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Machine Learning-Assisted Selection Matrix Development of Molten Salts in Ore Dissolution and Electrowinning for Metal Extraction

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ABSTRACT

The global transition towards sustainable and environmentally friendly practices has introduced new challenges for metal production and strengthened the need for the adoption of new processes. The application of electrochemical methods for metal extraction has been long utilised in industry, with the Hall-Heroult process employed as the primary route for aluminium production. Extracting metals such as iron and nickel from ores can rely on processes that use equipment including blast furnaces and smelters which pose issues including significant carbon emissions and high energy usage among other considerations including release of toxic gases and waste production through acid-base usage. The usage of molten salts with ore dissolution and electrowinning is being explored to address the poor-sustainability of the traditional processes and increase process efficiency. The inherent challenge with molten salt usage lies with its selection which ultimately impacts the physico-chemical properties that influence the efficiency of the process. There are an endless number of possible salt systems with only a few posessing properties such as low vapour pressure and melting point, high ionic and electrical conductivity, high purity and decomposition potential, etc, desired for electrowinning. Advancements in machine learning have enabled usage of this technology to accurately predict thermodynamic properties for molten-salt systems, and expedited exploration of predicting new electrochemical reactions.

This project aims to leverage machine learning techiques to first construct a model that can use the physico-chemical properties of existing molten-salt systems from literature and simulate the electrowinning operation to determine the efficiency of metal extraction. The second model will then explore different machine learning tools to effectively predict the physico-chemical properties of molten salts of new untested multi-component molten salt systems. Outputs from these models will be compiled in a searchable database of molten salt properties in Python to create a selection tool that can identify molten salt systems which exhibit ideal physico-chemical properties for optimal metal extraction. This tool will enable researchers and industry practitioners to perform a reduced number of experiments and validate the outputs of these machine learning models, addressing the challenges of performing a considerable number of experiments for different molten salt systems and the associated costs for the specialised materials and equipment used.

KEY WORDS

molten salts, fused salts, electrowinning, electrolysis, ore dissolution, dissolution, metals, metal extraction, machine learning

BIOGRAPHY

I am a Final Year Bachelor of Engineering (Honours) student majoring in Chemical Engineering at Curtin University. I am passionate about the resources and energy industry, and throughout my degree, I have gained industry work experience in different sectors. Exposed to engineering design and consulting at Ausenco, iron ore mining with site operations at Hancock Iron Ore, and upstream oil and gas in petroleum engineering at Chevron. I have been part of the Association of Chemical Engineering Students (ACES) club at Curtin supporting the student body and I am keen to grow my capabilities in diverse areas with new experiences.

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