The Reactor handbook discusses the distribution ratio per contact of TBP. Graphs are provided indicating this quantity:

In our situation with TBP, this translates to:

Where “T” refers to the TBP phase and H refers to the HNO3 phase.

Solving for PPB:

(1)

**1 Contact TBP:**

is the stock solution to be decontaminated, it has an initial concentration. is the contamination that TBP brings to the mix with each contact, in the case for U and Pu it is zero. Subsequent will indicate concentrations in the TBP phase at each stage.

Mass initial equals mass final:

Notice I am assuming that the densities and volumes do not change upon mixing, this is not true, because upon mixing some heat is released, and the density of the mixture isn’t exactly an average of the two phases (see reactor handbook Volume II Fuel Reprocessing pg 128 & 129). This assumption gets worse with smaller samples (as we have here), but I’m going to roll with it.

Solving for the new respective concentrations (substituting (1)).

Notice the percent of mass in each phase is a function of volume (and not density):

Solving for DR after first contact (H side):

For Screw up experiment (no sodium nitrite added):

The comparisons are done with the graph on page 155 (Fig 4.47) in the reactor handbook. The reason ours are better is because the point we are comparing with on the graph (0 solvent uranium saturation) used 2 M HNO3. Our experiments used 4 M HNO3. The extraction for U and Pu increase with increasing HNO3 molarity (see pg 154 Fig 4.46).

**2 Contact TBP:**

Concentrations after 1 contact are given as (repeated from above)

The percent of constituent removed when TBP is removed from the system:

Where TVR stands for the percent of TBP volume removed. The total mass for the second contact is:

During this contact, the concentrations are given as:

Where:

The concentration of TBP in the combined solution is:

**3 Contact TBP:**

The total mass for the third contact is:

Where:

During this contact, the concentrations are given as:

Where:

The concentration of TBP in the combined solution is:

**4 Contact TBP:**

The total mass for the fourth contact is:

Where:

During this contact, the concentrations are given as:

Where:

The concentration of TBP in the combined solution is:

Combining and solving for Matts experiment:

First set:

This changes our concentrations to:

Where is solved to be:

Because and

With (from the first TBP contact)

Whew they add up to one:

This simplifies Mtot,4

It also simplifies our constants:

These should be the parts in 87G (the H – but we have more because of evaporation)

The initial mass in a vial sent is:

After evaporation the concentration is:

Assuming density doesn’t change (we are very low on the saturation curve)

Low concentrations of U and Pu (after the first contact), might have different DR than what was expected. I know I shouldn’t be making Pu or U out of thin air.

Also notice…that the % loss in the density\_estimates excel spread sheet for vials 87G trace and 30G trace waste are similar to the estimates above. Its curious, is there a connection?

The plutonium estimate represents the upper bound on the calculation (because sodium nitrite wasn’t added to 30G before processing) (honestly this doesn’t make sense)

87G response should be multiplied

Averaging U and Pu evaporation correction:

Where (from Densitiy\_Estimates.xlsx)