



## INDUSTRIAL TECHNOLOGIES PROGRAM

# Energy-Efficient Melting and Direct Delivery of High Quality Molten Aluminum Complete Scrap-to-Caster System Will Save Energy and Reduce Costs in the Aluminum Industry

In aluminum foundries, aluminum is melted in natural gas-fired reverberatory furnaces, where heat is transferred to the surface of the molten aluminum by refractory radiation and some convection. These furnaces are characterized by poor thermal efficiencies ranging from approximately 20%–45%.

The Energy Efficient Isothermal Melting (ITM) of Aluminum project, previously funded by DOE, developed energy-efficient and emissions-free electric melting furnaces for large-scale aluminum operations. These furnaces use direct immersion electric resistance heaters which yield high thermal efficiency (more than 70% overall) and low melt loss (less than 1%). Unlike conventional gas-fired furnaces, ITM melts aluminum via conduction and convection using a multi-bay, continuous-flow system that features two

independent heating sources: The first is an array of high-heat-flux, direct-immersion electric heaters that supply melting heat; the second is a moderate-heat-flux refractory panel heating system that provides holding heat for the molten aluminum.

The ITM project has been extended to further improve the energy efficiency of the furnaces. The extension project will develop a combined system to efficiently melt and deliver molten metal. The system involves preparing the metal off-site, and transporting the molten metal in turbo-electric ladle (TeL) trucks to casting operations that use ITM immersion heaters. Docking stations at remote casting operations receive these vessels, allowing them to be drawn down over a period of time and essentially displacing on site holding furnaces. These holding vessels operate at less than

10 Btu/hr-lb compared to the 30 to 40 Btu/hr-lb consumed in typical industrial holding furnaces.

The combined system will outsource melting and eliminate large holding furnaces in many production facilities. Melting operations can be centrally located and operated in the most efficient mode, and foundries will receive ready-for-use and treated molten metal.



*A 7,000lb commercial prototype ITM was commissioned for Aleris Rolled Products at their Newport, OH facility. This unit is capable of a 5,000lb/hr output when melting light weight scrap (edge trim), and up to 7,000lb/hr solid charge.*



### Benefits for Our Industry and Our Nation

The integrated delivery and dispensing system further reduces metal loss and contamination, provides the flexibility to change alloy chemistry, and eliminates the need for energy-intensive holding furnaces at the casting site. The overall energy savings of the integrated system could exceed 85%, compared with the current practice of conventional melting, gas-burner-preheated ladles, and the reliance on insulation and superheated metal which limits transport time and distance.

Potential, annual benefits are the following:

- Energy savings of 12.7 trillion Btu
- Cost savings of \$45.7 million
- Reduced on-site generation of combustion gases, including carbon dioxide (CO<sub>2</sub>), sulfur oxide (SO<sub>x</sub>), nitrogen oxide (NO<sub>x</sub>), and particulates
- Reduced dross formation

### Applications in Our Nation's Industry

The commercial applications for the integrated ITM/TeL metal supply system are widespread. In the aluminum industry, both the wrought alloy and engineered castings sectors will have a compelling need for the integrated system. The potential cross-cutting applications for the technology will extend energy savings and environmental benefits beyond the aluminum industry, including other molten metal processes such as those involving lead, zinc, magnesium, and copper-based alloys, as well as the production of glass, chemicals, and forest products.

## Project Description

The objective of this technology is to eliminate melting and holding furnaces at the casting cell and move these operations to centralized and optimized off-site facilities.

A demonstration will prove the capability of operating a 6,000 lb/hr casting line with ready-to-use molten metal delivered by detachable transport vessels, with a gross energy input less than 650 Btu/lb, using off-site melters and no in-plant holding furnaces.

## Barriers

- Developing and demonstrating an integrated system to melt and transport molten aluminum
- Creating a paradigm shift in the industry required for implementing this technology

## Pathways

The new process will be showcased at Aleris International's operations and GM's Powertrain Division in Saginaw, Michigan, beginning in 2009. In this demonstration, melting will take place at Aleris in an Isothermal Melter, and then TeL trucks will transfer and dispense the molten aluminum at GM's casting operations site.

The strategies that will be used to achieve the project goal include the following:

- Develop electrically heated vessels to transfer molten metal to casting operations
- Develop docking stations to receive molten metal
- Integrate the technologies with an ITM furnace to form a complete system that improves energy efficiency

## Milestones

- Implement stand-alone direct immersion (DI) heaters for melting, and baffle and side pocket panel (BSPP) heaters for holding
- Implement conductive trough (CT)
- Design, build, and operate 7,000 lb/hr sized ITM furnace
- Design, build, and operate TeLs and docking stations
- Integrate ITM/TeL/CT unit operations to support 6,000 lb/hr casting line

## Commercialization

The commercialization strategy consists of developing strong partnerships with high-visibility end users and suppliers. Other components of the commercialization strategy include leveraging customer experiences and testimonials, providing leasing opportunities for melters and ladles, and expanding international sales through third parties.

## Project Partners

Apogee Technology, Incorporated  
Verona, PA  
(C. Edward Eckert: EDT58@aol.com)

General Motors  
Saginaw, MI

IMCO Recycling  
Saginaw, MI

Commonwealth Aluminum  
Uhrichsville, OH

Drexel University  
Philadelphia, PA

Argonne National Laboratory  
Argonne, IL

For more information contact:  
EERE Information Center  
1-877-EERE-INF (1-877-337-3463)  
[www.eere.energy.gov](http://www.eere.energy.gov)



U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

May 2009

CPS Agreement #13128