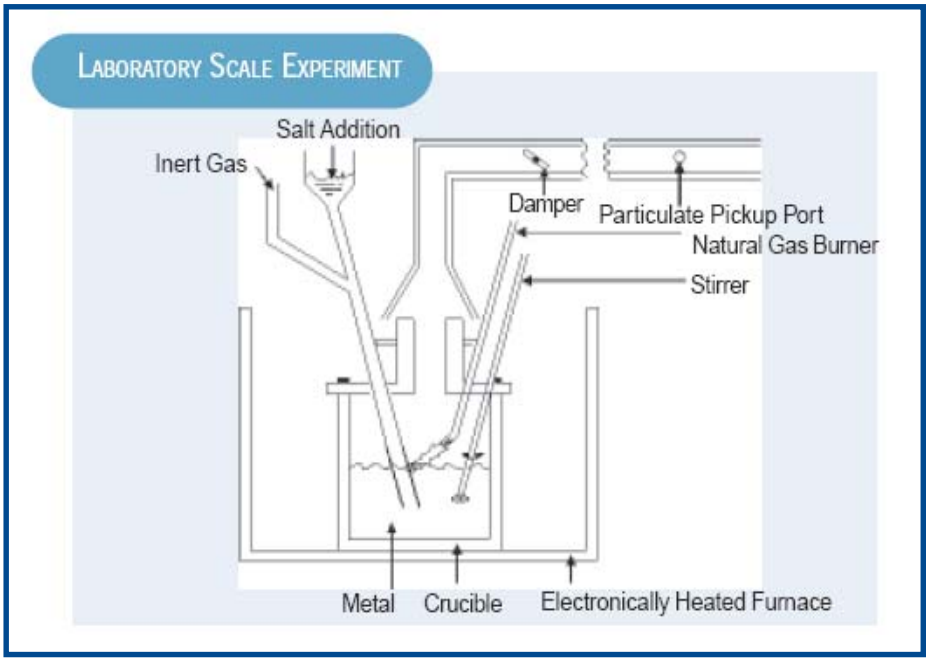
Molten Aluminum Treatment by Salt Fluxing with Low Environmental Emissions

Improved Aluminum Fluxing Process and Energy Efficiency

Primary and secondary molten aluminum processing and refining involve fluxing metal with either pure chlorine gas or a mixture of chlorine and inert gas. The stack emissions caused by this gas injection include dust particles, hydrogen chloride (HCl), chlorine, and aluminum chloride gases. Recently, Secondary Aluminum Maximum Achievable Control Technology (MACT), under the Clean Air Act, has set tough new limits on particulate matter and total hydrogen chloride emissions from the furnaces. Additionally, chlorine gas is highly toxic and its handling, storage, and use pose risks.

The objectives of this project are to investigate, understand, and minimize the emissions resulting from solid chloride flux addition to molten metal for alkali impurity and non-metallic inclusion removal. This project studied the salt metal interactions and monitored the emissions at laboratory scale, which will be verified on a commercial scale at Alcoa. The information obtained in these experiments will be used to develop mathematical models that will help optimize the process.



Schematic of the laboratory scale experimental set-up.

Benefits for Our Industry and Our Nation

- *Reduce the energy needs of the U.S. aluminum industry by 150 billion Btu per year by the year 2008*
- *Reduce chlorine fluxing usage by approximately one million pounds per year*
- *Reduce carbon dioxide (greenhouse gas) by an estimated 1.24 pound per ton of aluminum produced per year*
- *Reduce industry-wide (domestic) carbon dioxide by approximately 18.6 million pounds per year by the year 2008*
- *Eliminate bag-house and wet scrubber technology for emission control and reduce its maintenance costs*

Applications in Our Nation's Industry

Given the strong industry involvement in the project, this research will benefit a large segment of the aluminum industry.

Project Description

The research goal is to minimize energy consumption by (1) optimizing the fluxing process, thereby reducing processing time; (2) improving metal quality, thereby reducing scrap and rework; and (3) eliminating or reducing the use of chlorine gas fluxing by substituting solid chloride salts.

Barriers

Most of the technical problems were related to setting up and optimizing the equipment. The project team has addressed the problem and generated experimental results.

Pathways

- Thermodynamically analyze all possible chemical reactions between various salt components and metal
- Fabricate laboratory scale experimental setup at participating university
- Conduct laboratory scale experiments focusing on holding furnace applications and melting experiments
- Monitor particulate matter and gaseous emissions
- Validate laboratory scale results with commercial scale experiments at industry partner site
- Develop mathematical models based on the experimental and commercial scale results

Milestones

Results to Date:

- Conducted salt fluxing study
- Conducted laboratory scale experiments with five salts (S-1, S-2, S-3, FS-2, and FS-3) and four aluminum alloys (AA1100, AA5182, AA6061, and AA7050)
- Developed a method for salt injection into molten aluminum metal
- Quantitatively measured the HCl gas emissions from the salt fluxing
- Quantitatively measured the rates of alkaline impurity removal
- Studied the effects of various operation and materials parameters on the HCl emission and rates of impurity removal
- Quantitatively measured the rate of particulate matter emissions by salt fluxing

Future Milestones:

- Perform commercial scale experiments
- Develop mathematical model
- Transfer technology to industry

Commercialization

The results of this research and development program, including the mathematical models developed, will be available in the open literature and will facilitate commercialization of the new optimized process on solid chloride salt fluxing of melt.

Project Partners

Ohio State University Research Foundation
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Alcoa Technical Center
Alcoa Center, PA

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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September 2006
CPS Agreement #5655