1

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

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

- solve for C_1

$$\int_{T_0}^{T_1} k\,\partial T = -Q\int_0^{X_1} x\,\partial X$$

this, doesn't lead to that

$$T_1 - T_2 = \frac{QX^2}{4k}$$

$$T_0 - T_s \; \frac{QR^2}{4k} \quad x$$

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

Cartesian, where does R come from?

$\boxed{83}$

2

$$T_{clad} - T_{coat} = \frac{Q\, t_{coat}}{2 k_{coat}} R_{fuel} \Rightarrow T_{clad} = 600\,k + \frac{250\frac{W}{cm^3} \cdot 0.01cm \cdot 0.6cm}{2(0.015)\,W/cmK}$$

$$T_{clad} = 650\,k$$

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$$T_{gap} = T_{clad} + \frac{Q\, t_{clad}}{2 k_{clad}} R_f = 650 + \frac{250\frac{W}{cm^3}\ 0.05cm\ 0.6cm}{2(0.15\frac{W}{cmK})}$$

$$T_{gap} = 675^\circ k$$

$$T_f = T_{gap} + \frac{Q t_{gap} R_{fuel}}{2 K_{gap}} = 675 + \frac{250 \cdot 0.6 \cdot 0.005}{2(0.004)}$$

$$T_f = 768.75^\circ k$$

$$T_o = T_f + \frac{Q}{4k} R_f^2 = 768.75^\circ k + \frac{250(0.6)^2}{4(0.05)}$$

$$\boxed{T_o\,(\text{with Coat}) = 1218.75k}$$

Without Coat or $t_{coat} = 0$

$$T_o = T_{co} + \frac{Q\, t_{coat}}{2K_{coat}} R_f + \frac{Q\, t_{clad}}{2 k_{clad}} R_f + \frac{Q\, t_{gap}}{2 k_{gap}} R_f + \frac{Q R_f^2}{4k}$$

$$T_o = 600\,k + 0 + 25 + 93.75 + 450 = \boxed{1168.75^\circ k}$$

(3)

Heat assumed fission only

$\rho_U = \frac{237}{251} \cdot 12.3\ g/cm = 11.6\ g/cm$

-> where does 251 come from?

$\rho_{U-235} = 0.195 \cdot 11.6\ g/cm^3 = 2.26\ g/cm^3$

$A = \frac{6.022 \cdot 10^{23}\ \#/mol\ \ 2.26\ g/cm^3}{235\ g/mol} = 5.80 \cdot 10^{21}\ \#/cm^3$

- needed to switch to atoms instead of staying in grams

$Q = \sigma_f \cdot A \cdot \phi \cdot 220\ MeV \cdot 1.602 \cdot 10^{-13}\ J/MeV$

$Q = 570 \cdot 10^{-24} \cdot 5.80 \cdot 10^{21} \cdot 5 \cdot 10^{12} \cdot 220 \cdot 1.602 \cdot 10^{-13}\ \frac{J}{s\ cm^3}$

$\boxed{Q = 582.6\ \frac{W}{cm^3}}$ -> 505 W/cm^3

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(b)

$\rho_{U-235} = 2.26\ g/cm^3$ $\rho_U = \frac{\rho_{U-235}}{e_w}$ $\rho_{UO_2} = 10.97\ g/cm = \rho_U \cdot \frac{M_U}{M_{UO_2}}$

$10.97 = \left(\frac{\rho_{U-235}}{ew}\right) \cdot \frac{M_U}{M_{UO_2}}$ $ew = \frac{2.26}{10.97} \cdot \frac{237}{269} = 0.1815$

$\boxed{ew\% = 18.2\%}$

- set N_f equal, takes

$\frac{x}{A(UO_2)} = \frac{N_f}{N_A} \frac{1}{\rho_{UO_2}}$

(4)

(a) $LHR\left(\frac{z}{Z_0}\right) = LHR^\circ \cos\left[\frac{\pi}{2\gamma}\left(\frac{z}{Z_0}-1\right)\right] = LHR^\circ F\left(\frac{z}{Z_0}\right)$ 12/12

$Z_0 = 1.75 \quad \gamma = 1.3 \quad z = 1.4 \quad LHR^\circ = 350 \text{ W/cm}$ ✓

$LHR\left(\frac{1.4}{1.75}\right) = 350 \cos\left[\frac{\pi}{2.6}\left(\frac{1.4}{1.75}-1\right)\right] = 350 \cdot 0.971$ ✓

$$\boxed{LHR\left(\frac{1.4}{1.75}\right) = 340 \text{ W/cm}}$$ ✓

(b) $Q = LHR^\circ \int_0^{3.5} \cos\left[\frac{\pi}{2\gamma}\left(\frac{z}{Z_0}-1\right)\right] = 9.48 \cdot 10^4 \frac{J}{s}$ ✓

$\Delta T = \frac{Q}{\dot{m} c_p} = \frac{9.48 \cdot 10^4 \frac{J}{s}}{0.22 \frac{kg}{s} \cdot 4200 \frac{J}{kg\,K}} = 102.6^\circ K$ ✓ ✓

$$\boxed{T_{out} - T_{in} = 102.6^\circ K}$$

(5)

t	dy/dt	y
0.0	0	4.184
0.5	0.184	4.319
1.0	0.135	4.391
1.5	0.075	4.431
2.0	0.037	

$y = y_0 + dy(t)$

$y(0.0) = 4 + 0.184 = 4.184$

$y(0.5) = 4.184 + 0.135 = 4.319$

$y(1.0) = 4.319 + 0.075 = 4.394$

$y(1.5) = 4.394 + 0.037 = 4.431$

I am providing you w/ t_0 and $y_0 = 4$

You are stepping too far, your process is

$y_n = y_n + dt\, y_{n+1}$

instead of

$y_{n+1} = y_n + dt\, y_{n+1}$

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⑥ Fissile: An isotope with a lower critical threshold, after capturing a neutron, than single neutron separation energy.

4/4

Fertile: An isotope that will become fissile after capturing a neutron.

Fissianable: An isotope which can fission after capturing a neutron over some threshold energy.

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⑦ 1. Dramatic Swelling

4/4 2. Too many Phase changes in expected T-P range.

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⑧ The ratio of fuel Volume to internal Volume of the fuel element.

3/4 useful for swelling limitation estimations

-accommodates swelling

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⑨ If we use CANDU reactors we don't

otherwise it is necesary to have a large enough keff

8/8 to overcome the additional negative neutron reactivity of the non fuel reactor system.

UF_6 uranium Hexafluoride

In a centrifuge particles are stratified by rotational motion according to their molecular mass. Fissile Uranium-235 is sufficiently different from U-238 to allow separation.

(10) Finite (Element, Volume, Difference)

4/6

Finite Element is best for high fidelity Simulations.

- you dont say why...

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(11) DBN: The point where heat transfer becomes impeded by steam insulating the rod surface.

6/8 CHF: The point where heat flux peaks from nucleate boiling before begining a transition to film boiling.

DBN → ratio of the heat flux to CHF

12)

0/3