HW1 SP01C

Wednesday, January 18, 2023 2:15 PM

Motor with C/D nozzle

$$\dot{Q} - \dot{W} = \sum \dot{m}_e \left(h_e + \frac{V_e^2}{2} + gz_e\right) - \sum \dot{m}_i \left(h_i + \frac{V_i^2}{2} + gz_i\right) \quad [kW]$$

↓

$$V_e^2 = \frac{2\gamma R_u T_c}{M(\gamma-1)}\left[1 - \left(P_e/P_c\right)^{(\gamma-1)/\gamma}\right] + V_c$$

Assume:

Adiabatic: $\dot{Q} = 0$

No shaft work: $\dot{W} = 0$

assume very low M

$$0 = h_e + \frac{V_e^2}{2} + \cancel{gz_e} - h_i - \cancel{\frac{V_i^2}{2}} - \cancel{gz_i}$$

these are the same

$$V_e^2 = 2(h_i - h_e)$$

$$h_x = \frac{\gamma R T_x}{\gamma - 1}$$

$R = \frac{R_u}{M} \rightarrow$ script M

$$V_e^2 = 2\left[\frac{\gamma R T_i}{\gamma-1} - \frac{\gamma R T_e}{\gamma-1}\right]$$

$$V_e^2 = \frac{2\gamma R}{\gamma-1}(T_i - T_e)$$

$T_i = T_c$

$$V_e^2 = \frac{2\gamma R T_c}{\gamma-1}\left(1 - \frac{T_e}{T_c}\right)$$

$$V_e^2 = \frac{2\gamma R T_c}{\gamma-1}\left[1 - \left(\frac{P_e}{P_c}\right)^{(\gamma-1)/\gamma}\right]$$

b)

Thermally perfect: obeys $PV = nRT$

↳ can't always assume bc of gas particle interactions

Calorically perfect: C_v & C_p are constant w/in a temp range

↳ Generally invalid due to large temp changes involved