

(21.3) It is desired that 98% of all ^{233}Th formed by neutron capture in ^{232}Th decays to ^{233}U . How long time must elapse between end of irradiation and start of reprocessing?

$^{233}\text{Th}(\beta^-, 22.3 \text{ min}) \rightarrow ^{233}\text{Pa}(\beta^-, 27.0 \text{ d}) \rightarrow ^{233}\text{U}$. It can be seen that all ^{233}Th decays into ^{233}Pa within a short time. Hence the question is how long to wait until 98% of ^{233}Pa has decayed.

Begin by defining an arbitrary amount of initial ^{233}Pa atoms. We can e.g. assume 100 to make it simple.

$$N_0 := 100$$

$$N := 100 - 98$$

Amount remaining

$$t_{\text{half}} := 27.0 \cdot \text{day}$$

$$\lambda := \frac{\ln(2)}{t_{\text{half}}}$$

$$t_{\text{wait}} := \frac{\ln\left(\frac{N_0}{N}\right)}{\lambda}$$

$$t_{\text{wait}} = 1.317 \cdot 10^7 \cdot \text{sec} \quad \text{or} \quad t_{\text{wait}} = 152 \cdot \text{day}$$