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FIRST PRINCIPLES MODELLING OF THE SOLVENT EXTRACTION AND STRIPPING OF URANIUM INCLUDING MOLYBDENUM CONTROL

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ABSTRACT

Solvent extraction is a commonly used method in the production of uranium ore concentrate from run of mine ore. However, molybdenum commonly co-exists with uranium ores and, if not removed, can cause significant operational issues including crud formation and product contamination. Molybdenum readily co-extracts with uranium into the organic phase when commonly used ternary amine extractants, such as Alamine 336 and Armine 380, are used. Optimal rejection of molybdenum to the raffinate while minimizing product loss from organic regeneration requires detailed understanding of the chemistry occurring in the extraction, stripping, and regeneration circuits.

Typical approaches to understand molybdenum transport in an operational solvent extraction plant include development of plant extraction and stripping isotherms for uranium and molybdenum. These isotherms, while very useful, are specific to the operating regime from which they are obtained, and therefore, are of limited utility when ore characteristics change. In this work, we present an alternative approach to model solvent extraction based upon fundamental thermodynamic analysis. Rather than using plant isotherms, pure system (i.e. single component) isotherms available in the open literature are used to calculate fundamental thermodynamic constants of interfacial reactions. By isolating the extraction of a single component, the process can be represented exactly in a thermodynamic model and, thus, the free energy of the organic salts involved in the extraction mechanism can be calculated by data fitting. Pure system isotherm data generated by Yakabu and Dudeney (1987) for sulphuric acid / uranyl sulphate and Coca et al. (1989) for molybdic acid was used in this work.

Using the fitted thermodynamic model, a process model of a typical uranium solvent extraction plant, including extraction, stripping, and regeneration circuits, was developed using SysCAD. SysCAD is a highly flexible process simulation platform which is widely used in mineral processing. Recent improvements have enabled the integration of high fidelity thermodynamic engines, such as OLI, ChemApp (FACTSage), AQSol, HSC, and PHREEQC. Individual mixer-settler units were modelled using an embedded PHREEQC interface to calculate aqueous and organic chemical speciation in the mixer via free energy minimization.

References:

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