Centerline T?

$R_F = 0.6$ cm $\quad t_g = 0.003$ cm $\quad t_c = 0.05$ cm $\quad Q = 300 \frac{W}{cm^3}$

$K_c = 0.15 \frac{W}{cm\text{-}K} \quad K_f = 0.03 \frac{W}{cm\text{-}K} \quad h_{cool} = 2.5 \frac{W}{cm^2\text{-}K}$

$T_{cool} = 550$ K

$$LHR = \pi R_f^2 Q = \pi (0.6^2) 300 = \underline{339 \ W/cm}$$

$$\frac{LHR}{2\pi R_F} \Rightarrow \frac{339}{2\pi\, 0.6} = 90$$

$$T_{co} - T_{cool} = \frac{LHR}{2\pi R_f} \frac{1}{h_{cool}} = 90 \frac{1}{2.5} = 36\text{K}$$

$$\underline{T_{co} = 586\text{ K}}$$

$$T_{ci} - T_{co} = \frac{LHR}{2\pi R_F} \frac{t_c}{K_c} = 90 \frac{0.05}{0.15} = 30\text{ K}$$

$$\underline{T_{ci} = 616\text{ K}}$$

$$T_s - T_{ci} = \frac{LHR}{2\pi R_F} \frac{t_g}{K_g} \qquad K_g(He) = 16 \times 10^{-6}\, T^{0.79}$$

$$T \approx T_{ci}$$

$$= 90 \frac{0.003}{0.00256} = 105.6\text{ K} \qquad K_g = 16 \times 10^{-6} (616)^{0.79} = 0.00256 \frac{W}{cm\text{-}K}$$

$$\underline{T_s = 721.6\text{ K}}$$

$$T_0 - T_s = \frac{LHR}{4\pi K_f} = \frac{339}{4\pi (0.03)} = 900\text{ K} \quad \rightarrow \boxed{T_0 = 1621.6\text{ K}}$$

if we empirically account for $K(T) \to T_0$?

$$K_{ox} = \frac{1}{A + BT}$$

$A = 3.8 + 200 \times \cancel{FIMA}^{\,0}$

$B = 0.0217$

$$\frac{1}{B} \ln\left(\frac{A + BT_0}{A + BT_s}\right) = \frac{LHR}{4\pi}$$

$$\frac{A + BT_0}{A + BT_s} = \exp\left(\frac{B \times LHR}{4\pi}\right)$$

$$\frac{0.38 + 0.0217\,T_0}{0.38 + 0.0217\,(T_s = 721.4\text{ K})} = \exp\left(\frac{0.0217 \times 339}{4\pi}\right)$$

$\underline{T_0 = 1435\text{ K}}$ $\to$ $\underline{\Delta T \downarrow = 186\text{ K}}$

1) Q? U-10 Zr $\epsilon = 19\%$ $\rho = 16$ g/cc $\sigma_f = 587b$

$\phi = 5 \times 10^{12}$ $n/cm^2\text{-}s$

$Q = N_u E_f \phi \sigma_f$

U-10Zr → 22 at% Zr

$M(U\text{-}10Zr) = 0.78(0.19 \times 235 + 0.81 \times 238) + 0.22 \times 92$

$= 205.4$ g/mol

$N_u^{235} \rightarrow 16 \text{ g/cc} \; \frac{1 \text{ mol}}{205.4 \text{ g}} \; \frac{6.022 \times 10^{23} \text{ mole}}{1 \text{ mol}} \; \frac{0.784}{1 \text{ mole}} \times 0.19$

$= 6.951 \times 10^{21} \; \frac{U^{235}}{cm^3}$

$Q = (200 \times 10^6 \text{ eV})\left(1.602 \times 10^{-19} \frac{J}{eV}\right)\left(587 \times 10^{-24} \text{ cm}^2\right)\left(5 \times 10^{12} \frac{n}{cm^2\text{-}s}\right) \times \left(6.951 \times 10^{21}\right)$

$Q = 653.7 \; \frac{J}{cm^3\text{-}s} \rightarrow \boxed{654 \; \frac{W}{cc}}$

Forward Euler

$$\frac{dy}{dt} = -5y \qquad dt = 0.33 \quad t_0 = 0 \quad y_0 = 1$$

$\rightarrow$ integrate up to $t = 1$

$$y_1 = y_0 + dt\, y_0'$$

$t_1 = 0.33 \qquad y_1 = 1 + 0.33(-5(1)) = -0.65$

$t_2 = 0.66 \qquad y_2 = y_1 + dt\, y_1'$

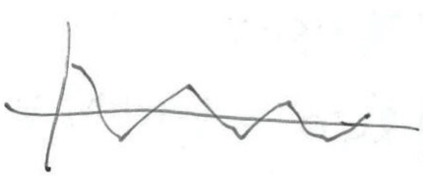
$$= -0.65 + 0.33(-5(-0.65))$$

$$= 0.4225$$

$t_3 = 1 \qquad y_3 = y_2 + dt\, y_2'$

$$= 0.4225 + 0.33(-5(0.4225))$$

$$\boxed{= -0.275}$$



Rod length 3.2 m $LHR^\circ = 300 \ W/cm$ $\gamma = 1.1$

LHR @ $z = 0.8$ m?

$$LHR(z) = LHR^\circ \cos\left(\frac{\pi}{2\gamma}\left(\frac{z}{z_0} - 1\right)\right)$$

$z_0 = \frac{L}{2}$

$z_0 = 1.6$ m

$$LHR(0.8) = 300 \cos\left(\frac{\pi}{2(1.1)}\left(\frac{0.8}{1.6} - 1\right)\right)$$

$$= \underline{226.7 \ W/cm}$$

Coolant Temp @ $z = 0.8$

$c_p = 4200 \frac{J}{Kg \cdot K}$ $\dot{m} = 0.3 \frac{Kg}{s\text{-rod}}$ $T_{cool}^{in} = 500K$

$$T_{cool}(z) = \frac{2\gamma}{\pi} \frac{z_0 \, LHR^\circ}{\dot{m} \, c_p}\left[\sin\left(\frac{\pi}{2\gamma}\right) + \sin\left(\frac{\pi}{2\gamma}\left(\frac{z}{z_0} - 1\right)\right)\right] + T_{cool}^{in}$$

$$= \frac{2(1.1)}{\pi} \frac{160(300)}{0.3(4200)}\left[\sin\left(\frac{\pi}{2(1.1)}\right) + \sin\left(\frac{\pi}{2(1.1)}\left(\frac{0.8}{1.6} - 1\right)\right)\right] + 500$$

$$T_{cool}(z = 0.8 \ m) = \boxed{509 \ K}$$