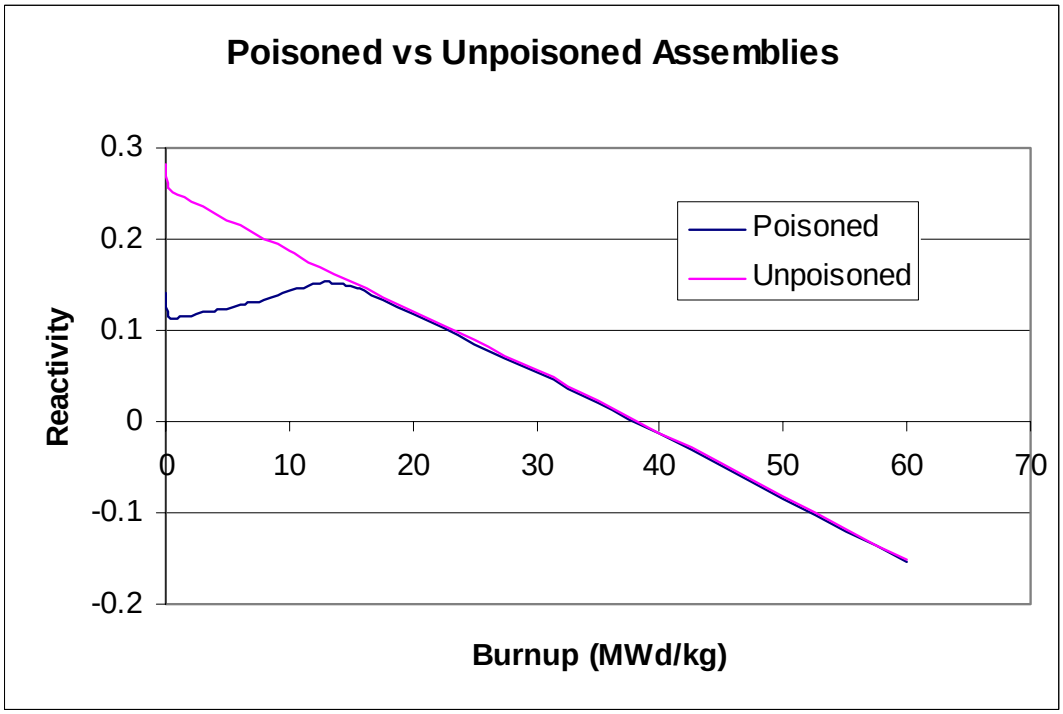
Lab 3 Solution
22.251
Fall 2005

(A)



The residual poison leaves a small reactivity penalty at 60 MWd/kg.

$\Delta\rho$ = -0.00153

(B) Reactivity feedback at zero burnup

(1a) Moderator Temperature Coefficient (MTC) with 1000 ppm boron

$$\frac{\rho_2 - \rho_1}{T_2 - T_1} = \frac{0.080233 - 0.081836}{583.1K - 573.1K} = -1.603x10^{-4}\,K^{-1}$$

(1b) Moderator Temperature Coefficient (MTC) with 0 ppm boron

$$\frac{\rho_2 - \rho_1}{T_2 - T_1} = \frac{0.13977 - 0.143344}{583.1K - 573.1K} = -3.574x10^{-4}\,K^{-1}$$

(2) Fuel temperature Coefficient (FTC) (Doppler)

$$\frac{\rho_2 - \rho_1}{T_2 - T_1} = \frac{0.13977 - 0.148407}{900K - 600K} = -2.88x10^{-5}\,K^{-1}$$

(3) Void Coefficient (VC)

$$\frac{\rho_2 - \rho_1}{Void_2 - Void_1} = \frac{0.13977 - 0.129822}{0\% - 10\%} = -9.95x10^{-4}\left(\%void\right)^{-1}$$

C) Additional reactivity effects

1) Δρ from CZP to HZP

$$\Delta\rho = HSP - CZP = 0.152621 - 0.200499 = -0.048 = -4.8\%$$

2) Δρ from HZP to HFP

$$\Delta\rho = HFP - HZP = 0.13977 - 0.152621 = -0.013 = -1.3\%$$

3) Δρ from xenon at 100 EFPH

Full power rating for this assembly is 38.13470 W/gU
100 EFPH = 3,813.47 Whr/gU
= 3,813.47 kWhr/kgU
= 0.159 MWd/kgU

SO, we can approximate the ρ value from a standard assembly at B=0.1 MWd/kg, which is:

ρ=0.115663

$$\Delta\rho = Xenon - HFP = 0.115663 - 0.13977 = -0.024 = -2.4\%$$

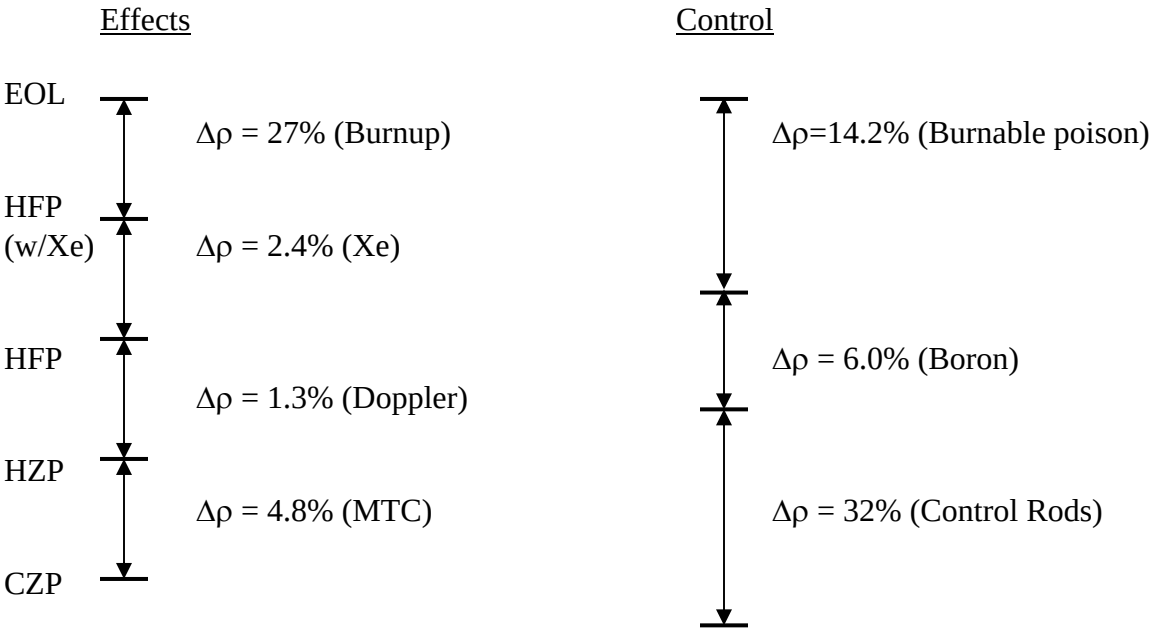
D) Control Rod Worth

Δρ = (ρ with control rods out)-(ρ with control rods in)
= 0.13977-(-0.1794) = 0.3192 = 31.9%

E) Reactivity Ladder

For the reactivity due to burnup:

$$\Delta\rho = EOL - Xenon = -0.15399 - 0.115663 = -0.27 = -27\%$$



$\Delta\rho_{Total}$=35.5%

$\Delta\rho_{Total}$=52.2%