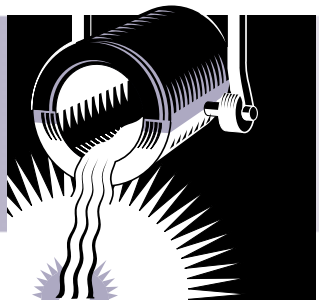
METAL CASTING

Project Fact Sheet



Mold Materials for Permanent Molding of Aluminum Alloys

Material and coating improvements target increased life-span and reduced cost of permanent molds

Benefits

Aluminum has a lower melt temperature than many ferrous alloys. By increasing the viability of producing permanent mold aluminum castings, this project will result in energy savings in melting -- the most energy intensive stage of the casting process. Moreover, by increasing casting quality, yield will be improved and thus less metal will need to be melted per ton of casting produced. Improved yield and the longer life of the mold also will lead to significant cost savings.

Applications

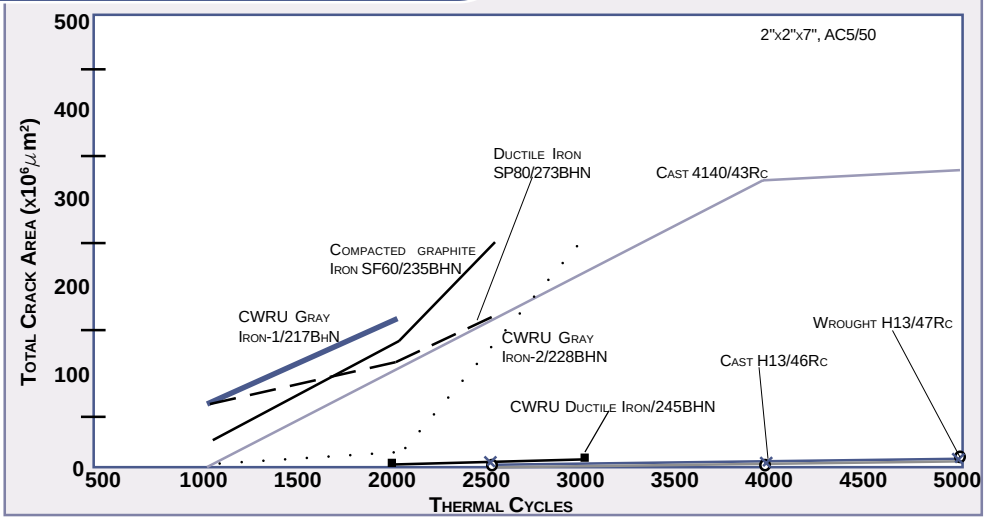
The results of this project can be applied by aluminum permanent mold casters throughout the metal casting industry. It will increase the range of castings viable by aluminum permanent molding.

Permanent molds used for molding aluminum alloys typically are selected from a large field of materials ranging from gray iron to high strength tool steels. The usual mode of failure of permanent molds is thermal fatigue cracking caused by the cyclic thermal stress on the mold face. Resistance to thermal fatigue can be increased by using mold materials that have a combination of high thermal conductivity, high strength at elevated temperatures, low coefficient of thermal expansion, and a low modulus of elasticity.

Researchers from Case Western Reserve University, in conjunction with the American Foundry Society, are conducting research to extend the life and improve the quality of permanent molds used in aluminum casting. The relative mold life under typical thermal conditions will be determined for a range of materials such as gray iron, ductile iron, and compacted graphite iron. Cast and wrought 4140 type steels, and cast and wrought H-13 steels also will be evaluated. Materials may be used as-is or alloyed to provide microstructures with different life and stabilities at elevated temperatures.

An additional goal of the project is to perform selective application of mold coatings to reduce the cost of the molds and to improve the surface quality of the aluminum castings produced. State-of-the-art coatings used in the permanent mold casting industry will be evaluated and compared.

Thermal Fatigue Performance of Permanent Mold Materials



The best material above is H13 wrought steel. The selection of mold materials depends on the number of castings to be purchased since the cost of the steels is increased.

Project Description

Goal: The goal of this research is to extend the life and improve the quality of permanent molds utilized in casting aluminum. An additional goal is to reduce the cost of the molds and improve the surface and soundness quality of the aluminum castings by selective application of coatings.

Progress and Milestones

This two-year project was awarded in 1999. Interim progress includes:

- Two cast iron compositions (gray cast iron and ductile iron) were formulated and cast into thermal fatigue bars. They have been machined and tested in the as-cast condition at the experimental foundry at Case Western Reserve . The ductile iron sample gross-cracked after the first cycle, the ductile iron after the 100th cycle. Researchers concluded that the tempering at 900 degrees F is insufficient to attain a reasonable ductile level. Additional tests at higher temperatures will be performed.

- Evaluation of refractory coatings are ongoing. Insulating properties are being determined by comparing the temperature of the coated sample to a reference, uncoated steel sample. The degradation of the coating is then evaluated.

Interim results from this project were presented at an industry conference in October 2000. The large difference in die life and the relative cast of the molds were highlighted. The improvements that could be obtained in the life of gray and ductile iron molds were also demonstrated. Based on this study, the large number (250 people) in attendance have been guided on how to select mold sand casting materials based on the results presented.

Project Partners

Case Western Reserve University
Cleveland, OH

American Foundry Society
Des Plaines, IL

Amcast Automotive, Southfield, MI

Arrow Aluminum Casting, Woodstock, IL

Bohn Aluminum Corporation, Butler, IN

DCD Technology, Cleveland, OH

Foseco, Inc., Cleveland, OH

Grand Rapid Aluminum Casting, Grand Rapids, MI

Hayes Lemmerz-CMI, Ferndale, MI

Progress Casting Group, Plymouth, MN

Stahl Specialty Company, Kingsville, MO

St. Louis Precision Castings, St. Louis, MO

UES, Inc., Annapolis, MD

For additional information, please contact:
Harvey Wong
Office of Industrial Technologies
Phone: (202) 586-9235
Fax: (202) 586-6507
Harvey.Wong@ee.doe.gov
http://www.oit.doe.gov/IOF/metalcast/

Please send any comments, questions, or suggestions to webmaster.oit@ee.doe.gov.

Visit our home page at www.oit.doe.gov

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

OIT

August 2000