AISI CO2 breakthrough

AISI is the organizer of North America’s research efforts for the CO2 Breakthrough Program, an international research program coordinated by worldsteel to develop transformational processes for making steel with the goal of significantly reducing CO2 emissions and is consistent with the steel industry’s position that the solution to climate change must be global and technology-based. Phase I of the CO2 Breakthrough Program began as a joint program under the Technology Roadmap Research Program between the members of AISI and the DOE. Steelmakers and leading scientists from around North America presented and evaluated a number of concepts and ultimately selected two technologies for further development.

The AISI CO2 Breakthrough Program is organized and managed as an opt-in program and consisted of two projects. 1.) Iron making by Molten Oxide Electrolysis - MOE [produces iron and oxygen, no CO2] Massachusetts Institute of Technology, and 2.) Novel Flash Iron making - University of Utah, based on the direct gaseous reduction of fine iron oxide concentrates (using natural gas) in a flash reduction process.

A project at Massachusetts Institute of Technology, is developing a process to produce iron by Molten Oxide Electrolysis (MOE), an environmentally friendly technology for the production of metals. MOE is a derivative of molten salt electrolysis, a technology that has been producing tonnage metal for over 100 years – aluminum is produced in this manner. To produce iron by MOE, molten iron oxide is decomposed by the action of electric current into liquid iron and oxygen gas. What sets MOE apart from all other metal producing technologies is that it is carbon-free and, except for GHG emissions in the production of electricity, generates no significant greenhouse gases.

The team at MIT has succeeded in demonstrating the technical viability of MOE by producing liquid metal and oxygen gas in a laboratory-scale cell. Next steps on the project involve testing/validation for scale-up. Funding is needed for an industrial pilot-scale plant beginning in 2012.

The Molten Oxide Electrolysis (MOE) project completed bench-scale experimentation work in 2011 under AISI’s $6.5M (100% industry funded) CO2 Breakthrough flagship program, a component of worldsteel’s Global CO2 Breakthrough Program, to develop iron and steelmaking technologies to dramatically reduce or eliminate CO2 emissions. (Total USS investment, $1.222M, 2008-2011)

MOE was invented at MIT (principal investigator Donald Sadoway) and represents a radical departure from all current ironmaking technologies. To produce iron by MOE, molten iron oxide is decomposed by the action of electric current into liquid iron and oxygen gas. What sets MOE apart from all other metal producing technologies is that no carbon is used in the process thus there is no emission of CO2 (except from the source of electricity) and pure oxygen gas is the by-product. The feasibility of electrolytic ironmaking by Molten Oxide Electrolysis has been demonstrated at the laboratory scale, verified the basic electrochemistry is sound, and a cost-effective inert anode material has been discovered to sustain oxygen production. What remains is the demonstration of scalability.
The proposed Next Phase encompasses an $8.0M, 3-year effort for: process physical and numerical modeling of a 3,000A electrolytic cell and small scale experimentation as required for model verification; design and construction of 3,000A electrolytic cell; and continuous operation of the cell to generate design data for a first generation industrial size electrolytic cell including installation and operating cost estimates. Using the results of this research, this new manufacturing process can be confidently and expeditiously developed to industrial scale, i.e., 350 kA.

Two proposals were submitted in response to the DOE IMI funding announcement (in June 2011) and next steps for AISI CO₂ Breakthrough technology scale-up. AISI’s application, “A Novel Flash Ironmaking Process,” (with Utah) was selected for a $7.1 million award in June 2012. This project was one of thirteen selected out of the more than 1400 letters of intent, 1200 concept papers, and over 250 full applications DOE evaluated as part of this funding opportunity.

AISI’s other application, “Development of Large-Scale Lab Cell for CO₂-free Iron-making by Molten Oxide Electrolysis” (with MIT), was not selected for an award. As such, because of the significant investment required, MOE work is tabled having consumed available industry funds by the end of 2011 and not being able to secure government funding for technology scale-up.