NucE 497I

Homework 2

1. A zirconium alloy nuclear fuel cladding tube undergoes corrosion and hydriding when exposed to the reactor environment. According to a simple model the growth of the oxide scale is initially cubic, changing to a linear regime at a critical oxide thickness. The component undergoing corrosion is immersed in water at 340 C in the first cycle, at 320 C in the second cycle and 330 in the third cycle. The fuel cycle is 1 year.

a) The oxide transition occurs at 2 microns. Does this occur in the first cycle?

b) Calculate the final oxide thickness when the fuel reaches end of life (after 3 cycles).

c) If a single temperature is used for the three cycles what would be the maximum temperature to keep the corrosion layer under 15 microns after three years?

$$\delta(\mu m) = K_c t(days)^{1/3}$$

$$K_c = 504 * \exp(-4600 / T(K))$$

$$\delta(\mu m) = K_L (t - t^*)(days)$$

$$K_{L-Zry4} = 3\times 10^9 \exp(-15700 / T(K))$$

$$K_{L-ZIRLO} = 6\times 10^7 \exp(-13800 / T(K))$$

2. Considering the hydrogen pickup fraction to be 15%, and considering that the cladding ductility relative to a reactivity initiated accident is severely impaired when the H concentration reaches 700 wt. ppm, after how many days of 350 C reactor exposure would cladding ductility be severely impaired? For this case consider that the material goes into linear behavior as soon as service starts and no change in temperature occurs throughout the life of the fuel.