(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?

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

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

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

(a)

$N_{fiss} := \frac{P_{fiss}}{E_{fiss}} \cdot t_{irr}$ $N_{fiss} = 8.1 \cdot 10^{25}$ $m_{FP} := \frac{N_{fiss}}{N_A} \cdot M_{235}$ $m_{FP} = 31.6 \cdot kg$

(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.

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

$y_{235} := \frac{m_{left}}{m_{fuel} - m_{lost}}$ $y_{235} = 9.11992 \cdot 10^{-3}$ or $y_{235} = 0.91 \cdot \%$