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

Comments from the peer review and Responses

Comment:

A part of manuscript in “INTRODUCION” is font size 11pt. Ruthenium -> , ruthenium P.4, 3rd line, “inner sphere complex (5)” -> “inner sphere complex (5)” Information of Ru complexes (Fig.3) preparation should be put in this paper.

Response:

Font size corrected

“Ruthenium” corrected as “ruthenium”

Spent organic obtained during processing of high burn up fuel needs a cycle for recovery of Plutonium before disposal of the organic stream. When the plant spent organic is treated hydrazine stabilised uranous resulted in aqueous product streams having higher Ru activity per unit mass of Pu which poses difficulty during processing and reconversion plutonium nitrate solution by oxalate precipitation process. Hence a process is required to reduce Ru activity in the organic phase before treating with hydrazine stabilised uranous.

Ru forms various Ru-NO-NO3-H2O complexes in the aqueous phase and kinetics of transformation of one species to other take places as a function of nitric acid concentration in the aqueous phase. It is reported that for a typical acidity of 6 M the mole fraction of 0.03, 0.08, 0.48, 0.38 and 0.03 for non nitrate, mono nitrato, dinitrato, trinitrato and tetra nitrato. Hence in Purex process conditions the probable species of concern are dinitrato, trinitrato. It is also reported that the distribution ratio of mono nitrate or dinitrato species are very much lower than tri or tetra nitrato species. Therefore the extraction trend of tri nitrato species with TBP as a function of nitric acid is important. It is reported in the literature that the distribution ratio of Ru,NO-tri-nitrato species decreases with increase in nitric acid beyond 0.4 M feed acidity. Hence acidity around 5.5 M is chosen for scrubbing without affecting extraction behaviour of U/Pu.

Ru-NO-NO3-H2O-TBP complex can exists as outer sphere complex and exchange reaction takes place to form inner sphere complex, Ru-NO-NO3-TBP after replacing H2O molecules. It is reported that once Ru-NO-NO3-TBP complex forms it is very difficult to scrub or strip it with nitric acid.

The above information is incorporated in the revised paper

Conclusion: Is the effect of Ru scrubbing from organic phase using 5.5M HNO3 enough based on Table 1 ? It should be discussed from viewpoint of process requirement.

References : [4] bigger font size Entirely, additional explanation is better for readers.

Overall: Please upload a revised paper incorporating the minor corrections/comments above. If you have new relevant data, you are welcome to include these. Please upload a revised paper by 1st of April 2022.

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The reduction of Ru activity in the first contact is attributed to the loading of nitric acid to the organic phase, decreased the availability of free TBP for Ru extraction, thereby refluxing Ru to the aqueous phase.

Nearly same Ru activity in the organic phase for second and third contact is attributable to formation of stable inner sphere complex.

The treated organic phase having 0.5 mCi/L is treated with hydrazine stabilised uranous and results are given in table.2. The aqueous product is having very low Ru activity as compared to the treated organic obtained in this step. Higher Ru activity in the treated organic is attributable to the availability of more TBP for complexing with Ru due to absence of competition from nitric acid.

Conclusion:

Is the effect of Ru scrubbing from organic phase using 5.5M HNO3 enough based on Table 1 ? It should be discussed from viewpoint of process requirement.

Yes

Results of this study indicates that for the recovery of Pu from spent organic obtained with higher Ru should be scrubbed with 5.5 M nitric acid to reflux Ru to the aqueous phase without affecting the concentration of U/Pu in lean organic feed taken for treatment. Organic phase obtained after scrubbing with nitric can be contacted with hydrazine stabilised uranous resulted plutonium aqueous product having very low Ru activity amenable for further processing.

The data in the table 1 indicates that the scrubbing with reaches a saturated values of about 0.485 mcI/L after three contacts with 5.5 M Nitric acid acid scrub.

References : [4] bigger font size

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