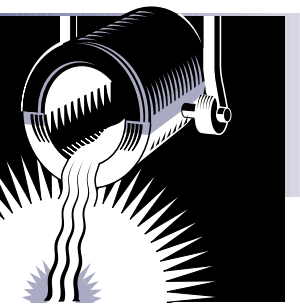
METALCASTING

Project Fact Sheet



Development of Aluminum-Iron Alloys for Magnetic Applications

Benefits

- Allows for lighter, more efficient motors
- Lowers gas consumption in automobiles and extends range for electric cars
- Reduces air emissions
- Improves magnetic performance in alternating current (AC) and direct current (DC) motors
- Provides for simpler development of alloys using powder metallurgy
- Offers faster rotating speeds and improved electrical performance from stronger and more ductile iron-aluminum magnetic parts
- Fewer hysteresis losses render magnets more responsive to lower applied fields

Applications

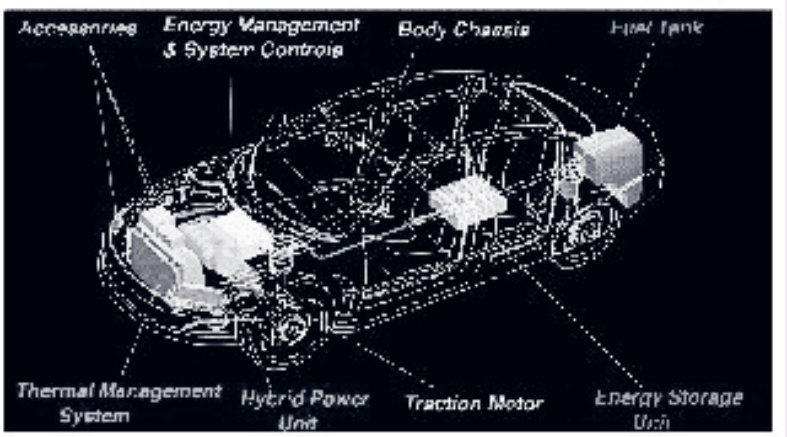
The use of aluminum-iron alloys represents a new approach in the magnets used in electric motors. These motors are also applicable for use in electric vehicles. The weight reduction and response would improve the mileage range of the electric vehicle, currently a major hindrance to its acceptance in the marketplace.

New method of alloying aluminum and iron improves the efficiency of electric motors

Increasing numbers of small motors are used in conventional automobiles to provide safety and comfort to passengers. In addition, development continues in the design and manufacture of electric cars and hybrids. However, the efficiency of motors used in these applications must be improved so they require less electrical power and are friendlier to the atmosphere.

Many recently developed motors contain permanent magnets to conserve electrical energy supply. But while high-energy permanent magnets are readily available, current research is unlikely to yield improvements in magnet technology, in part because too much attention is being directed toward the design of magnetic circuits. In contrast, the soft magnetic core, also an important segment of the magnet, has been mostly ignored. Using powder metallurgy, Magna-Tech P/M Labs is developing a soft magnetic aluminum-iron alloy to replace the silicon irons or phosphorus irons now used in the cores of permanent magnets.

Aluminum-Iron Alloys for Magnetic Applications



National Renewable Energy Laboratory diagram

A hybrid electric vehicle (HEV) is an optimized mix of various components, including permanent alternating current (AC) magnets.

Project Description

Goal: Develop a new, soft magnetic iron-aluminum alloy featuring improved magnetic induction, improved structure, more sensitive magnetic properties, lower core losses, and improved tensile strength.

Aluminum alloys are expected to be lighter than current alloys, leading to 10 to 20 percent projected increases in motor efficiency. In addition, the reduced weight of iron-aluminum alloys should result in more miles-per-gallon of gasoline and lower emissions of exhaust products to the atmosphere.

Improved motor design accounts for many of the improvements in engine efficiency over the years. Permanent magnets have replaced traditional copper-wound soft magnetic cores and improved controls in AC motors have also resulted in greater efficiency. These motors have been improved, but there is further room for improvement in efficiency. Permanent magnet design is set, and no further advancements in permanent magnets with a greater energy product appear to be in sight. Magna-Tech P/M Labs' aluminum-iron alloys, with their reduction in magnet weight and cost, could be the development that the motor industry has been looking for.

Magna-Tech P/M Labs is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Study aluminum-iron alloys by preparing blends of powder and compacting and fabricating specimens. Use conventional powder metallurgy technology to produce parts.
- Define magnetic and tensile properties of aluminum alloys and compare them with the properties of existing commercial alloys.
- Test the DC magnetic properties of the alloys in accordance with ASTM test methods. For AC magnetic properties, Magna-Tech intends to purchase a wattmeter and adapt the DC equipment to perform test measurements. Magna-Tech will also measure the resistivity of the alloys.

Economics and Commercial Potential

In 1997, the total value of motor shipments was $10.3 billion. Most of these were small motors. The market for motors is therefore firmly established. The need to use less electrical power and reduce greenhouse gas has provided an impetus to improve motor design. Many recently developed motors contain permanent magnets to conserve on electrical energy supply. While high-energy permanent magnets are readily available, current research efforts are unlikely to yield improvements in these permanent magnets.

The automotive industry accounts for 70 percent of the current market for powder sales. Magna-Tech believes iron-aluminum alloys can be cost effective compared to the phosphorus iron powders used today to supply this market. If Magna-Tech can develop this alloy system, significant improvements in motor performance could be achieved. Magna-Tech needs only to gain approval for use of the alloy in the designed parts. In addition, Magna-Tech would be in a strong position to serve a potential market for electric and hybrid vehicles.

Industry of the Future—Metal Casting

The metalcasting industry – represented by the American Foundrymen's Society (AFS), North American Die Casting Association (NADCA), and the Steel Founder's Society of America (SFSA), has prepared a document, ***"Beyond 2000,"*** *to define the industry's vision for the year 2020. OIT's Metalcasting Vision Team partners with metalcasters, national laboratories, universities, and trade/environmental/technical organizations to develop and implement energy efficiency technologies that benefit both the industry and the United States. Recently, the Metalcasting Team facilitated the development of the Metalcasting Technology Roadmap, which outlines industry's near-, mid-, and long-term R&D goals.*

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The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

Project Partners

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