SOLVENT EXTRACTION PROCESS DEVELOPMENT FOR PARTITIONING AND TRANSMUTATION OF SPENT FUEL

M. C. Regalbuto, J. M. Copple, R.A. Leonard, C. Pereira, and G. F. Vandegrift

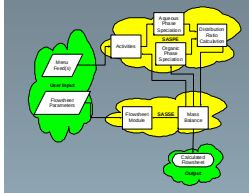
Chemical Engineering Division, Argonne National Laboratory

Modeling

Flowsheets developed using AMUSE have demonstrated the accuracy of the model's predictions.

"AMUSE" is the Argonne Model for Universal Solvent Extraction

AMUSE Flowchart



AMUSE calculates flowsheets for
- PUREX
- UREX
- SREX
- TRUEX

If feed compositions and D values are known, flowsheets can be calculated for
- CSSX
- CCD-PEG
- TALSPEAK
- Others

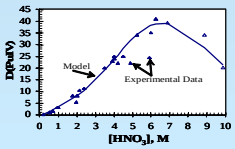
Input Sheet in AMUSE

Flowsheet Input:
- Feed compositions
- Flow rates
- Temperatures
- Number of stages
- Stage efficiencies

Flowsheet Output:
- Effluent compositions
- Process stage compositions
- Stage-wise D-values
- Flowsheet diagram

Other Outputs:
- Aqueous phase speciation
- Thermodynamic activities
- Distribution ratios of extractable species.

Model vs. Experimental Data



D-value predictions from chemically significant equilibria and thermodynamic activities for H^+, NO_3^-, & H_2O

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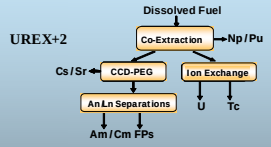
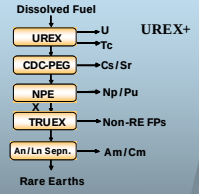
Spent Fuel Treatment

The use of solvent extraction processes for spent fuel treatment has been proven to be a viable separation option for spent fuel partitioning and transmutation



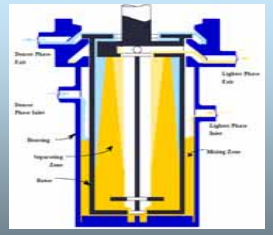


The UREX+ processes separates key radionuclides into:
- U for disposal as LLW
- Tc for disposal as HLW
- I for disposal as HLW
- Cs/Sr for decay storage then disposal as LLW
- Pu/Np for production of mixed-oxide fuel,
- Am/Cm for fast-reactor fuel or transmutation
- All remaining soluble fission products for disposal

Equipment

Equipment development, such as the ANL centrifugalcontactor, further advances the practical implementation of solvent extraction

Design based on:
- 34 years of experience in building, testing, and using contactors at Argonne
- Model for contactor operation developed at Argonne
- Experience in determining nuclear criticality safety
- The latest drafting and mechanical design technology



Schematic of operating contactor stage

Prototype 15-cm contactor (40 L/min)

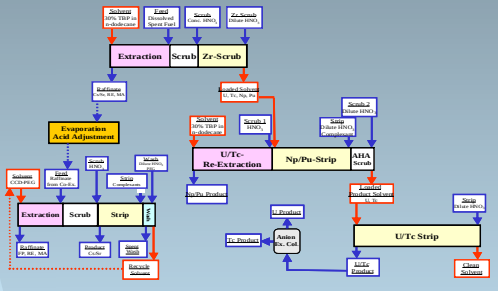
Argonne National Laboratory is Operated for the U.S. Department of Energy by The University of Chicago

Demonstration

Demonstration of different solvent extraction flowsheet alternatives for the UREX+ process provides options to evaluate and select an economical and proliferation-resistant fuel cycle

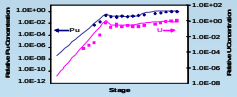
During Fiscal Years 2003 and 2004:
- Two alternative UREX+ solvent extraction processes were demonstrated
- The feed consisted of a pin of irradiated Big Rock Point uranium oxide fuel dissolved in nitric acid
- The flowsheets for each process were developed using the AMUSE code

Co-Extraction Flowsheet for FY2004 Demonstration

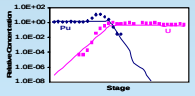


Stage Profiles for FY2004 Demonstration

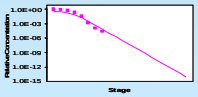
Experimental values shown as discrete points.
AMUSE predictions shown as solid lines.



Aqueous stage profiles for Pu and U in the extraction/scrub section.



Aqueous stage profiles for Pu and U in the Np/Pu-Strip section.



Aqueous stage profiles for U in the U/Tc-Strip section.

Stage profiles show accuracy of model in predicting extraction behavior.