① Angélica María López Morales

$$\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right)+Q=0 \qquad T'(x_0)=0 \quad k_0=0$$

$$T(x_1)=T_1 \quad x_1=X$$

$$\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right)=-Q$$

$$k\frac{\partial T}{\partial x}=-Qx+C_1$$

$$0=-Q\cdot 0+C_1 \Rightarrow C_1=0$$

$$k\frac{\partial T}{\partial x}=-Qx$$

$$\frac{\partial T}{\partial x}=-\frac{Q}{k}x$$

$$T=-\frac{Q}{k}\frac{x^2}{2}+C_2$$

$$T_1=-\frac{Q}{k}\frac{X^2}{2}+C_2$$

$$C_2=T_1+\frac{Q}{k}\frac{X^2}{2}$$

$$T=-\frac{Q}{2k}x^2+T_1+\frac{Q}{k}\frac{X^2}{2}$$

$$\boxed{T-T_1=\frac{Q}{2k}(X^2-x^2)}$$

To get the provide equation it was assumed:

① steady state
② axisymmetric
③ Temperature is constant in z
④ the thermal conductivity is constant

Angelica Lopez Morales #2

④ $T_0 = ?$

$T(r = 0,4\,cm) = ?$

$K_{cot} = 5 \frac{w}{mK}$

$K_{clad} = 15 \frac{w}{mK}$

$K_f = 0,5\, w/cm\text{-}K$

$K_g = 25\, w/m\text{-}K$

$h_{cool} = 5,5\, w/cm^2K$

$T_{cool} = 800K$

$Q = 400\, w/cm^3$

$r_1 = r_f = 0,6cm$

$r_2 = r_{c1} = 0,8cm$

$r_3 = r_{co} = 0,85cm$

$r_4 = r_{cot} = 0,86cm$

$$T_{cot} = \frac{Q}{2h_{cool}} R_f + T_{cool}$$

$$= \frac{400 w/cm^3}{2 \cdot 5,5 \frac{w}{cm^2K}} \cdot 0,6cm + 800K$$

$$= 821,81\,K$$

$$T_{CO} - T_{cot} = \frac{Q \cdot t_{cot}}{2 \cdot K_{cot}} \cdot R_f$$

$$T_{CO} = \frac{400 w/cm^3 \,[0,86cm - 0,85cm] \cdot 0,6cm}{2 \cdot 5 \frac{w}{mK} \cdot \frac{1m}{10^2 cm}} + 821,81K$$

$$= 845,81\,K$$

$$T_g - T_{co} = \frac{Q\, t_{clad}}{2K_{clad}} \cdot R_f$$

$$T_g = T_{CI} = \frac{400 w/cm^3 \cdot (0,85 - 0,8)\,cm}{2 \cdot 15 \frac{w}{mK} \cdot \frac{1m}{10^2 cm}} \cdot 0,6cm + 845,81K$$

$$T_g = 885,81\,K = T_{CI}$$

$$T_f - T_{CI} = \frac{Q}{2h_{gap}} R_f$$

$$T_f = \frac{400 W/cm^3 \,[0,8-0,6]cm}{2 \cdot 25 \frac{W}{mK}} \cdot 0,6\,cm + 885,81\,K$$

$$= 981,81\,K$$

$$T_0 = \frac{Q}{4k} R_f^2 + T_f = \frac{400 W/cm^3 \cdot (0,6\,cm)^2}{4 \cdot 0,5 \frac{W}{cmK}} + 981,81\,K = \underline{1053,81\,K}$$

$$T(r_i = 0,4) = \frac{Q}{4k} \left(R_f^2 - r^2\right) + T_f$$

$$= \frac{400 W/cm^3}{4 \cdot 0,5 W/cmK} \left(0,6^2 - 0,4^2\right) cm^2 + 981,81\,K$$

$$= \underline{1021,81\,K}$$

(3) $k_f = 15,5 \frac{W}{mK}$

$e = 0,195$

$\rho_f = 15,67 \frac{g}{cm^3}$

$\sigma_f = 570 \cdot 10^{-24} cm^2$

$\phi_n = 2 \cdot 10^{12} \frac{n}{cm^2 s}$

a) $Q = E_f \cdot \Sigma_f \cdot \sigma_f \cdot \phi$

$U = 235 \cdot 0,195 + 238 \cdot 0,805 = 237,415\,aum$

$mass(U_3Si_2) = 3 \cdot 237,415 + 2 \cdot 28$

$= 768,24\,aum$

$N_{U-235} = 15,67 \frac{g}{cm^3} \cdot \frac{mol}{768,24\,g} \cdot 6,022 \cdot 10^{23} \frac{atom}{mol}$

$\cdot \frac{3U}{1\,U_3Si_2} \cdot 0,195$

$= 7,18 \cdot 10^{21}\,atom/cm^3$

$Q = 200\,MeV \cdot 10^6 \frac{eV}{MeV} \cdot 1,602 \cdot 10^{-19} \frac{J}{eV} \cdot 7,18 \cdot 10^{21} \frac{atom}{cm^3} \cdot 570 \cdot 10^{-24} cm^2 \cdot 2 \cdot 10^{12} \frac{n}{cm^2 s}$ (#4)

$Q = 2602,25\ w/cm^3$

b) $\rho_{UO_2} = 10,97 \frac{g}{cm^3}$ $\quad mass(UO_2) = 237,41 + 2 \cdot 16 = 269,41\ g/mol$

$7,18 \cdot 10^{21} \frac{atom}{cm^3} = 10,97 \frac{g}{cm^3} \cdot \frac{mol}{269,4\,g} \cdot 6,022 \cdot 10^{23} \frac{atom}{mol} \cdot \frac{1\,g}{1\,UO_2} \cdot enrich.$

$enrig. = 0,108\,\%$

(4) $CHR = 150\,w/cm$
$z_0 = 1,5$
$H = 1,1$

a)

$CHR = 1,8\,m = ?$

$$CHR(1,8m) = CHR^0 \cos\left[\frac{\pi}{2H}\left(\frac{z}{z_0} - 1\right)\right]$$

$$= 150 \frac{w}{cm} \cos\left[\frac{\pi}{2 \cdot 1,1}\left(\frac{1,8}{1,5} - 1\right)\right]$$

$$= 143,92\ w/cm$$

b) $$T_{cool} - T_{cool}^{i} = \frac{1}{1,2} \cdot \frac{1,5 \cdot 150\ w/cm}{\dot{m} C_p} \underbrace{\left[\sin\left(\frac{\pi}{2 \cdot 1,1}\right) + \sin\left(\frac{\pi}{2 \cdot 1,1}\left(\frac{1,8}{1,5} - 1\right)\right)\right]}_{= 1,2715}$$

water $$\Delta T = \frac{1}{1,2} \cdot \frac{1,5 \cdot 150\ w/cm}{0,22\ \frac{kg}{s\,rod} \cdot 4200 \frac{J}{kg}} \cdot 1,2715$$

$= 0,2580$

#5

Sodio $\Delta T = \frac{1,5 \cdot 150}{1,2 \cdot 0,12 \cdot 1404} \cdot 1,2715$

$= 1,415$

Sodium tee larger change.

(5) $dt = 0,33 \quad t_n = 2 \quad y(t_0) = 6 \quad t_0 = 1 \quad y' = 4t - 3t^2$

$t_0 = 1 \quad y(t_0) = 6$ forward

$t_1 = t_0 + \Delta t = 1 + 0,33 = 1,33 \quad y_1 = y_0 + dt\, y_1' = 6 + 0,33 \cdot (4 - 3)$

$= 6,33$

$t_2 = t_1 + \Delta t = 1,33 + 0,33$

$= 1,66 \quad y_2 = y_1 + dt\, y_1' = 6,33 + 0,33 \cdot (4 \cdot (1,33) - 3(1,33^2))$

$= 4,334$

$t_3 = t_2 + \Delta t = 2 \quad y_3 = y_2 + dt\, y_2' = 4,334 + (4(1,66) - 3(1,66^2))$

$= 4,7072$

Backward.

$t_0 = 1 \quad y(t_0) = 6$

$t_1 = 1,33 \quad y_1 = y_0 + dt\, y_1' = 6 + 0,33 \cdot [4(1,33) - 3(1,33^2)]$

$= 6,004$

$t_2 = 1,66 \quad y_2 = y_1 + dt\, y_2' = 6,004 + 0,33 \cdot [4(1,66 - 3(1,66^2)]$

$= 5,4671$

$t_3 = 2 \quad y_3 = y_2 + dt\, y_3' = 5,4671 + 0,33[4 \cdot 2 - 3 \cdot 2^2)$

$= 4,1471$

(5) A fissile isotope can undergone fission by absorption of thermal neutron. On the other hand and fissionable isotope can undergone fission as well but by energetic neutrons, Finally a fertile isotope does not undergone fission by thermal or energetic neutron but can ~~absorb~~ get a neutron an be converter into a fissile isotope.

(7) (1) Because it drastically swells
(2) Have anisotopic thermal expansion an irradiation growths

(8) smear density is the radio of the volumen of fuel pellet to fuel element

$$\text{smeardensity} = r_1^2 / r_2^2$$

it is necessary because the fuell swell so an smear density less than 1 is important to avoid fuel-cladding mechanical and chemical interactions

(9) Uranium need to be enriched because U-235 is an small percent of natural uranion and U-238 do not undergone fission by thermal neutron

UF_6 is utilite in the enrichment process

In the centrifuge method the gas is placed in a centrifuge cylinder and rotate at high speed because U-235 and U-238 have different mass, the gass molecules of ~~the~~ U-238 will move towards the outside of the cylinder, then ~~rotor~~ U-235 ~~not~~ enriched can be obtained

(10) Mo, Cs → fission products yields are effectively the same (double hump distribution)

(11) ① finite difference.
② finite volomen
③ finite element.

finite element is more correctly used due to more flexibility with geometry and boundary conditions than finite difference which have been traditionaly use. Finite volomen is not use because it cannot solve for stress