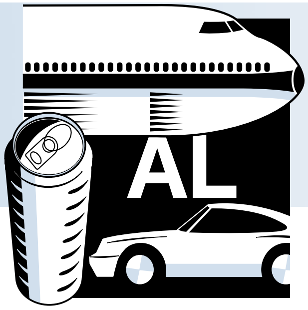
ALUMINUM

Project Fact Sheet



Aluminum Carbothermic Technology Advanced Reactor Process (ACT-ARP)

Benefits

The potential benefits of this project include:

- reducing electrical energy consumption by more than 30 percent
- reducing production costs by 25 percent
- reducing capital costs by 50 percent
- significantly reducing total CO_2 generation
- eliminating fluoride emissions from the aluminum production step
- eliminating volatile organic carbon fumes from the anode production step
- eliminating spent pot lining solid waste

Applications

This project could reduce the energy, capital and environmental cost of producing aluminum. Lower-cost aluminum would improve the aluminum industry's penetration into other markets.

ACT-ARP is a significant advancement as an alternative aluminum reduction process

The advanced reactor process (ARP) is a new process for the production of aluminum by carbothermic reduction. This technology has been proposed as an alternative to the current Hall-Heroult electrolytic reduction process. ARP has the potential to produce primary aluminum at a power consumption in the range of 8.5 kWh/kg at an estimated 25 percent reduction in manufacturing cost. Although the carbothermic process involves the generation of carbon-based greenhouse gases (GHG), the total GHG reduction from power plant to metal should be substantial due to the significantly reduced power consumption, the elimination of perflourocarbon emissions, and the elimination of carbon anode baking furnace emissions. The estimated capital investment required for ARP will be about 50 percent less than that for Hall-Heroult cell technology. The labor required for plant operation will also be reduced.

ARP is a multi-step high temperature chemical reaction that produces aluminum by reduction of alumina with carbon. Optimization for reaction products requires a multi-zone furnace operating at temperatures in excess of 2,000°C. A significant portion of the aluminum is in the gas phase at these temperatures. A continuously operating furnace capable of producing the high temperatures required and recovering the molten and gas phase products is critical for the development of this technology. This is Phase I of a multi-phase effort to develop an ACT reactor based on advanced, high temperature, electric-arc furnace technology and improved understanding of the process reactions.

Advanced Reactor Process

ARP is a new process for producing aluminum.

Project Description

Goals: The goals of this project are to demonstrate the technical, economic and environmental viability of aluminum carbothermic technology by using advanced high temperature (>2,000^0 C) bench- and laboratory-scale reactors. The project team will address technical hurdles which have prevented full development and implementation of this technology in the past. These include the high temperatures required and their effect on 1) the recovery of aluminum and 2) the materials of construction for the reaction zones, and 3) reduction of carbide impurity in the aluminum product. The most promising process options will be selected for further evaluation in larger laboratory-scale research planned for Phase II.

Progress and Milestones

- The team will estimate or measure various properties and parameters that are critical to applying ACT successfully in the aluminum smelting process. Physical properties of slag and metal phases such as viscosity, thermal conductivity and electrical resistivity affect reactor design and are basic, fundamental thermodynamic values that cannot be altered. A thorough understanding of these values is necessary to overcome barriers that have halted progress in the past.

- The team will develop advanced computer models, incorporating the thermodynamic and physical property values attained. The models will apply to both equilibrium, non-equilibrium, steady and non-steady state conditions. The modeling will enable the team to make predictive calculations of process performance at various operating conditions, resulting in improved design, operation and control of the process.

- The team will conduct physical modeling to support the computer simulations. This modeling will address reactor design components that affect system mass transfer characteristics that are critical to successful operations. Physical modeling helps establish design parameters such as the proper underflow slot area between reactor stages and the effect of slag stirring on rate of Al_2O_3 extraction to reduce carbon in the metal phase.

- The team will develop a continuous electric arc furnace process operated in the slag resistance mode and separate the pre-reduction step from the metal production step. Initially, each stage will be developed separately. A follow-on program will link the stages in a single multi-zoned reactor.

- The team will determine the rate of decarbonization, the limits of decarbonization, and methods for improving the rate and limits of decarbonization for the metal product.

- The team will estimate both capital and operating costs for ARP at commercial scale using data and results to establish process design, optimum operating conditions and mass and energy balances.

Commercialization Plan

The project team considers commercializing ACT a potentially significant contributor to the U.S. aluminum industry's ability to increase production rates while reducing production costs. The criteria for commercial success is a 25 percent reduction in the cost to produce aluminum, a 50 percent capital cost savings over the Hall-Heroult process and an environmentally acceptable system. A commercialization plan has been developed to market ACT efficiently.

Project Partners

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