Exam 3: NE533: Nuclear Fuel Performance

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=300 K, Δρ0=0.015, BD=5 MWD/kgU, ρ(UO2) =10.97 g/cc, t=300 days.
2. (8 pts) What is the total creep in a RXA zirconium cladding given a von mises stress of 120 MPa, a temperature of 600 K, a LHR of 200 W/cm, and a time of 100 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. (14 pts) Two fuel pellets have been irradiated for 60 hrs at 1600 K. One fuel sample has a grain size of 10 microns and the other has a grain size of 25 microns. How much more fission gas is released in the smaller grained fuel pellet?
4. (8 pts) List and describe the three stages of fission gas release?
5. (10 pts) What are the five types of fission products that form in the fuel? List a role each plays in fuel performance.
6. (12 pts) What are the four conditions that must be met for SCC? Briefly describe how each is met in PCI.
7. (8 pts) Describe the irradiation growth of hcp Zr due to point defects.
8. (8 pts) Describe the three stages of zirconium cladding creep in a fuel rod.
9. (3 pts) Name three properties that vary as a function of stoichiometry in UO2.
10. Diagram

    Description automatically generated(3 pts) What are the two types of mitigation strategies to limit PCI?
11. (4 pts) What is the typical charge state of U in UO2? What causes it to change?
12. (4 pts) List three benefits of using Zr cladding.
13. (6 pts) What role does iodine play in the corrosion of Zr cladding?
14. (3 pts) Based on the figure at the right, which reaction is more favorable, Nb/NbO, or Ba/BaO?