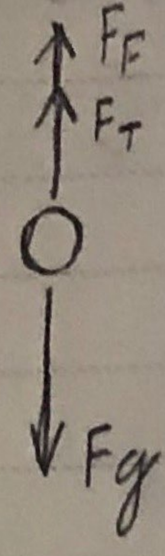
Date:

Free Body Diagram



(Assumption Simplification
movement only in z)

F_F = Friction of air

F_T = m·a of super critical CO_2

F_g = m·g of gravity

$V_0 = 5\ m/s \downarrow$

$\dot{m}$ $\left(\frac{kg}{s}\right)$: mass flow $\quad \dot{m} = \rho V A$

$\dot{V}$ $\left(\frac{m^3}{s}\right)$: Volume flow $\quad \dot{V} = V A$

$$V_2 = V_1 \frac{A_1}{A_2}$$

$P = mV$

$P = (5kg)(5\ m/s)$

$P = 25\ kg\frac{m}{s}$

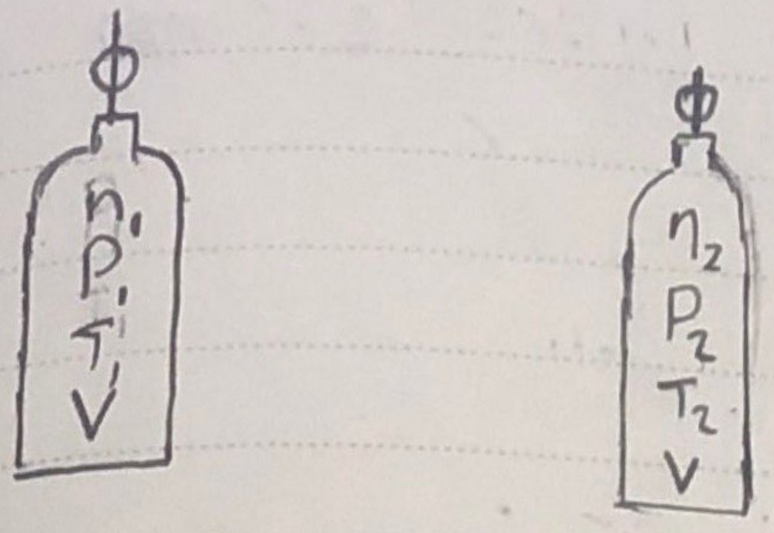
$F = (5kg)(9.8\ m/s^2)$

$F = 49\ N$

Tank Pressure (No Heat Trans)

1800 psi

(IGL) Reversible, adiabatic
no heat trans



$$n_1 = \frac{P_1 V}{R T_1} \qquad n_2 = \frac{P_2 V}{R T_2}$$

$$11.211 \text{ mol} = \frac{P_1 \ (0.00064 m^3)}{(8.3 \text{HJ/K·mol})(323.1 K)}$$

$$\frac{6.52}{47055604.48} \ \frac{N \cdot m}{m^2} \rightarrow \frac{J}{m^3}$$

$$47055604.48 \text{ Pa} = P_1$$

* $P_1 = 6824.83$ PSI

$P_{max} = 1798$ PSI

$P_0 = 1700 \text{PSi} = 11721.087$ kPa
$1800 \text{psi} = 12410.5 \text{kPa}$

$$n_1 = \frac{(11721.08 \text{kPa})(0.00064 m^3)}{(8.314 \text{J/K·mol})(323.1 K)}$$

$n_1 = 0.00279$ mol

(mols)

$$\text{mols} = \frac{493.44 \text{ g}}{(44.01 \text{ g/mol})} = 11.211 \text{ mol}$$

$$n_1 = \frac{(12410.5 \text{kPa})(0.00064 m^3)}{(8.314 \text{J/K·mol})(323.1 K)}$$

$$n_1 = \frac{2.956}{0.00295} \text{ mol} \times 44.01 \text{ g/mol}$$

$$n_1 = \frac{130.12}{0.1301} \text{ g}$$

$n_2 = \text{mol}$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{R/C_p}$$

$$T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{R/C_p}$$

$1 \text{Pa} = 1 \frac{N}{m^2}$

$R = 8.314$ J/K·mol

↳ (Pressure kPa)

$C_p = 37.2$ J/mol·K

$T = 50°C = 323.1 K$

(molar mass)

44.01 g/mol

(Density)

CO_2 Lq 771 g/L

(Volume)

0.64 L = 0.00064 m^3

(grams CO_2)

(0.64 L)(771 g/L) = mass

493.44 g = mass

Date: Tank Pressure Limit 3000 or 4500 psi

68Cl X 80Cl

5/3 Hydro Testing 7500 psi

IGL

P = 7500 PSI = 51710.68 kpa

T = 323.1 K 68Cl 80Cl

V = 0.001114 m^3 or 0.001310 m^3

R = 8.314 J/K·mol

$$n_{68} = \frac{P_1 V}{RT} = \frac{(51710.68 \text{ kPa})(0.001114\ m^3)}{(8.314\ J/K \cdot mol)(323.1\ K)} = 0.021446 \text{ mol}$$

$$\times 44.01\ g/mol$$

0.9437 g 943.77g

0.000943 kg 0.94376g

$$n_{80} = \frac{(51710.68\ kPa)(0.001310\ m^3)}{(8.314\ J/K \cdot mol)(323.1\ K)} = 0.025217 \text{ mol} \quad 25.217 \text{ mol}$$

$$\times 44.019\ g/mol$$

1.1098g 1109.82g

0.0011098kg 1.1094g

Date: (Bernoullis Equation) 0.64L 1.8 kPsi

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g Z_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g Z_2$$

($\frac{1}{2}\rho V_1^2$ and $\rho g Z_2 \to 0$)

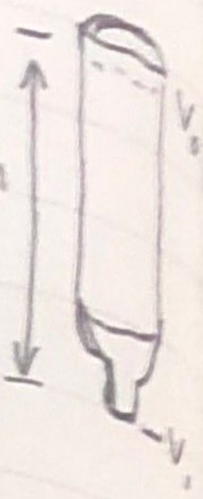
$$12.4\ Mpa + \rho g Z_1 = (0.101325\ Mpa) + \frac{1}{2}\left(131.6 \frac{kg}{m^3}\right) V_2^2 \quad | h_0 = 0.32m,\ h_1 = 0$$

$$12.298\ Mpa + \left(412.697 \frac{kg}{m^3} \frac{m}{s^2} m\right) = \frac{1}{2}\left(131.6 \frac{kg}{m^3}\right) V_2^2$$

$$\sqrt{186905.968} = V_2^2$$

$$432.326 = V_2$$

$$\boxed{432.326 \frac{m}{s} = V_2}$$



(Atm)

$P_2 = 0.101325\ Mpa$

$= 101325\ Pa$

$1\ Pa = \frac{N}{m^2} = \frac{kg \frac{m}{s^2}}{m^2}$

$P_1 = 1800\ psi = 12.4\ Mpa$

$\rho = 131.6\ kg/m^3$

$V_1 = 0$

$V_2 = \sqrt{2gh} = 1.9798 \frac{m}{s}$

$\dot{m} = \rho A V$

$\theta = 0.25in = 6.35\ mm$

$A = 0.00003167\ m^2$

$$\boxed{\dot{m} = 1.801\ kg/s}$$

$m = 0.1301\ g = 1.301 \times 10^{-4}\ kg$

$Time = 7.223 \times 10^{-5} s$

$A = 59847A.25 \frac{m}{s^2}$

$F = ma$

$F = 778.61\ kg \frac{m}{s^2}$

$F = V \cdot \dot{m} \left(kg \frac{m}{s^2}\right)$

$F = 778.6\ N$

$F = 778.6\ N$

(Impulse)

$P = mV$

$P = \frac{0.0562\ kg \frac{m}{s}}{407.98}$

$m = \frac{0.1301\ g}{0.9437\ kg}$

(Bernoulli's Equation) 68C1 X 80C1 7.5M psi

(68C1) → 0

$P_1 + \frac{1}{2}\rho V_1^2 + \rho g z_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g z_2$

$h_0 = 30\,mm = 0.3$ $h_0 = 28\,mm = 0.28$

$m_{68} = 0.94379\,g$ $m_{80} = 1.1088$

$51.71\,Mpa + \rho g z_1 = 0.1013\,Mpa + \frac{1}{2}(131.6\,\frac{kg}{m^3})V_2^2$

$V_{68} = 0.001114\,m^3$ $V_{80} = 0.00130\,m^3$

$51.608\,Mpa + (386.904\,\frac{kg}{m^3}\,\frac{m}{s^2}\,m) = \frac{1}{2}(131.6\,\frac{kg}{m^3})V_2^2$

$T = 323.1\,M$

$\sqrt{784321.98} = V_2$

$885.61\,\frac{m}{s} = V$

$\dot{m} = \rho A V$ $\varnothing = 0.25in = 6.35mm$

$A = 0.00003167\,m^2$

$P = m V$

$P = 0.00094\,kg\,V$

$P = \cancel{8.324}\,kg\,\frac{m}{s}$ 0.8324

$\boxed{\dot{m} = 3.691\,kg/s}$ $F = V \cdot \dot{m}$

$F = 3268.78\,N$

(80C1)

$P_1 + \rho g z_1 = P_2 + \frac{1}{2}\rho V_2^2$

$51.71\,Mpa + (386.904\,\frac{kg}{m^3}\,\frac{m}{s^2}\,m) = 0.1013\,Mpa + \frac{1}{2}(1\cancel{8}6.6\,\frac{kg}{m^3})V_2^2$

$885.61\,\frac{m}{s} = V$

(Impulse)

$P = m V$ $1.109kg$

$P = (\cancel{0.001109}\,kg)(885.61\,\frac{m}{s})$

$P = \cancel{0.9821}\,kg\,\frac{m}{s}$

982.14

$\dot{m} = 3.691\,\frac{kg}{s}$