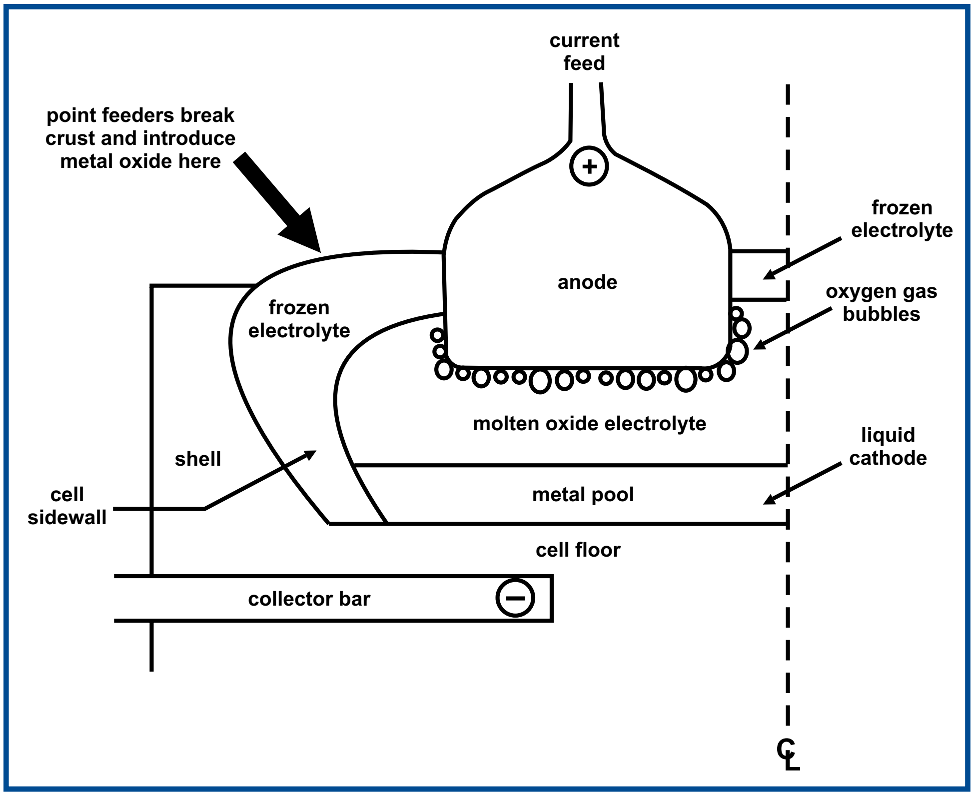
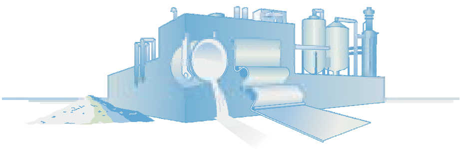
Technical Feasibility Study of Steelmaking by Molten Oxide Electrolysis

Using Carbon-Free Anodes will Reduce CO_2 Generation During Ironmaking

Molten oxide electrolysis (MOE) is an extreme form of molten salt electrolysis, a technology that has been used for over 100 years to produce large amounts of metal, including aluminum, magnesium, lithium, sodium, and the rare-earth metals. Molten oxide electrolysis distinguishes itself from all molten salt electrolytic technologies through its use of carbon-free anodes, facilitating the production of oxygen gas at the anode. Molten oxide electrolysis is totally carbon-free and does not produce CO or CO_2 -- only oxygen. This technology offers powerful environmental advantages over conventional technology and one of the lowest CO_2-emitting breakthrough technologies per unit metal product.



Cell for Molten Oxide Electrolysis Iron Production



Benefits for Our Industry and Our Nation

Molten oxide electrolysis reduces CO_2 emissions, produces tonnage oxygen with commercial value, decreases need for CO_2 sequestration and disposal, reduces costs associated with curbing emissions, and creates an iron-making process without the need for coke or blast furnaces.

Applications in Our Nation's Industry

Using electricity to reduce iron ore could eventually replace carbon-based ironmaking processes that generate large amounts of CO_2.

Project Description

The goal of this project is to assess the technical feasibility of producing iron via molten oxide electrolysis at the bench scale while determining optimum values of process operating parameters.

Barriers

The technical hurdles to be overcome in this project are:

- Identifying appropriate electrolyte chemistries that sustain oxygen evolution with compatible anodes
- Establishing a relationship between current and the concentration of free oxide ion
- Lack of documentation of current density and optical basicity for electrolytes with larger anodes in an iron-rich melt

Pathways

This project will identify appropriate electrolyte chemistries and demonstrate their compatibility with candidate anodes to sustain oxygen evolution. The goals will be achieved through: 1) conducting material and energy balances; 2) evaluating impurity behavior; 3) determining MOE kinetics; and 4) completing pilot-scale testing.

Progress and Milestones

- Reconstruct physical plant for iron electrolysis (Complete)
- Evaluate metal alloy anodes and characterize candidate anode (Complete)
- Develop computer model for anode material selection and evaluate computer-selected anodes (Complete)
- Characterize candidate anode
- Compare and refine computer model and conduct pilot-scale testing

Commercialization

The final deliverable of this project will be a fully functional laboratory-scale electrolysis cell that produces metallic iron along with by-product oxygen. Successful laboratory-scale testing will enable further development to demonstrate the technology in industrial settings.

Project Partners

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Gallatin Steel
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HYLSA
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Mittal Steel, USA
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