Exam 3: NE533: Nuclear Fuel Performance

Show your work. Point values are indicative of the depth of expected response. Check units.

1. A ZIRLO cladding tube is in reactor at 625 K for 400 days. The initial wall thickness is 500 μm.
2. Estimate the oxide thickness after this time? (8 pts)
3. Assuming the hydrogen pickup fraction is 18%, what is the weight PPM of hydrogen in the cladding after one year? Assume PBR = 1.56, ρZr = 6.5 g/cc, ρZrO2 = 5.68 g/cc. (8 pts)
4. Determine the total change in the fuel volume given: αth=11x10-6, fission rate = 3.5x1013 fiss/cm3-s, T=1200 K, Tref=300 K, Δρ0=0.01, BD=5 MWD/kgU, ρ(UO2)=10.97 g/cc, t=85 days. (16 pts)
5. What is the total creep in a zirconium cladding given a von mises stress of 200 MPa, a temperature of 600 K, a LHR of 150 W/cm, and a time of 1.5 years? Use nominal values from lectures. (12 pts)
6. What are the five types of fission products that form in the fuel? (5 pts)
7. Describe the concept of microstructure-based fuel performance modeling and why it is potentially beneficial. (6 pts)
8. List three benefits of using Zr cladding. (6 pts)
9. Why does metallic fuel undergo constituent redistribution? (5 pts)
10. What are some of the key differences in MOX fuel compared to LWR fuel? Emphasize differences on in-reactor behavior/performance/environment. (8 pts)
11. What are the four conditions that must be met for SCC? Briefly describe how each is met in PCI. (8 pts)
12. What leads to the possibility of oxide fuel pulverization/fragmentation in the HBS? How are scientists addressing this topic? (6 pts)
13. What are the performance/behavior differences between a RIA and a LOCA? Provide an example of a RIA. (8 pts)
14. What are two of the pathways to make the fuel/cladding system more accident tolerant? Provide an ATF option being considered that targets one of these pathways. (6 pts)
15. Provide two examples of limiting phenomena governing LWR operation. (4 pts)