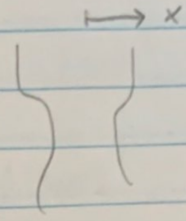
Mod 04 Problem

Steel &copper



Assume:

1-D heat trans.

conduction in x dir

k, α const

Analysis:

Use MATLAB for plots

$$\frac{T(x,t) - T_i}{T_\infty - T_i} = \text{erfc}\left(\frac{x}{2\sqrt{\alpha t}}\right) - \exp\left[\frac{hx}{k} + \frac{h^2\alpha t}{k^2}\right]\text{erfc}\left[\frac{x}{2\sqrt{\alpha t}} + \frac{h\sqrt{\alpha t}}{k}\right]$$

2667.2 $\rightarrow T_\infty - T_i$

$x = (0,3)$, $t = 2, 5, 10, 15$

↳ Assume inches. \ convert to m

Steel: $h = 10\,000$, $k = 60.5$, $\alpha = 17.7 \times 10^{-6}$, $T_{melt} = 1643K$

b) t when melting point reached

used MATLAB plots

this happens at $t = 2$ when $x = 0$

c) Plot copper profile

d) t when copper melts

Copper ex. will melt at 18 sec at $x = 0$

e) copper is more conductive (higher k) which means heat is drawn away faster than in steel

Mod 05

Assume - LOX/LH 2 min

$\dot{m} = 347$ kg/s r = 6.0 Palm

a) mass for 2 minute burn (Fuel)

$M_{total} = 347 \times 120 sec = 41640$ kg total ✓

$$\dot{m}_f = \frac{\dot{m}_{tot}}{1+r} = \frac{347}{7} = 49.57$$

$m_f = \dot{m}_f (120)$

$\boxed{m_f = 5948.57 \text{ kg}}$

b) $\dot{m}_{ox} = r \times \dot{m}_f = (49.57)(6) = 297.42$

$m_{ox} = \dot{m}_{ox} (120)$

$\boxed{m_{ox} = 35690.4 \text{ kg}}$

c) vol H for 2 min burn

$\rho = m/V$

$$V = m/\rho = \overset{m_f}{5948.57} / \overset{\text{google}}{0.08375} \text{ kg/m}^3$$

$\boxed{V_H = 71027.7 \text{ m}^3}$

d) length of cyl tank for H if inner diam = 1.6

$t_r = \rho_c A_c l_c \dot{m}$

$$l_c = \frac{t_r}{\rho_c A_c \dot{m}} = \frac{120 \text{ sec}}{0.08375 \frac{kg}{m^3} \cdot \frac{1.6^2 \pi}{4} m^2 \cdot 49.57 \text{ kg/s}}$$

$\boxed{l_c = 45.16 \text{ m}}$

Mod 06

gas & LOX

Assume- $P_c = 250$ psi, ARatio = 5.0 time = 20 sec

Analysis - a) on CEQUEL

b) highest performance => high Isp
this occurs at mixture ratio of $\boxed{3}$

c) $\varepsilon = 5.0$ e/t $P_c = 250$

$A_t = \dfrac{F_v \, c^*}{Isp_v P_c \, g_o}$ = est F_v = 30 000

$A_t = \dfrac{30000 \times 4258}{220.9 \times 250 \times 32.2}$

$\boxed{A_t \approx 71.83 \text{ in}^2}$

Scanned with CamScanner