Project 2 logic — Kyle Adler & Jackson Cyuas

$\frac{F_x}{F_t}\left(\frac{C_{J,ideal}}{C_{J,conv}}\right)$ vs. $\frac{f_x}{f_t}\left(\frac{A_e}{A_t}=\varepsilon\right)$

start w/ M_e value array

→ calculate A_e/A^* array & P_e/P_0 array

C_T, $C_{J,conv}$

Inputs: γ, P_e/P_0 (or A_e/A^* too?) → Check for shock

Shock if $P_e < P_{shock}$

Find P_{shock}: $\frac{A_e}{A^*} = \frac{1}{M_{sup}}\left[\frac{2}{\gamma+1}\left(1+\frac{\gamma-1}{2}M_{sup}^2\right)\right]^{\frac{\gamma+1}{2(\gamma-1)}}$

→ Find M_{sup} → $P_{sup} = PR(M_{sup})$

Across shock: $\frac{P_{shock}}{P_{sup}} = 1+\frac{2\gamma}{\gamma+1}\left(M_{sup}^2-1\right) = \frac{P_{shock}/P_0}{P_{sup}/P_0}$

→ if $\frac{P_e}{P_0} > \frac{P_{shock}}{P_0}$, calculate new J

If shock in nozzle:

$C_J = \gamma M_e^2 \frac{P_e A_e}{P_{0_1} A_1^*}$ Need M_e:

$$M_e^2 = -\frac{1}{\gamma-1} + \sqrt{\frac{1}{(\gamma-1)^2} + \frac{2}{(\gamma-1)}\left(\frac{2}{\gamma+1}\right)^{\frac{\gamma+1}{\gamma-1}}\left(\frac{P_{0_1}A_1^*}{P_e A_e}\right)^2}$$

→ $P_e = P_a$

→ $C_{J_{shock}} = \gamma M_e^2 \frac{P_a}{P_0}\frac{A_e}{A^*}$

P_{shex} for $\frac{A_e}{A^*} = 2$, $\gamma = 1.2$

$$\frac{A_e}{A^*} = \frac{1}{M_{sup}}\left[\frac{2}{\gamma+1}\left(1+\frac{\gamma-1}{2}M_{sup}^2\right)\right]^{\frac{\gamma+1}{2(\gamma-1)}} \rightarrow M = 2.0551$$

$$\frac{P_{sup}}{P_0} = \left(1+\frac{\gamma-1}{2}M_{sup}^2\right)^{\frac{\gamma}{1-\gamma}} = 0.12077$$

$$\frac{P_{shex}}{P_0} = \frac{P_{sup}}{P_0}\left[1+\frac{2\gamma}{\gamma+1}(M^2_{sup}-1)\right] = 0.545$$

$A_e/A^* = 915 \rightarrow M = 6.6 \rightarrow \frac{P_{sup}}{P_0} = 7\varepsilon{-4}$

$\rightarrow \frac{P_{shex}}{P_0} = 0.0332$

Line of max thrust: $P_e = P$

Shock line logic:

the first time $\frac{P_n}{P_0} > \frac{P_{shex}}{P_0}$, copy down $\frac{A_e}{A^*}$, $\frac{\tau}{\tau_{conv}}$

Do this for all $\frac{P_n}{P_0}$ parameter values & plot resultant points