PEL TEMA 2 SEMANA 5

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$M = 2\,g/mol$

$\gamma = 1.35$

$\Gamma(\gamma) = 0.6761$

$c^* = 5500\,m\,s^{-1}$

$R_u = 8.314\,J/mol\,K$

$A_g = 1.2\,cm^2 = 0.0012\,m^2$

$R = 4157\,J/kg.K$

(condiciones tobera adaptada)

1.7kg combustible / 5 segundos

$\therefore \dot{m}_{combustible} = 0.34\,kg\,s^{-1}$

$V_s = 9075\,m\,s^{-1}$

(a) $\dot{m} = 0.34\,kg\,s^{-1}$ //

(b) $P_c = \frac{c^* \dot{m}}{A_g} = 13.58\,MPa$ //

$T_c = (c^* \Gamma(\gamma))^2 R^{-1} = 3326\,K$ //

(c) $\dot{E} \simeq \dot{m} V_s \simeq 3085.5\,N$

$C_E = \frac{\dot{E}}{P_c A_g} = 1.65$

$I_{sp} = 9075\,m\,s^{-1}$

en tobera adaptada:

$I_{sp} \approx V_s \approx 9075\,m\,s^{-1}$ //

(d) $C_E = (c^*)^{-1} I_{sp} = 1.65$ //

(e) $C_E = C_{Eadap} = \Gamma(\gamma)\sqrt{\frac{2\gamma}{\gamma-1}\left[1-\left(\frac{P_s}{P_c}\right)^{\frac{\gamma-1}{\gamma}}\right]}$

$\therefore \frac{P_s}{P_c} = 3.33 \cdot 10^{-3}$ //

(f) $\varepsilon = \frac{A_s}{A_g} = \frac{\Gamma(\gamma)}{\left(\frac{P_s}{P_c}\right)^{1/\gamma}\sqrt{\frac{2\gamma}{\gamma-1}\left[1-\left(\frac{P_s}{P_c}\right)^{\frac{\gamma-1}{\gamma}}\right]}} = 18.94$ //

(g) $C_E = \Gamma(\gamma)\sqrt{\frac{2\gamma}{\gamma-1}\left[1-\left(\frac{P_s}{P_c}\right)^{\frac{\gamma-1}{\gamma}}\right]} + \varepsilon\left(\frac{P_s}{P_c} - \frac{P_{amb}}{P_c}\right)$ with $P_{amb} = 0$ en el vacío

$\therefore C_E = 1.713$

(h) $I_{sp} = c^* C_E = 9421.5\,m\,s^{-1}$ //

(i) considerando $\Delta V = 6\,km\,s^{-1} = 6000\,m\,s^{-1}$

$\Delta V = I_{sp} \ln\left(\frac{M_0}{M_f}\right) \quad \therefore \frac{M_0}{M_f} = e^{\frac{\Delta V}{I_{sp}}} = 1.89$ //

(j) $M_0 = M_S + M_{CP} + M_P$, con $M_S = 700\,kg$; $M_{CP} = 200\,kg$

$1.89 = \frac{M_S + M_{CP} + M_P}{M_S + M_{CP}} \Rightarrow M_P = 801\,kg$ //