

## Optimization of Ruthenium concentration in PUREX Process during Fast reactor fuel Reprocessing

Thursday, April 21, 2022 1:40 PM (2 hours)

In Purex process, Ruthenium is one of the troublesome fission products due to its complex chemistry and presence of multiple oxidation states & some extractable stable complexes in nitric acid medium. The higher concentrations of both stable and radioactive ruthenium isotopes, pose many challenges. During the reprocessing of FBR spent fuel, the tri and tetra nitrate complexes of ruthenium get extracted in the first cycle in to TBP. The daughter product of Ru106 is Rh106 which is a hard gamma emitter with a half-life of only 30 s. This leads to the degradation of the solvent due to the extraction of radioactive ruthenium. The degraded solvent in turn holds high plutonium in to the organic phase rendering it unstrippable. In addition, the radioactive Ruthenium pick up will contribute significantly to the residual activity of the product stream. Also, the extractable ruthenium species pose problems in the treatment of the lean organic. Hence it is necessary to limit the co-extraction of Ruthenium in to the solvent. In order to accomplish this, a scheme to scrub the plant stream with concentrated acid has been tested in the plant.

In the CORAL plant during the reprocessing of Pu rich mixed carbide spent fuel discharged from FBTR, the first cycle extraction was carried out at an acidity of 5.5 M. This resulted in the reduction of ruthenium activity in the loaded organic by more than 50%. This reduction was due to the fact that the distribution ratio of ruthenium bears an inverse relation to the concentration of nitric acid in the aqueous phase in equilibrium with the organic in contact with the acid. Analysis of the plant data shows about 30-40% retention of ruthenium activity in the loaded organic. This could be due to the presence of tri nitrate nitrosyl complex of ruthenium  $\text{RuNO}(\text{NO}_3)_3$  under the operating conditions which is extracted by TBP. In the loaded organic phase, the extracted ruthenium is initially expected to be existing as an outer sphere complex, which is slowly gets converted to an inner sphere complex which renders the complex un-scrubbable even with a high acid stream.

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**Session Classification:** Poster Session

**Track Classification:** Track 3. Fuels, Fuel Cycles and Waste Management