Exam 3: NE591-10: Nuclear Fuel Performance

1. A fuel pellet with an average grain size of 8 microns is irradiated with a volumetric fission rate of 3.0e14 fiss/(cm3-s). Assume the pellet is at a uniform temperature of 1300 K.
2. What is the total fission gas diffusion coefficient at this temperature? (6 pts)
3. How many gas atoms/cm3 are released from the fuel after 2 years of irradiation? Assume the yield y = 0.3017. (10 pts)
4. The pellet is removed from the reactor and from its cladding. It is then moved to a furnace and annealed at 2000 K. Estimate how long before 30% of the gas trapped in the pellet is released. (6 pts)
5. A ZIRLO cladding tube is in reactor at 550 K for one year. The initial wall thickness is 500 μm.
6. Estimate the oxide thickness after this time? (8 pts)
7. Calculate the amount of irradiation creep assuming m = 300 MPa and LHR = 250 W/cm. (5 points)
8. Determine the total volume change in the fuel. Assume: αth=11x10-6, burnup=0.018 FIMA, T=1800 K, Tref=300 K, Δρ0=0.01, BD=7 MWD/kgU, ρ(UO2)=10.97 g/cc. (12 pts)
9. What are the five types of fission products that form in the fuel? (6 pts)
10. List the three stages of fission gas release. (6 pts)
11. Name two types of thermal creep. Which type of creep is based on bulk diffusion? (6 pts)
12. Describe the concept of microstructure-based fuel performance modeling, including why it is valuable. (8 pts)
13. List three benefits of using Zr cladding. (6 pts)
14. Why does metallic fuel undergo constituent redistribution? Why does this affect fuel performance? (10 pts)
15. What is a RIA, and what can occur to the fuel during a RIA? (10 pts)
16. Where can hydrides form within cladding? What causes hydride concentrations to be heterogeneous? (6 pts)