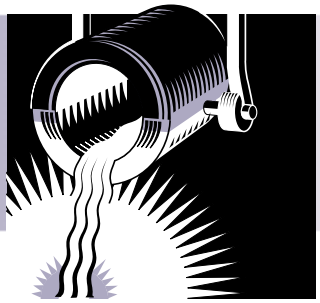
METAL CASTING

Project Fact Sheet



ENHANCEMENTS IN MAGNESIUM DIE CASTING

BENEFITS

Benefits will accrue in several ways. Melting is the most energy intensive stage in casting. As advances are made in magnesium die casting processes, die casters will see melting-related energy savings since magnesium has a lower melt temperature than alternative metals. These savings are estimated to reach 341 billion Btu per year by 2020. A secondary benefit, increased use of light weight magnesium components in automotives will help to improve fuel efficiency in the transportation sector thereby reducing energy requirements and automotive emissions.

APPLICATIONS

The results of this project can be applied throughout the magnesium die casting community and will increase the competitiveness of magnesium die castings. The primary market for magnesium die castings is for high strength, light weight automotive components. Components with these properties are in increasing demand to improve fuel efficiency in the automotive sector. Results of this research will be widely disseminated among magnesium die casters and tool makers.

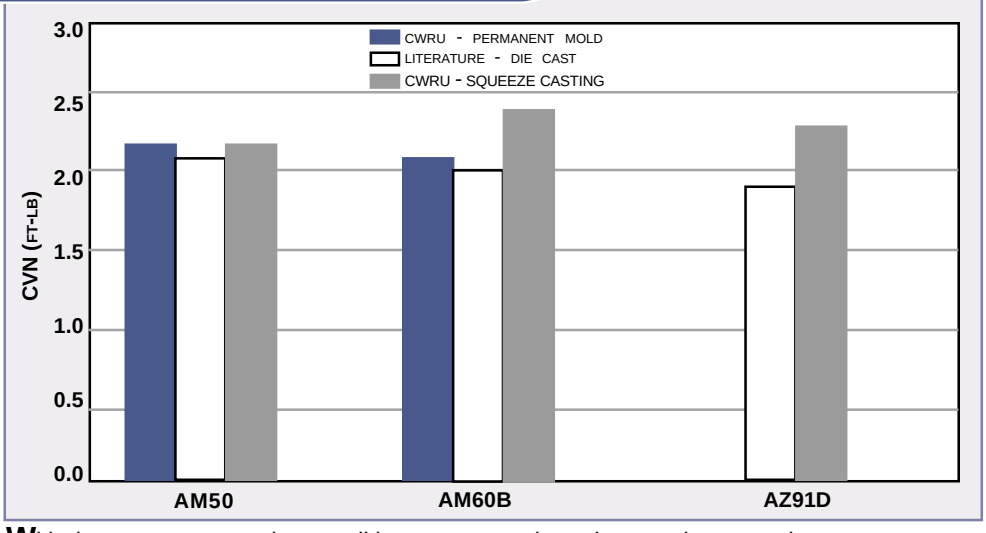
STUDY IMPROVES IMPACT PROPERTIES OF CAST MAGNESIUM ALLOYS AND SEEKS TO REDUCE DIE FATIGUE

Magnesium alloys offer an excellent combination of light weight, ease of manufacturing, and good engineering properties. This combination makes magnesium an attractive choice for automotive applications. However, inconsistent mechanical properties, in particular impact properties, have been a concern among designers.

Case Western Reserve University, in conjunction with the North American Die Casting Association and industry partners, is conducting research to improve the toughness of cast magnesium alloy products. This research also will evaluate the effect these alloys have on the thermal fatigue life of steel dies used in magnesium die casting.

The study will utilize an industrial-scale 275 pound magnesium melting furnace at Case Western Reserve. Specific areas being studied include alloy selection, processing conditions, and the life of the dies and tools that are employed to make magnesium die castings. This study is establishing relationships between processing variables and the resulting alloy toughness. Recommended "best workmanship" procedures will be developed for implementation in magnesium casting facilities.

CHARPY V-NOTCH IMPACT STRENGTH OF MAGNESIUM ALLOYS



With the proper processing conditions, very good test bar results were obtained for permanent molds.

Project Description

Goal: The goal of this project is to improve the toughness of cast magnesium alloy products and evaluate the effect these alloys have on the thermal fatigue life of steel dies used in magnesium die casting.

Progress and Milestones

The heat transfer conditions during magnesium die casting are a very significant factor in controlling the process. The heat transfer conditions in the die differ from aluminum die casting because of the lower specific heat, heat of fusion, and differing solidification periods of magnesium alloys. It requires a means of effectively preheating the die and maintaining it at the desired temperature. This project will consider these different heat transfer requirements by thermal modeling. The results of the modeling will be checked by experiments that measure the heat losses that occur in the ladle, shot sleeve, ingate, and die casting cavity. Thermal fatigue resistance of die steels will be conducted in magnesium alloys and compared to the results obtained for these steels in molten aluminum alloys under similar testing conditions.

This project was awarded in 1998. Specific milestones include:

- A 275 lb, industrial-scale, magnesium melting furnace has been fabricated for testing purposes at Case Western Reserve. This was an in-kind industry contribution to the research.
- Magnesium test bars have been produced. Methods of protecting the metal from oxidation during delivery to the shot are being evaluated. The testing of impact properties of the squeeze cast magnesium alloys is in progress.
- Industry-provided magnesium components have been collected for testing.
- The study on the toughness of magnesium alloys is underway.

This investigation has analyzed the properties and castability of magnesium alloys compared to aluminum alloys. Castings have been produced in metal molds using the permanent molds in the permanent molding process and the squeeze casting project. The processing of magnesium alloys requires special handling because of its lower heat capacity and the difficulty experienced in avoiding misruns and hot tears when cast in different shapes. The impact resistance at room temperature for these magnesium alloys were higher for AM60 than the others and reached 5.0 foot pounds for this alloy. However, without the proper casting technology values of only 2.4 and 2.1 foot pounds were obtained with AM60.

The importance of the metal processing and handling condition for these magnesium alloys is shown in the figure on the previous page. With the proper processing conditions, very good test bar results were obtained for permanent molds. The work on the squeeze casting machine also indicated that the properties were affected by the loss of the superheat and required large ingates and high rates of flow.

Project Partners

Case Western Reserve University, Cleveland, OH

North American Die Casting Association, Rosemont, IL

A. Finkle & Sons Co., Chicago, IL

Chrysler Corporation, Auburn Hills, MI

CMM Services, Morton, IL

Crucible Steel, Syracuse, NY

DCD Technologies, Cleveland, OH

Ford Motor Company, Dearborn, MI

FPM Heat Treating, Chicago, IL

General Die Casters, Akron, OH

General Motors, Bedford, IN

Mercury Marine, Solon, OH

Partnership for a New Generation of Vehicles

UBE Machinery, Ann Arbor, MI

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.

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

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August 2000