Argonne research could lead to cooler aluminum production

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Researchers at the U.S. Department of Energy's Argonne National Laboratory and NorandaFalconbridge, Inc. are developing a way to produce aluminum at significantly reduced temperatures. The collaborative research effort could eventually lead to significant reductions in the energy costs and emissions of greenhouse gases associated with aluminum production.

The four-year, $2.25-million joint project is one phase of a long-term effort to improve on the massive electrolytic cells in which aluminum is produced on an industrial scale. In these cells, alumina, dissolved in a molten electrolyte, is stripped of its oxygen atoms by a strong electrical current and converted into the metallic aluminum that makes up consumer products like soda cans and aircraft wings.

John Hryn, the Argonne metallurgist leading the project, said the process usually requires temperatures of 960 degrees C. At that temperature, few materials can withstand the oxygen produced electrolytically inside the cell. Sacrificial carbon anodes have been used in aluminum production since the process was invented in 1886. As aluminum is formed, the carbon anode is consumed by oxygen, and the resulting carbon dioxide bubbles out of the cell.

For many years, researchers have sought a new, non-consumable anode to replace carbon anodes. Hryn thinks the answer may lie in modifying the cell electrolyte to operate at lower temperatures. Several years ago, he and his colleagues discovered an electrolyte composition that can dissolve alumina and produce aluminum metal at 700 degrees C, more than 250 degrees cooler than current electrolytes.

“The lower operating temperature opens up the possibility for new anode materials,” he said.

Using standard aluminum-bronze anodes in bench-scale tests at Argonne, Hryn and colleagues demonstrated that the new electrolysis cells operated for 100 hours without any significant corrosion at the anode. Also, the cell produces oxygen as a byproduct instead of carbon dioxide and perfluorocarbon, two kinds of greenhouse gas produced in carbon anode electrolytic cells.

However, Hryn cautions that the largest hurdles still remain. The system must be tested at successively larger scales, each involving higher electrical currents and running for longer periods of time.

“At larger scales, we start to see the materials issues emerge,” Hryn said. “Things that seem to work well on the bench tend to fail at larger scales, primarily because you are working at these extreme conditions. Our advantage is that we are operating 250 degrees lower than everybody else, and that's a big difference for materials.”

The cooperative research and development agreement between Argonne and Noranda formalizes a joint effort that has existed for the past four years. Hryn said it is important for Argonne to have an industrial partner at this stage of the project.

“We get their input on what is important to them right at this stage," he said, "so as we get larger, we're addressing exactly their concerns. Working with industry early on is really the key to success.”

If the new electrolytic cells are successful and replace the old cells and their consumable carbon anodes, the benefits to the aluminum industry and the environment will be tremendous. The Department of Energy, in conjunction with members of the aluminum industry, released an “Inert Anode Roadmap” six years ago that projected energy efficiency increases of 25 percent, operating cost reductions of 10 percent, and greenhouse gas emissions reductions of 7 million metric tons of carbon equivalent in the United States. Also, aluminum producers using nonconsumable anode technology will not have to purchase carbon anodes or maintain facilities that produce them.

“There's a huge incentive to get rid of all that,” Hryn said.

NorandaFalconbridge, Inc. is a leading mining and metals company. It employs 16,000 people at its operations and offices in 18 countries and is listed on the New York Stock Exchange (NRD) and the Toronto Stock Exchange (NRD.LV).

Source: Argonne National Laboratory

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