INL/CON-22-66524-Revision-0

Use of Novel Diglycolamide Extractants in Liquid-liquid Separations of Light Rare Earths

March 2022

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1.2.14 Use of Novel Diglycolamide Extractants in Liquid-Liquid Separations of Light Rare Earths

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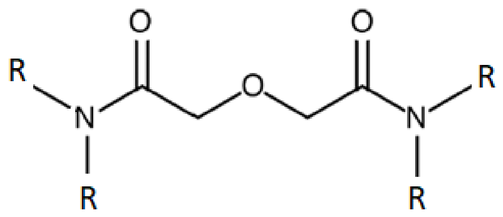
Background

- Modified diglycolamide (DGA) extractants show high affinity for lanthanides and improved separation factors compared to phosphonic acids used commercially.
- Previous studies with DGAs include flowsheet design and implementation into solvent extraction equipment but at low extractant concentration.
- Current efforts focus on developing another novel DGA with different alkyl chains that can extract light rare earths using a higher ligand concentration than previous DGAs, creating a more competitive product for light rare earth separation.

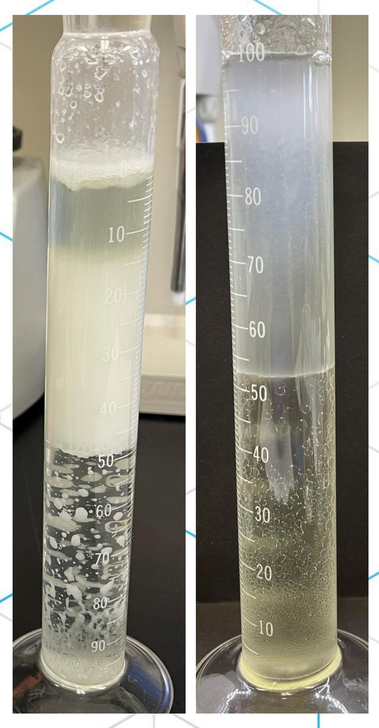


- The scope of this project is to test a recently developed DGA (DGA-6) for application in solvent extraction equipment.
- Evaluation includes dispersion testing, preliminary flowsheet design to determine an organic to aqueous phase ratio (O/A), and an acid dependency study.

Dispersion Testing

- Provides insight into aqueous/organic pair compatibility with solvent extraction equipment
- Extractant is mixed with a simulated leach liquor containing La, Ce, Nd, and Pr. The break time and interfacial heights are used to quantify the dispersion number.
- Problematic gelling of the extractant can occur with heavy metal loading, higher DGA concentrations, and at larger scales.

Determining an adequate DGA concentration:



- DGA concentration was decreased until a fair dispersion rating or better was achieved in a batch contact with the simulated leach liquor.
- Final extractant composition: 0.25 M DGA with 5v% Exxal-13 in Isopar-L

DGA-6 Concentration	Dispersion Number Rating
0.5 M – small scale	Fair
0.5 M – large scale	Gel Formation
0.4 M – small scale	Good
0.4 M – large scale	Gel Formation
0.3 M – large scale	Poor
0.25 M – small scale	Fair
0.25 M – large scale	Good

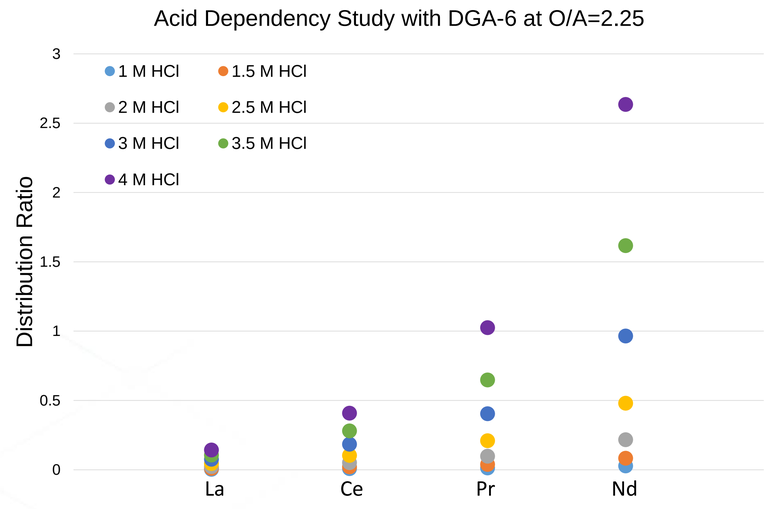
Preliminary Flowsheet Design

- Used assumptions derived from previous DGA experiments and phosphonic acid flow sheets to make necessary estimations for calculations
- Performed mass balance on the extraction, scrub, and strip sections in a DGA-6 preliminary flowsheet to determine the O/A in the extraction section:

O/A=2.25

Acid Dependency Study

- The acid concentrations in simulated leach liquors were varied to maximize extraction as well as separation of La and Ce from Nd and Pr



- Increased acid concentration directly correlates with distribution ratio as well as the split between La and Ce from Pr and Nd.

% Extraction				
[H+]	La	Ce	Pr	Nd
2.5 M	9.5%	19.9%	34.4%	57.0%
3 M	15.3%	30.9%	50.8%	74.2%
3.5 M	20.6%	41.5%	64.7%	86.1%
4 M	25.3%	51.0%	75.2%	93.2%

- Target acidity maximizes Pr and Nd recovery while minimizing co-extraction of Ce and La to reduce scrubbing requirements.

Future Work

- Further batch contact testing will be performed with the simulated leach liquor at the desired acid concentration, replicating counter current flow. Analysis will provide data for number of stages required in the final flowsheet design.
- The final flowsheet will be executed in mixer settlers with the DGA extractant provided by Marshallton Research Laboratories.

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CMI Critical Materials Institute — An Energy Innovation Hub

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