QUIZ #3 Solutions

Solutions, Quiz #3

1. Calculate the specific burnup value for 1 year's operation of a 1000-MW electricity nuclear power reactor with overall efficiency of 33%. The initial U-235 content in the fuel loading is 2800 kg. The remainder is U-238 and the initial enrichment is 0.03. Also Calculate the burnup fraction assuming that U-235 fission is the only source of heat in the reactor and the its energy production is 1.3 grams/ MWd .
   Fractional burnup β= number of fissions/initial number of heavy atoms **(6 points)**

2. Briefly state the function of each of the following components in a reactor: the fuel, the moderator, the coolant, the reflector, the control rods, thermal shield, and the containment. **(4 points)**

1. Heat energy generated in one year

$$= \frac{1000}{0.33} \times 365 \frac{d}{year} = 1.1 \times 10^6 \text{ MW-d}$$

The mass of fuel load $= \frac{2800}{0.03} = 93333 \text{ kg} = 93.3 \text{ tonnes}$

Specific burnup $= \frac{1.1 \times 10^6}{93.3} = 11.8 \times 10^3$ MW-d/tonne #

To determine β, Find specific burnup of U-235

$$= \frac{1}{1.3 \frac{g}{MW\text{-}d}} \times 10^6 \frac{g}{tonne} = 769 \times 10^3 \text{ MW-d/tonne}$$

$$\beta = \frac{769 \times 10^3}{11.8 \times 10^3} = 0.0153 = 1.5\%$$

2- A typical response would be :-

Component	Function
Fuel →	Heat energy production and sustaining critical reaction.
moderator →	slowing down neutrons to thermal levels to maximize the probability of fission reaction
Coolant →	keep the fuel cool and transfer the heat out of the core to generate steam
reflector →	To reflect some of the neutrons back to the core, otherwise they would have escaped the reactor
Control rods →	Control and regulate the reactor power, and maintain criticality.
Thermal shield →	absorb radiation and reduce thermal stresses
Containment →	Final barrier between radioactive materials and the environment.