Exam 4: NE533: Nuclear Fuel Performance

1. A ZIRLO cladding tube is in reactor at 650 K for 300 days. The initial wall thickness is 500 μm. Utilize nominal equations from class.
   1. Estimate the oxide thickness after this time? (10 pts)
   2. Assuming the hydrogen pickup fraction is 18%, what is the wt. ppm of hydrogen in the cladding? Assume PBR = 1.56, ρZr = 6.5 g/cc, ρZrO2 = 5.68 g/cc, and initial H content is 35 wt. ppm. (6 pts)
2. The oxide thickness on a 2.5x2.5x0.01 cm Zr coupon is 0.005 cm. What was the weight gain of this sample? (0.01 cm = 100 mm) (6 pts)
3. Discuss metallic fuel constituent redistribution. (6 pts)
4. What are some of the key performance (environmental, material, chemical, etc.) differences in MOX fuel systems compared to LWR fuel? (8 pts)
5. What are the different regions in restructured MOX fuel, and why do they form? (8 pts)
6. What is a RIA and what are its impacts on the fuel? (8 pts)
7. What is a LOCA? How does a LOCA differ from a RIA with regard to material impacts? (8 pts)
8. Provide two examples of limiting phenomena governing LWR operation. (4 pts)
9. What does hydrogen water chemistry mean? Why is it used? (8 pts)
10. Discuss two of the key phenomena in TRISO fuels. (8 pts)
11. Where can hydrides form within cladding? What causes hydride concentrations to be heterogeneous? What effect do hydrides have on the cladding? (10 pts)
12. What is the rate-limiting step in the water corrosion of Zr cladding? (4 pts)
13. Explain what the Pilling-Bedworth Ratio is and how it relates to passivation. (6 pts)