76/100

-15, 10/25

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Exam 2
Question 1 -5, T increase due to fission, gap decrease due to thermal expansion

Point 1. Startup, ~~the heat~~ the fuel and cladding are still at fabrication conditions, indicated by point being at 0 burnup.

2. Fuel densification occurs and the gap increases. This is indicated by the gap increase from point 1 to point 2 -1, impact on T?

3. Defects in the fuel cluster together and fission gas segregate to the grain boundaries and voids.
-4, Swelling decreases gap and raises T. Cladding creeps down

4. The gap is closed. The gap width reaches zero.
-3, T increases due to fission gas release, then decreases due to more swelling

5. Pellet and cladding interact and the cladding corrodes or fails. This is indicated by the gap is closed and the centerline temperature is increasing.
-2, T increases because fuel k decreases with burnup

Question 2

-8, 22/30

a) $D = D_1 + D_2 + D_3$ $\dot{F} = $ ~~[illegible]~~ $2e13\ f/cm^3 s$

$D_1 = 7.6E-6\ e^{\left(\frac{-3.03eV}{kbT}\right)} = 0$

-2, Why zero?

$D_2 = 1.41\times10^{-18}\ e^{\left(\frac{-1.19eV}{kbT}\right)}\sqrt{\dot{F}} = 0$

$D_3 = 2E-30\dot{F} = 4E-17$

$\boxed{D = 4E-17\ cm^2/s}$

b) $N_r = f\ N_{gas}$

shouldn't be boxed

$N_{gas} = y\ \dot{F} + V_{fuel}$

$\frac{N_{gas}}{V_{fuel}} = (0.3017)(2e13)(63072000) = \boxed{3.806E20\ atoms/cm^3}$

$N_r = f\ N_{gas}$

$f = 4\sqrt{\frac{Dt}{\pi a^2}} - \frac{3Dt}{2a^2}$

$f = 4\sqrt{\frac{(4E-17)(63072000)}{\pi\ (8E-4)^2}} - \frac{3(4E-17)(63072000)}{2\ (8E-4)^2}$

$f = 0.136$

$N_r = 0.136(3.806E20)$

$\boxed{N_r = 5.168\ E19\ atoms/cm^3}$

c) $f = 0.1$

$f = 6\sqrt{\frac{Dt}{\pi a^2}} - 3\frac{Dt}{a^2}$

$f^2 = \frac{36Dt}{\pi a^2} - \frac{9D^2t^2}{a^4}$

$\frac{9D^2t^2}{a^4} - \frac{36Dt}{\pi a^2} + f^2 = 0$

$\frac{9(4E-17)^2t^2}{(8E-4)^4} - \frac{36(4E-17)t}{\pi(8E-4)^2} + (0.1)^2 = 0$

$3.515E-20t^2 - 7.162E-10t + 0.01 = 0$

$t = \frac{7.162E-10 \pm \sqrt{-4(3.515E-20)(0.01) + (7.162E-10)^2}}{2(3.515E-20)}$

$\boxed{t = 1.019E10\ s}$

-4, You need to recalculate D at 2273 K

$N_r = 0.1(3.806E20)$

$\boxed{N_r = 3.806E19\ atoms/cm^3}$

-2, Only gas left after release

-1, 29/30

Question 3

a) $t^* = 6.62E{-7}\, e^{\left(\frac{11949}{T}\right)} = 295$ days

$\delta^* = 5.1\, e^{\left(\frac{-550}{T}\right)} = 2.04\ \mu m$

$\delta = 2.04 + 6.25E{-3}\,[365 - 295] = 2.4775\ \mu m$

$W = 2.4775\ \mu m \times 14.7 = \boxed{36.42\ mg/dm^2}$

$\boxed{b)\ t_{clad} = 600\ \mu m - \frac{2.04}{1.56} = 598.69\ \mu m}$

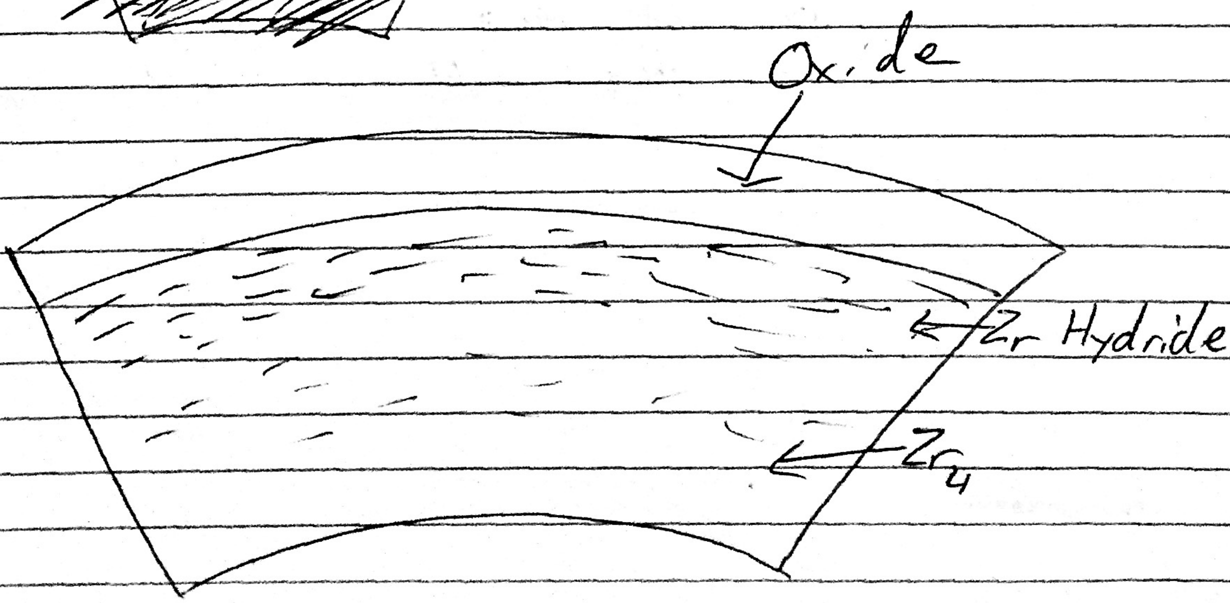
c) $C_H = \dfrac{2 f \delta \rho_{ox} f_{O_2} \, {}^{m_H}/_{m_O}}{\left(t - \frac{\delta}{PBR}\right) \rho_{metal}} \times 10^6$

$C_H = \dfrac{2(0.15)(2.04)(5.68)(0.26)\left(\frac{1}{16}\right)}{\left(600 - \frac{2.04}{1.56}\right) 6.5} \times 10^6$

$\boxed{C_H = 14.52\ wt.\ ppm}$

-1, math error, should be 17.87 wt.ppm

d)



-0, 15/15

Question 4

a) The major differences between a LOCA and RIA is the cause of the temperature increase and how fast it occurs. In a RIA there is a large insertion of reactivity causes a large and sudden temperature increase, which causes a pressure increase in the fission gases and can cause the cladding to crack and fuel dispersal. In a LOCA the coolant pressure drops and the fuel slowly heats up because the decay heat is not being removed. The temperature increase causes the internal pressure to rise and the cladding balloons out before possibly cracking and dispersing fuel.

b) The similarities are that the temperature increases and the cladding and crack or burst allowing fuel dispersal.

c) Silicon Carbide is a cladding alternative which could make the reactor safer in accident conditions because it does not react with steam like zircalloy does so there would be reduced hydrogen production