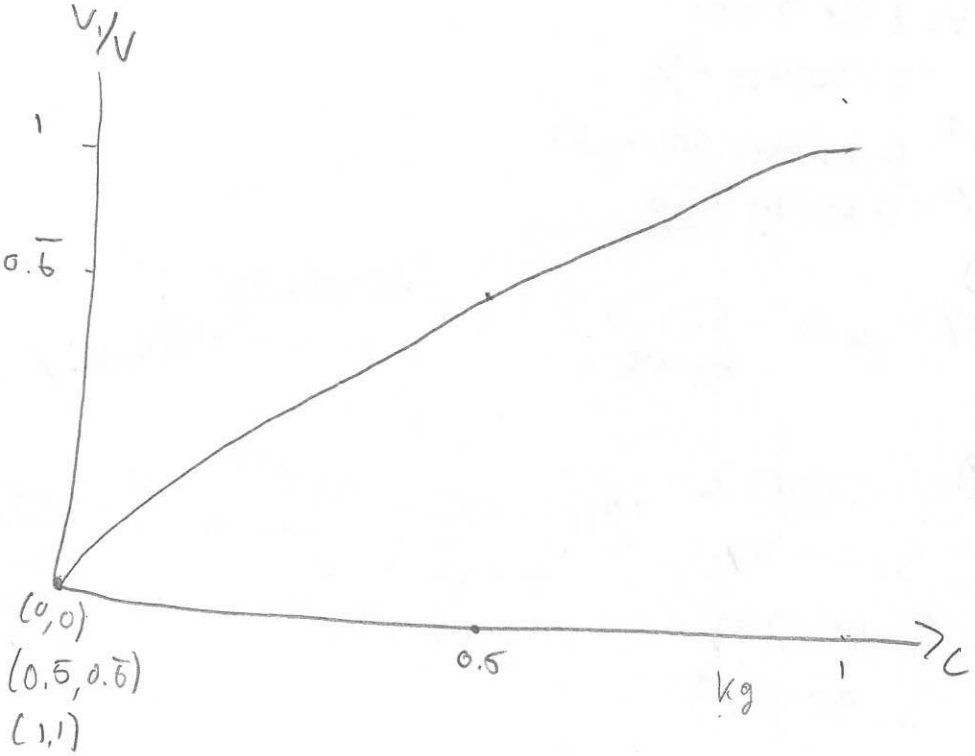
$\frac{1 - c}{2c} = \frac{V - V_1}{V_1}$

$\frac{1}{2c} - \frac{1}{2} = \frac{V}{V_1} - 1$

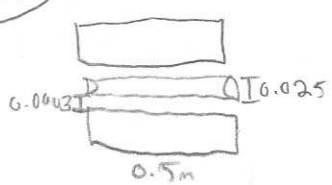
$\frac{1}{2c} + 1/2 = \frac{V}{V_1}$

$\frac{1 + c}{2c} = \frac{V}{V_1}$

$\therefore \frac{V_1}{V} = \frac{2c}{1 + c}$

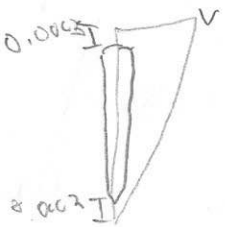


(1.77)



$v = 3\ m/s$

$SG = 0.91$



$|F_r| = |F_{r+}| = \tau \cdot A$

$\tau = \mu \frac{du}{dy}$, $\frac{du}{dy} = \frac{V - 0}{0.0003 - 0} \frac{V}{0.0003} = \frac{3}{0.0003} = 10000\ \frac{1}{s}$

$A = \pi d l$

$= \pi \cdot 0.025 \cdot 0.5$

$= \pi \cdot 0.0125$

$\mu = \rho \nu = [8E\text{-}4]\ \frac{kg}{m^3} [0.91 \cdot 1000]\ \frac{kg}{m^3} = 0.728\ \frac{kg}{m \cdot s}$

$\tau = 10000 \cdot 0.728 = 7280\ \frac{kg}{m\ s^2} = \frac{7280\ N}{m^2}$

$\therefore F_r = 7280 \cdot 0.0125\pi$

$= 91\pi$

$= 285.885\ N$

(1.81) $\tau = \mu \frac{V_u}{Y}$ $\tau = \mu \cdot \frac{du}{dy}$

$\mu = 1.002E-3 \frac{Ns}{m^2}$, $\frac{u}{U} = 2\frac{y}{h} - \frac{y^2}{h^2}$

$h = 0.1 m$

$U = 2 m/s$

$\frac{du}{dy} = U\left[\frac{2}{h} - \frac{2y}{h}\right] = \frac{U \cdot 2}{h}\left[1 - y\right]$

@ $y=0$, $\frac{2 \cdot 2}{0.1} = 40 \frac{1}{s}$

$\tau = 1.002E-3 \cdot 40$

$\tau = 0.04008 Pa$

Compressibility

May 20 2020

(1.95) $E_v = 4.14E6 \frac{lb}{in^2} = -V_0 \frac{dp}{dV}$

$= -V_0 \cdot \frac{p_2 - p_1}{0.01 V_{in}}$

$\frac{N}{m^2}$

$4.14E6 = -\frac{[p_2 - p_1]}{0}$

$41400 = -p_2 + p_1$

$p_2 = p_1 - 41400 \text{ psi}$

$\Delta p = 41400 \text{ psi}$

(1.96) $21000 MPa = -\frac{V_0 \cdot 35}{V_2 - V_0}$

$\frac{21000}{35} = \frac{-V_0}{V_2 - V_0}$

$\frac{1}{600} = -\frac{V_2 - V_0}{V_0}$

$\frac{1}{600} = \frac{-V_2}{V_0} + 1$

$\frac{599}{600} V_0 = V_2$

$\therefore \Delta = \frac{1}{600}$ ↓

(1.98) $p_1 = 25 \text{ psi}$ $pV = nRT$, $p_1 V_1 = p_2 V_2$

$+14.7$

$= 39.7$

$39.7V = p_2 \frac{1}{3}V$

$p_2 = 119.1$

$p_{gauge} = 119.1 - 14.7$

$= 104.4 \text{ psi}$