SELECTIVE REMOVAL OF IMPURITIES FROM MOLTEN ALUMINUM ALLOYS

A process to take unwanted metals out of aluminum alloys can increase efficiency in recycling.

As a highly recyclable metal that is used in many industrial sectors, aluminum is a crucial link in the circular economy supply chain. To achieve the right mix of strength, corrosion resistance, and other desirable properties, manufacturers create aluminum alloys with differing elements. However, with each round in the repeated melting and reuse of aluminum alloys, impurities such as iron, copper, zinc, magnesium, silicon, and manganese accumulate.

The heterogeneity of scrap compositions makes these impurities difficult to manage, which is a challenge for recycling. Recyclers typically manage impurities in recycled aluminum alloys by diluting scrap with purer primary aluminum metal. The metal research firm Phinix is developing and commercializing alternative methods to address impurities in aluminum alloys.

With research partners at Worcester Polytechnic Institute, Kingston Process Metallurgy, Smelter Service Corp., and Certified Flux Solutions, Phinix LLC has demonstrated the removal of iron and manganese from molten aluminum scrap. The process could save energy and avoid carbon emissions by reducing the need for new aluminum in the recycling process and boosting the quality of recycled aluminum alloys.

PROJECT DESCRIPTION

The project's main approach was to use a predetermined quantity of "scavenger(s)" that combines with both aluminum and "impurity" elements to form stable impurity-rich intermetallic compounds under specific temperature and time conditions. Subsequently, the solid product can be separated through appropriate methods to yield a purified aluminum melt.

After conducting a survey of the current landscape in aluminum alloy purification techniques, the team performed computational thermodynamic modeling to select the most promising target impurities and scavenger(s) for experiments. A series of experiments was conducted to test methods for removing iron, copper, silicon, manganese, and zinc from melted aluminum scrap. Lab trials revealed that intermetallic gravity sedimentation was highly efficient at removing iron and manganese. After optimizing the process, the team conducted trials on several thousand pounds of molten alloy at a commercial plant. The large-scale experiments verified the findings of lab-scale experiments, and a preliminary techno-economic analysis suggests this method for removing iron and manganese is economically feasible.

PROJECT NUMBER: 20-01-RR-4010

PROJECT IMPACT

By increasing the use of scrap aluminum and lowering the need for primary aluminum, this process could save 29.6 petajoules of energy and avoid 1.6 million metric tons of carbon dioxide emissions annually.

NEXT STEPS

PHINIX has signed a licensing agreement with a domestic secondary aluminum producer to commercialize the process across the domestic secondary aluminum industry. Moving forward, three industrial partners have agreed to participate in a follow on the pilot plant phase on a new REMADE contract. The goal is to fabricate and test parts produced from purified aluminum melts using the new process for use in the automotive industry.

PROJECT PARTNERS

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PUBLICATIONS

Das, S.K., Mishra, B., Powell, A., Sinha, M.K., Davis, B., Hiscocks, J., Grosko, T., Pickens, J., Giageos, A. Selective Recovery of Elements from Molten Aluminum Alloys: Final Report for REMADE Project: 20-01-RR-4010. December 2023.

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PATENTS

Utility and PCT patent application filed in 2023. Title of Invention: SELECTIVE REMOVAL OF IMPURITIES FROM MOLTEN ALUMINUM.

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