(14.2) What fraction of neptunium is in the +4 state in a 0.1 M $Fe(SO_4)_2$ solution of acidity 1 M H^+, assuming an initial Np(V) concentration of 9.4 mM ?

Use $E=E^o-(\boldsymbol{R}T/n\boldsymbol{F})\ln(ox/red)$ for both Np and Fe and put both E:s equal.

First some constants and given values:

$R := 8.31451 \cdot joule \cdot mole^{-1} \cdot K^{-1}$ $\quad q_e := 1.6021773 \cdot 10^{-19} \cdot coul$ $\quad N_A := 6.022137 \cdot 10^{23} \cdot mole^{-1}$

$F := q_e \cdot N_A$ $\quad n := 1$ $\quad T := (25 + 273.15) \cdot K$

$E_{0Np} := 739 \cdot mV$ In 1 M $HClO_4$, from Handbook of Chem. and Phys., 62nd Ed.

$C_{Np} := 9.4 \cdot 10^{-3} \cdot mole \cdot liter^{-1}$ $\quad E_{Np}(X_{Np}) := E_{0Np} - \frac{R \cdot T}{n \cdot F} \cdot ln(X_{Np})$ $\quad X_{Np}=(Np)_{ox}/(Np)_{red}$

$E_{0Fe} := 747 \cdot mV$ In 1 M $HClO_4$, from Handbook of Chem. and Phys., 62nd Ed.

$C_{Fe} := 0.1 \cdot mole \cdot liter^{-1}$ $\quad E_{Fe}(X_{Fe}) := E_{0Fe} - \frac{R \cdot T}{n \cdot F} \cdot ln(X_{Fe})$ $\quad X_{Fe}=(Fe)_{ox}/(Fe)_{red}$

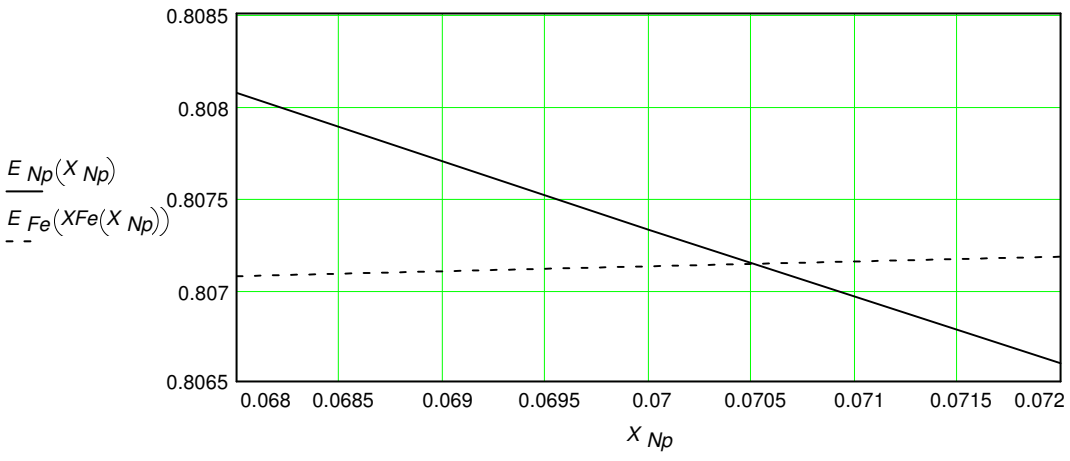
Reduction reaction: $Fe^{2+} + NpO_2^+ + 4H^+ = Fe^{3+} + Np^{4+} + 2H_2O$

This gives the requirement that concentrations of Fe^{3+} and Np^{4+} should be equal.

$X_{Np} := 0.068, 0.070 .. 0.072$ $\quad C_{Np4}(X_{Np}) := \frac{C_{Np}}{1 + X_{Np}}$

$C_{Fe3}(X_{Np}) := C_{Np4}(X_{Np})$ $\quad C_{Fe2}(X_{Np}) := C_{Fe} - C_{Fe3}(X_{Np})$

$XFe(X_{Np}) := \frac{C_{Fe3}(X_{Np})}{C_{Fe2}(X_{Np})}$



$\frac{1}{} = 0.9341$ Answer 93%

$1 + 0.0705$