ALUMINUM

Project Fact Sheet

Isothermal Melting Process (ITM)

Benefits

- Annual energy savings of 2.14 × 10^{13} Btu
- Significantly reduced dross formation
- Reduced carbon dioxide emissions associated with energy savings
- Low melt loss via rapid low temperature submersion melting
- ITM requires one fifth the floor space compared to conventional melting
- High energy efficiency operations
- Excellent metal quality that exhibits low dissolved gas and suspended solids
- Homogeneous metal composition through recirculation
- Low capital cost

Applications

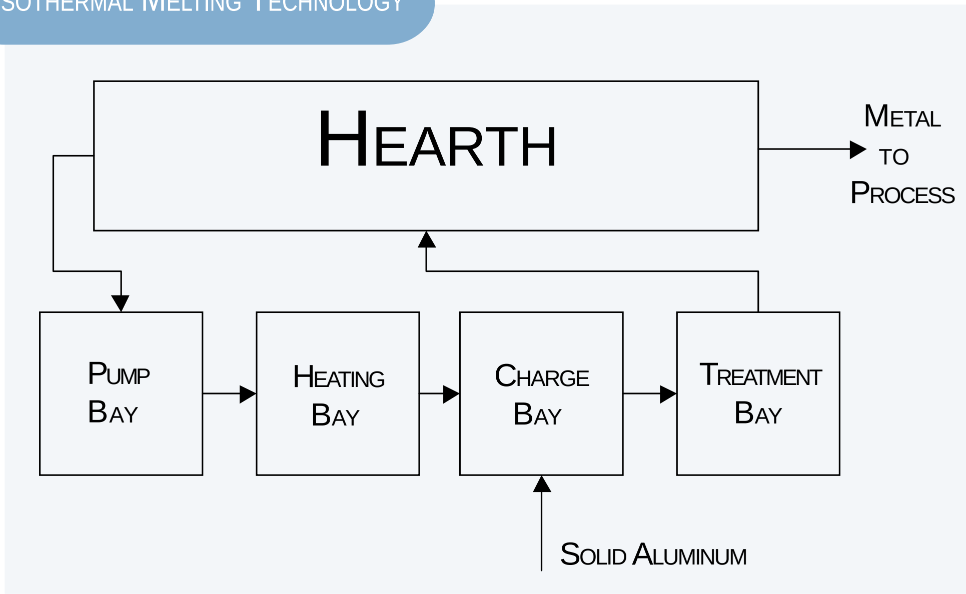
The overall scope of the ITM application is industry-wide and covers all aspects of aluminum melting. ITM can be applied throughout the aluminum industry. Nearly all aluminum must be melted for process into a finished product. ITM can accomplish this with significant energy and environmental savings.

Energy efficient isothermal melting of aluminum

The ITM Process saves half the energy and emissions associated with conventional melting. New materials and construction techniques for immersion heaters make ITM practical for large scale aluminum operations. Most aluminum is melted in reverberatory furnaces that use natural gas or fuel oil burners. These furnaces use radiant heating as the dominant heat transfer mechanism and have poor thermal efficiency (less than 30 percent). Their emissions create environmental concerns and their combustion gases are detrimental to metal quality. They promote oxidation and hydrogen adsorption. Conductive heat transfer from immersion heaters can provide thermal efficiencies as high as 97 percent and avoid detrimental combustion gas contact with aluminum.

New materials and construction techniques allow immersion heaters to be built with high heat flux (approximately 70,000 Btu/hr-ft^2) and external coatings that provide mechanical and chemical protection. These new heater designs are based on a highly conductive, impact resistant ceramic coating on a metallic sheath and a highly thermally conductive, dielectric integral coupling medium between the sheath and the heat producing element. This allows heat transfer by conduction to be the dominant mode, rather than particle to particle radiation heat transfer that prevails in conventional immersion heaters with compacted powder coupling media. The composite refractory coating is resistant to corrosive attack by the molten aluminum, yet sufficiently thin enough to provide a high heat flux. High flux heaters incorporated into the ITM are practical for very large scale applications.

Isothermal Melting Technology



Process arrangement for Isothermal Melting System.

Project Description

Goals: The goal of this project is to demonstrate Isothermal Melting (ITM) on a technically and commercially viable scale.

ITM is accomplished in a multi-bay flow system. The electronically controlled immersion heaters raise the temperature in the heating bay. The hot molten aluminum from the heater bay provides the energy to melt the solid aluminum charge. Metal is withdrawn and returned to the hearth at approximately the same temperature (hence, isothermal melting). High flux (>130 Watts per square inch) and external material coatings provide the mechanical and chemical protection that make this system practical. Technical viability will be demonstrated at a scale small enough to allow for careful parametric monitoring and control, yet of a sufficient size to provide useful scale-up information. To demonstrate commercial viability, project partners will implement ITM at an aluminum casting facility that will operate twenty four hours per day in a routine production. Importantly, molten aluminum produced by isothermal melting will be used to make commercial products.

Progress and Milestones

Immersion Heater Optimization

- Evaluate composite coated sheaths in molten aluminum.
- Design and manufacture high watt density immersion heater elements for use in molten aluminum.
- Successfully operate immersion heater at a watt density of 130 Watts per square inch and demonstrate durability over a six month operation.
- Optimize the heater's internal design to increase the total input power of the heater to 50 kW.

Heating and Charging Chamber Design

- Design a heating chamber for placement of individual heaters and flow arrangement to maximize heat transfer at a 300 pound per hour (lb/hr) melt rate.
- Build and demonstrate the operation of a 300 lb/hr melt rate heating chamber.
- Develop mathematical model for scale-up to a 10,000 lb/hr melt rate.

System Integration on a Commercial Scale

- Design a complete ITM system for a 10,000 lb/hr melt rate.
- Develop the required sensor and control methodology to balance electric power input with recirculation and charge rates for isothermal conditions.
- Construct a 10,000 lb/hr melt rate chamber.
- Conduct detailed performance and durability assessments.
- Assess tolerance of various low-grade scrap charge material.
- Develop design criteria for scale-up to a 75,000 lb/hr melt rate.

Commercialization Plan

The industrial participants in this project fully embrace the objectives of ITM and will become the first users. Project partners will have an exclusive limited field of use licensed for three years past the first commercial use of ITM at the 10,000 lb/hr melt rate, with the right of first and last refusal for two additional years. The project partners will have enjoyed a valuable lead following the exclusive license period.

Project Partners

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April 2001