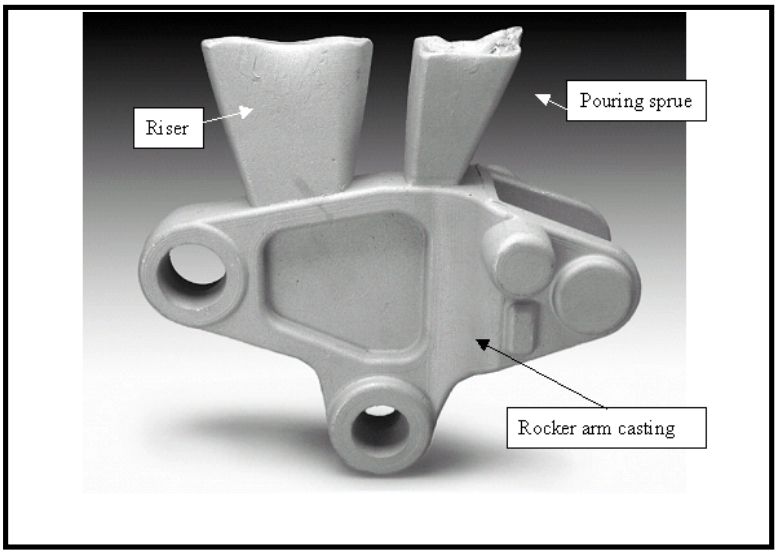
Industrial Technologies Program

Light Metals Permanent Mold Casting

There is emphasis on vehicle weight reduction to improve fuel economy by automakers . Aluminum and Magnesium based alloys can replace more ferrous alloys to achieve better fuel economy. Some of the advantages of the permanent mold casting process, compared to sand casting processes, are better surface finish, precise and consistent dimensional control, and improved mechanical properties. The selection of permanent mold cast Aluminum and Magnesium based alloys is hampered by lack of adequate data on the foundry characteristics and the mechanical properties.

There is limited information in open literature on the gravity and low-pressure permanent mold casting of Al-Mg alloy 535 and many of the Magenesium alloys that are of interest to the automotive industry. Currently, high-pressure die-casting is the major production route of magnesium alloy components used in automotive applications. However, most of the high-pressure die cast components cannot be heat-treated. Gravity tilt-pour, and low-pressure permanent mold casting of powertrain components from magnesium alloys can lead to reduced porosity defects, and thus allow for the heat treatment to meet performance requirements. It is anticipated that magnesium use in automotive applications may rise to 12.4 kg from the current 4 kg per vehicle, and gradually increase to 100 kg per vehicle by the year 2020. The use of magnesium in other commercial applications is also expected to increase due to its high-strength-to-weight ratio.

Significant energy savings can be achieved by using gravity and/or low-pressure permanent-mold casting processes, with sand or permanent-mold cores. Energy savings of about 250 kWh per ton of castings are possible by switching from sand to permanent mold Significant energy savings can be achieved by using gravity and/or low-pressure permanent-mold casting processes, with sand or permanent-mold cores. It has been estimated that energy savings of about 250 kWh per ton of castings can be realized by switching from sand to permanent mocasting. The



Benefits for Our Industry and Our Nation

- *Estimated energy savings of 10 trillion Btu over 10 years*
- *Energy saved from sand molding and finishing of castings.*
- *Improved casting yield (less metal to be re-melted) with permanent mold, about 65 percent compared with 50 percent or less for sand castings.*
- *Elimination of and/or reduced sand use.*
- *Reduced heat treatment cost with T5 heat treatment, instead of T6.*

Applications in Our Nation's Industry

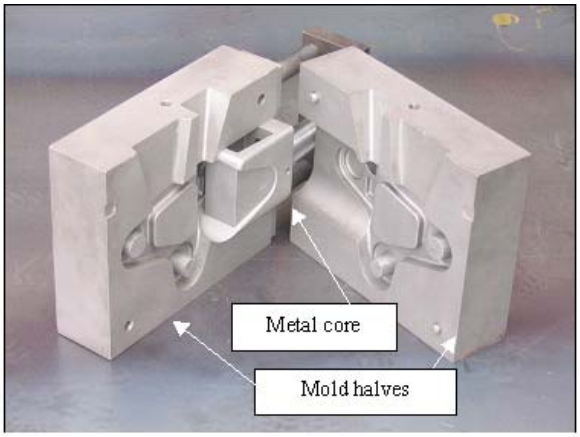
The research will develop the gravity and/or low-pressure permanent-mold casting processes with sand or permanent-mold cores for aluminum and magnesium based alloys. This will achieve significant energy savings through yield rate improvement for automotive and marine fuel economy.

environmental and health concerns associated with sand disposal and working conditions are eliminated. Additional energy savings can be achieved by using Al-Mg Alloy 535 since it exhibits good mechanical properties and dimensional stability in the as-cast condition. A more cost effective T5 heat treatment can be used. Hence, it does not require the more expensive solution treatment, water quenching, and aging treatment commonly used for T6 heat treatment. Cast magnesium structures have the potential to reduce vehicle weight by over 150 kg, which could reduce vehicle emissions by 5 percent and reduce fuel consumption.

Project Description

The main objectives of this project are to:

- Establish the processing parameters for selected prototype automotive, marine and other components during gravity and low pressure permanent mold casting of Al-Mg alloy 535 and Mg alloys AM50 and a creep resistant alloy (based on suggestion from industrial partners).
- Determine the microstructure and mechanical properties in the as-cast as well as heat-treated alloys mentioned above.
- Benchmark the casting processes and alloy properties.



Milestones

This project's planned tasks include:

1. Identification of prototype components
2. Casting and mold design
3. Fabrication of molds
4. Casting process development
5. Characterization
6. Corrosion behavior
7. Field trials of the components
8. Benchmarking of casting process and material properties
9. Technology transfer
10. Data analysis and report writing

Project Partners

CANMET-MTL
Ottawa, Canada

American Foundry Society
Schaumburg, IL

Cast Metals Coalition Partnership
Charleston, SC

Alcan International, Ltd.
Kingston, Ontario, Canada

Centre Integré de Fonderie et de Metallurgié, Abijan, France

ECK Industries, Inc.
Manitowoc, WI

Grenville Castings Limited
Smith Falls, Ontario, Canada

Magma Foundry Technologies, Inc.
Arlington Heights, IL

Powercast Manufacturing, Inc.
St. Eustache, Quebec, Canada

Premier Aluminum, Inc.
Racine, WI

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy

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