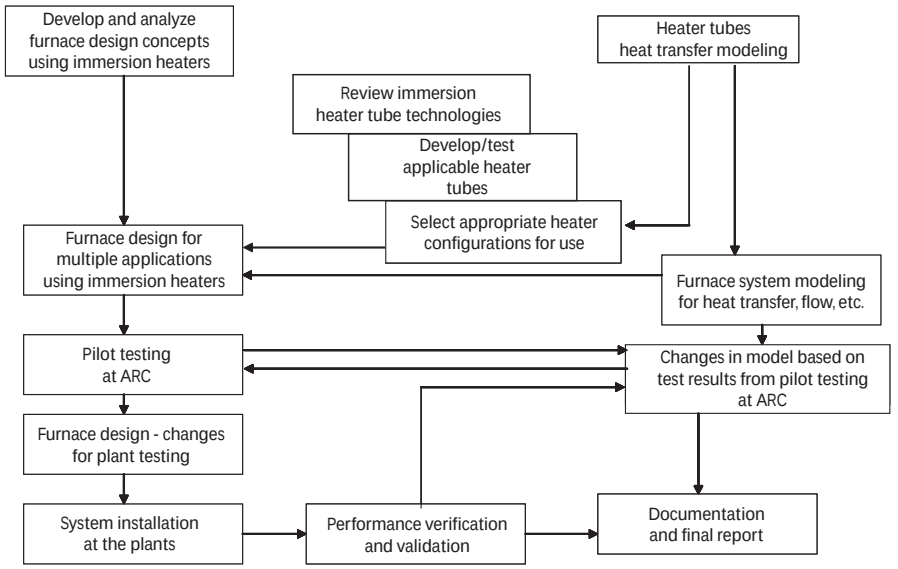
Industrial Technologies Program

Advanced Scalable Clean Aluminum Melting Systems

Immersion Heating of Aluminum Will Reduce Energy Consumption and Environmental Impacts. Reverberatory furnaces are typically used to heat aluminum to melting temperatures with open flame, direct-fired, wall-mounted burners. The primary mode of heat transfer is through radiation from the refractory brick to the aluminum, some convective heat transfer also provides additional heating from the burner to the aluminum. Typical aluminum reverberatory furnaces have melting efficiencies ranging from 15 to 39 percent, and averaging between 26 and 31 percent. Reverberatory aluminum melters have a high volume processing rate, along with low operating and maintenance costs. However, there are high metal oxidation rates, low efficiencies, and large floor space requirements.

Immersion heater furnaces provide a good alternative to reverberatory melters. Immersion heater furnaces heat the metal bath by direct contact. The burner is immersed in the molten aluminum and a pre-mixed burner provides hot combustion gases that are circulated through the housing. The combustion gases never come into contact with the molten aluminum, thus reducing oxidation losses, and the submerged burner provides enhanced heat transfer to the molten charge, thus improving thermal efficiency. Aluminum melting efficiencies of 60 to 65 percent have already been achieved by one immersion burner, and a laboratory-scale immersion electric heater developed under a DOE cost-shared project ("Isothermal Melting") shows promise for developing future models with in-plant thermal efficiencies of 97 percent.

Project Flow Sheet



Benefits for Our Industry and Our Nation

- *Energy savings in the metal casting industry alone could range from 2.7 to 4.2 trillion Btu per year after 10 years, if some 25 percent of the aluminum melted was with an immersion burner.*
- *A savings of $23-24 million per year in the metal casting industry alone could be realized after 10 years if 25 percent of the aluminum melted is done with an immersion burner.*
- *Multiple environmental benefits could be realized, including reduction of carbon, nitrogen oxide, carbon monoxide, VOC, and particulate emissions.*

Applications in Our Nation's Industry

Considering that melting represents 55% of the energy use in the Metalcasting industry, the substitution of immersion heating in melting aluminum in reverberatory furnaces will enable significant reduction in energy consumption and environmental impact in the industry. The proposed technology, coupled with couple heater improvement, would enable cost-effective retrofits to a range of existing furnace sizes, reducing the economic barrier to application.

Project Description

The overall goal of this project is to develop and demonstrate integrated, retrofitable technologies for clean aluminum melting systems in both the metal casting and aluminum processing industries. The scope focuses on immersion heating coupled with metal circulation systems that provide significant opportunity for energy savings, as well as reduction of melt loss. The primary deliverables will be:

- Evaluation and improvement of both gas-fired and electric resistance immersion heaters.
- Demonstration of combined immersion heating and metal circulation in a highly instrumented 1 ton experimental furnace, as well as in production melting and holding units to enable quantification of energy and melt loss reduction benefits.
- A predictive modeling tool available to industry providing melting furnace design and operating parameters for both retrofit and new furnace designs.

Milestones

This project's planned tasks include:

1. *Evaluate/improve immersion heating devices*
   Secat will lead the project team that will select systems for evaluation, evaluate corrosion and erosion in molten metal, and identify and implement alternative materials and coatings.
2. *Modify ARC Experimental Reverberatory Furnace*
   The project team will install and test immersion heaters, add upgraded instrumentation and controls, and identify and install circulation systems.
3. *Funadmental modeling and validation*
   The team will develop heat transfer and fluid flow models and validate these models on the ARC Experimental Reverberatory Furnace.
4. *Parametric studies*
   These studies include industrial furnace characterization and evaluation of relevant furnace cases.
5. *Validation*
   Validation will take place in a metal casting furnace and a large sidewell melting furnace.
6. *Commercialization*
   The team will develop design and operating guidelines, undertake an economic and energy analysis, and disseminate this information.

Project Partners

Secat, Inc., Lexington, KY
Amcast, Dayton, OH
Arco Aluminum, Louisville, KY
DOE Albany Research Center
Albany, OR
E3M, Inc., North Potomac, MD
Hydro Aluminum North America
Lindthicum, MD
Imco Recycling, Irving, TX
Logan Aluminum, Russellville, KY
Metaullics, Inc., Solon, OH
Oak Ridge National Laboratory
Oak Ridge, TN
Seco/Warwick, Meadville, PA
Trace Die Casting
Bowling Green, KY
University of Kentucky
Lexington, KY
Wise Alloys, Muscle Shoals, AL

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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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Energy Efficiency
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