Exam 3: NE533: Nuclear Fuel Performance

Show all work. Label question number in your response. Pay attention to units. Point values correspond to expected depth of response.

1. (14 pts) Determine the total change in the fuel volume given: αth=10x10-6, fission rate = 6x1013 fiss/cm3-s, Tf=1600 K, Tref=500 K, Δρ0=0.015, BD=5 MWD/kgU, ρ(UO2) =10.97 g/cc, t=300 days.
2. (10 pts) What is the total creep in a RXA zirconium cladding given a von Mises stress of 85 MPa, a temperature of 650 K, a LHR of 200 W/cm, and a time of 200 days? A0 = 3.14 × 1024; G = 4.2519 × 1010 − 2.2185 × 107T; n = 5; Q = 2.7 × 105, C0=1.654E-24; C1=0.85; C2=1
3. (10 pts) Two fuel pellets are irradiated for 60 days at 1500 K at a fission rate of 3x1013 fiss/cm3-s. One fuel sample has a grain size of 10 microns, and the other has a grain size of 25 microns. What fraction of fission gas is released in each?
4. (5 pts) What is the typical charge state of U in UO2? What can cause it to change?
5. (5 pts) How does the oxygen concentration change across the fuel pellet? How does Mo impact this?
6. (3 pts) Name three properties that vary as a function of stoichiometry in UO2.
7. (10 pts) What are the five types of fission products that form in the fuel? List a role each plays in fuel performance.
8. (9 pts) List and describe the three stages of fission gas release.
9. (5 pts) What is creep? What is one mechanism of creep (name and physical description)?
10. (3 pts) List three benefits of using Zr cladding.
11. (6 pts) Describe the irradiation growth of hcp Zr due to point defects.
12. (8 pts) Describe how creep impacts the Zr cladding over time in a fuel rod.
13. (12 pts) What are the four conditions that must be met for SCC? Briefly describe how each is met in PCI.
14. (5 pts) What role does iodine play in the corrosion of Zr cladding?