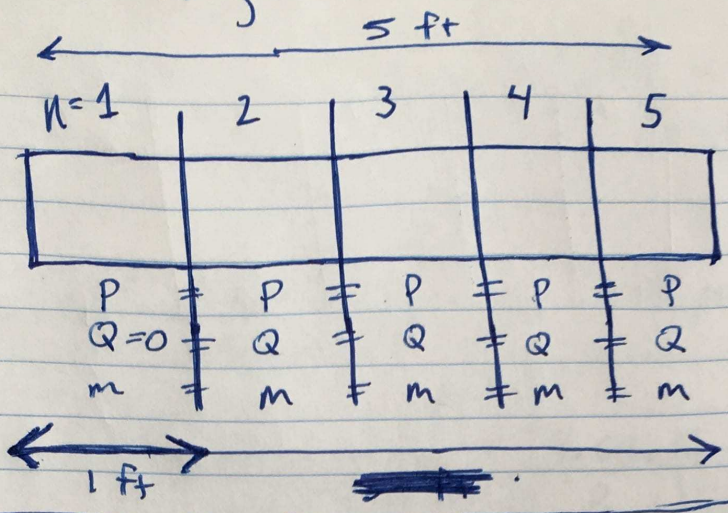
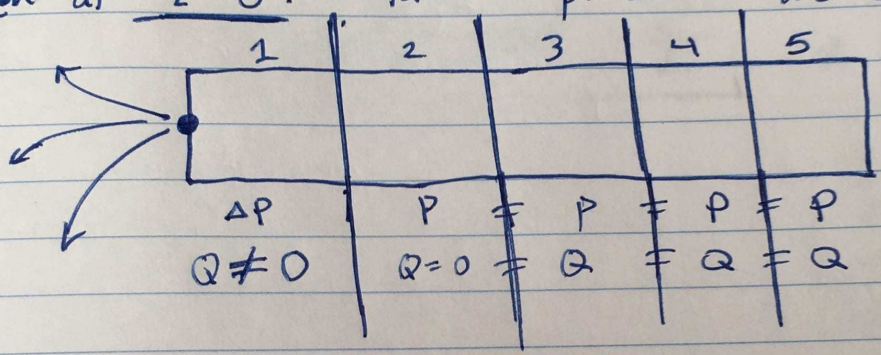
FEA : Hagen - Poiseuille



capillary tube, held at constant 10 psig across length, filled with air

then at $t = 0$: tube is pierced at one end



Equations used:

Hagen - Poiseuille: • $Q = \frac{\Delta P \pi d^4}{128 \mu L}$

• $\Delta m = \rho Q \Delta t$

• $m_1 = m_0 - \Delta m$

• $P_1 = \frac{m_1 R_{air} T_K}{\pi \left(\frac{d}{2}\right)^2 \Delta x}$

Dimensions/values:

$d = 0.00635\ m$

$dx = 0.3048\ m$

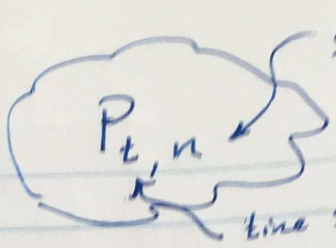
$\mu_{air} = 1.98E-5\ Pa \cdot s$

$R_{air} = 287.06\ J/kgK$

$\rho = 1.225\ kg/m^3$

$dt = 8.89e-04\ s$

t start at t=1



t=0

$$Q_{t,1} = \frac{\Delta P_{t,1} \pi d^4}{128 \mu dx}$$

10 psig = 68947.6 Pa

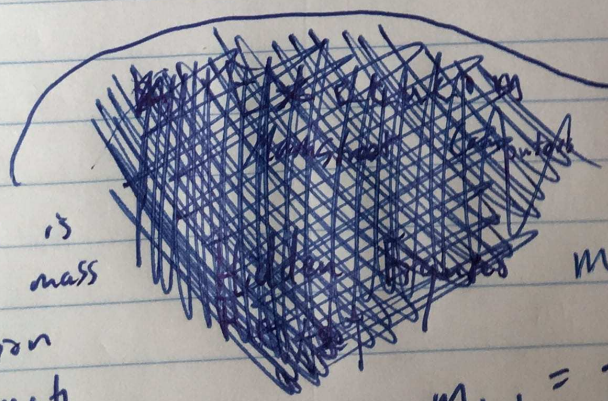
$$Q_{t,1} = \frac{(68947.6\ Pa)\,\pi\,(0.00635\ m)^4}{128\,(1.98\,E-05\ Pa\cdot s)\,0.3048\ m}$$

$$Q_{t,1} = 0.4559\ \frac{m^3}{s}$$

* This suggests flow is moving at 42 x speed of sound? So there must be a problem already but I continue for anyway

$$\Delta m_{t,1} = \rho Q_{t,1} \Delta t = 1.225\ \frac{kg}{m^3}\left(0.4559\ \frac{m^3}{s}\right)(8.89e-04\ s)$$

$$\Delta m_{t,1} = 4.9649e-04\ kg$$



m_0 is initial mass in section length

$$m_{t,1} = m_0 - \Delta m_{t,1}$$

$$m_{t,1} = \rho V - \Delta m_{t,1}$$

$$m_{t,1} = \pi\left(\frac{d}{2}\right)^2 \Delta x\, \rho - \Delta m_{t,1}$$

$$m_{t,1} = \pi\left(\frac{0.00635\ m}{2}\right)^2 (0.3048\ m)\left(1.225\ \frac{kg}{m^3}\right) - \Delta m_{t,1}$$

$$m_{t,1} = -4.441e06\ kg$$

$$P_{1,1} = \frac{m_{1,1} R_{air} T_K}{V}$$

~~$P_{1,1} = (-4.4415e$~~

$$P_{1,1} = \frac{(-4.8467e-04)(287.06\ J/kg\,K)(303.15\ K)}{\pi\left(\frac{0.00635\ m}{2}\right)^2 (0.3048\ m)}$$

$P_{1,1} = -4.4415e06\ Pa$ (640 psig)

X

The negative is wrong but also so is the magnitude which I am struggling with