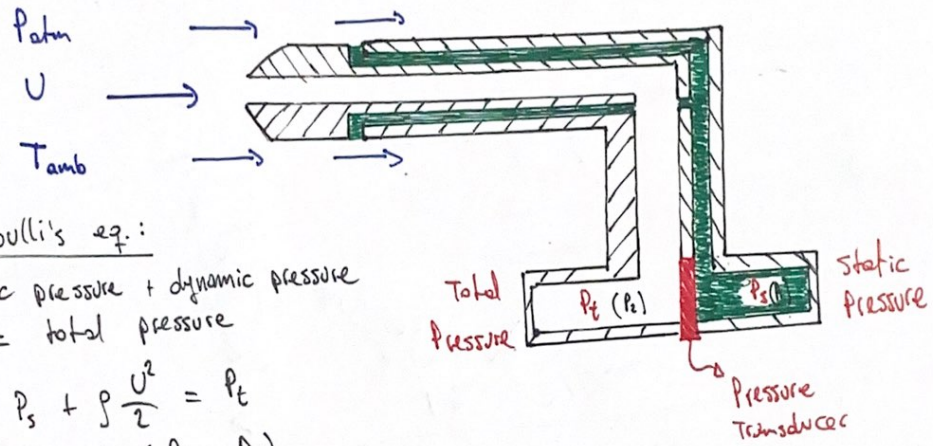
Hot-Wire Calibration

We use a Pitot Tube as our velocity reference:



Bernoulli's eq.:

static pressure + dynamic pressure = total pressure

$$\Rightarrow P_s + \rho \frac{U^2}{2} = P_t$$

$$\Rightarrow U^2 = \frac{2(P_t - P_s)}{\rho}$$

$$\Rightarrow U = \sqrt{\frac{2\Delta P}{\rho}}$$

or (no vertical velocity on pitot tube; as $h_1 = h_2$)

$$P_1 + \frac{1}{2}\rho U_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho U_2^2 + \rho g h_2$$

$$\Rightarrow U_1^2 = \frac{2(P_2 - P_1)}{\rho} = \frac{2(P_t - P_s)}{\rho}$$

From ideal gas law:

$$PV = nRT = \frac{m}{M}RT$$

$$\Rightarrow \rho = \frac{M}{R} \times \frac{P}{T}$$

with $M \sim 0.029$ kg.mol^{-1}

$R \sim 8.314$ J.K^{-1}.mol^{-1}

$P = P_{atm}$ } given by manometer

$T = T_{amb}$ }

We use King's law to obtain calibration curve:

$$e^2 = A\sqrt{U} + B$$

with e in [V] (tension signal from hot-wire)

U in [m/s] (velocity calculated with pitot tube & Bernoulli)

∴ To obtain velocity from tension signal:

$$U = \left(\frac{e^2 - B}{A}\right)^2$$