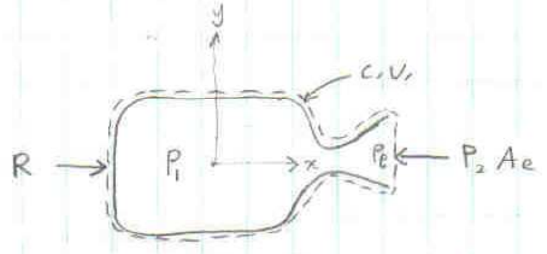
Rocket Thrust Equation

Use a control volume analysis and Newtons 2nd law for a non-acceleration control volume.



Basic Eqn.

$$\bar{F} = \bar{F}_S + \bar{F}_B = \frac{\partial}{\partial t}\int_{CV} \bar{V} \rho \, d\forall + \int_{CS} \bar{V} \rho \bar{V} \cdot d\bar{A}$$

Assume
1. No body forces
2. Steady flow ($\dot{m}$ = constant)
3. Uniform flow of gases from nozzle, at velocity v_e
4. One dimension flow
5. $P_e \geq P_2$

equation reduces to

$$\bar{F}_S + \bar{F}_B^{\,\nearrow 0(1)} = \frac{\partial}{\partial t}\int_{CV} \bar{V} \rho \, d\forall^{\,\nearrow 0(2)} + \int_{CS} \bar{V} \rho \bar{V} \cdot d\bar{A}$$

$$F_{Sx} = \int_{A_e} v_x \rho \, v_e \cdot dA \qquad \text{where } v_x = v_e$$

where $F_{Sx} = R - (P_e - P_2) A_e$

& $\int_{A_e} v_e \rho v_e \cdot dA = \int_{A_e} v_e \left| \rho V_e \, dA \right| = v_e \dot{m}$

$\therefore \Rightarrow R = v_e \dot{m} + (P_e - P_2) A_e$ where R is the thrust, denote F

$$\boxed{F = v_e \dot{m} + (P_e - P_2) A_e}$$