

(21.6) A reactor starting with 3% ^{235}U produces 6000 MWd energy/t U fuel each year. Neglecting fission in ^{238}U , (a) how much fission products have been produced after 5 years? (b) What is the ^{235}U concentration if plutonium fission also is taken into account?

$$N_A := 6.022137 \cdot 10^{23} \cdot \text{mole}^{-1} \quad M_{235} := 235 \cdot \text{gm} \cdot \text{mole}^{-1} \quad x_{235} := 3 \cdot \%$$

$$m_{\text{fuel}} := 1000 \cdot \text{kg}$$

$$P_{\text{fiss}} := 6000 \cdot 10^6 \cdot 24 \cdot 3600 \cdot \text{joule} \cdot \text{yr}^{-1} \quad E_{\text{fiss}} := 3.20 \cdot 10^{-11} \cdot \text{joule} \quad t_{\text{irr}} := 5 \cdot \text{yr}$$

(a)

$$N_{\text{fiss}} := \frac{P_{\text{fiss}}}{E_{\text{fiss}}} \cdot t_{\text{irr}} \quad N_{\text{fiss}} = 8.1 \cdot 10^{25} \quad m_{\text{FP}} := \frac{N_{\text{fiss}}}{N_A} \cdot M_{235} \quad m_{\text{FP}} = 31.608 \cdot \text{kg}$$

(b) assume about 2/3 of the fission products is from fission of U; the rest mainly from fission of Pu. Neglect the mass loss in fission.

$$m_{\text{lost}} := m_{\text{FP}} \cdot \frac{2}{3} \quad m_{\text{left}} := m_{\text{fuel}} \cdot x_{235} - m_{\text{lost}} \quad m_{\text{left}} = 8.928 \cdot \text{kg}$$

$$y_{235} := \frac{m_{\text{left}}}{m_{\text{fuel}} - m_{\text{lost}}} \quad y_{235} = 0.00912 \quad \text{or} \quad y_{235} = 0.912 \cdot \%$$