METALCASTING

Project Fact Sheet

Highly Efficient Rapid Tooling Using Optimized Cooling Passages

Benefits

- Saves approximately 125,500 kWh of electricity per year per tool designed with conformal (conforms to the part geometry) cooling; such a tool might produce cast aluminum suspension components and process about 30 tons of aluminum each year; at 50 percent market penetration, savings equal 937 million kWh or 9.6 trillion Btu per year
- Increases casting process efficiency up to 50 percent by faster cycling times, improved quality, and lower scrap rates
- Potential for significant energy savings through reduced materials consumption in tool production
- Decreases scrap and rework in tool use
- Reduces industry die investment due to superior quality and cooling
- Improves die life
- Produces higher-quality tooling more quickly and less expensively
- Reduces cycle time, leading to increased productivity and decreased market prices for the end user
- Return on investment within 3 years

Applications

This technology has applications in the die casting and permanent mold casting industries, where problems associated with poor thermal conductivity in materials are a concern. Particular benefits exist for casting aluminum parts, which can exhibit serious problems due to thermal breakdown. The technology can be applied to magnesium, plastic, and other accepted proprietary or novel casting materials. This conformal cooling provides commercial tooling for products constructed of metals or plastics, such as automobiles, PCs, and glass products.

A rapid-prototyping process improves investment-casting technology by effectively positioning cooling channels in tooling

The investment-casting process, where the mold must be destroyed to remove the final product, uses various technologies to produce tooling, which is then used to create, cast, or mold parts. Currently, this tooling is cooled through a machining process that drills channels into the tooling. These channels are then filled with flowing water. This traditional cooling method is less than optimal because the passages can only be directed at right angles that cannot be optimally placed next to those strategic areas that need cooling. The result is a slower cycle time between the production of one part and the casting of the next part.

A new highly efficient rapid tooling technology using optimized cooling passages, designed by Edison Materials Technology Center, represents a significant upgrade from the conventional approach. This new technology employs rapid-prototyping (RP) techniques to generate tool and ceramic-core patterns used in the investment-casting process. This process allows for conformal placement of cooling lines, which creates a more exacting tooling-design pattern. This unique technology produces novel cooling-passage configurations and geometries that traditional drilling techniques are unable to create. Using RP techniques, steel parts are fabricated to produce ceramic cores. The RP tool patterns and ceramic cores are then joined together, and the assembly is used with the investment-casting processes to generate cast tooling with optimized cooling passages.

Rapid-Prototyping Process

Part Design
⇓
Tool Design ⇒ Cooling Passage Design
↓
RP Tool Pattern ⇐ SLA Tool Model
↓ ↓
Tool Casting ⇐ RP Ceramic Core

The rapid-prototyping (RP) process provides a more efficient means of reducing cycle times while increasing production rates, which leads to lower energy use and increased profitability for manufacturers. Stereolithography (SLA) will be used to produce patterns of the tool halves with the cooling passages as holes in the pattern.

Project Description

Goal: Test the rapid-prototyping process to optimize the technology and prepare it for commercialization.

The unique aspect of this highly-efficient rapid tooling process is its use of an accepted rapid-prototyping technology that uses laminated object manufacturing (LOM) of ceramic tapes to fabricate ceramic cores. Further development is continuing in advanced rapid-prototyping methods to optimize the design of cooling passages in the respective tools. Unlike other tooling processes utilized in the industry, this new technology more quickly and efficiently produces optimized cooling lines in all tooling shapes and sizes, increasing thermal efficiency and leading to better cycle times and increased productivity.

Edison Materials Technology Center developed 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

- The technology developer has partnered with strategic leaders in the materials field to test the conformal cooling lines in investment-cast tooling under standard operating conditions.
- Once substantial benefits over the former technology have been proven, commercialization to the global investment-casting industry will begin.
- The technology developer is partnering with leaders in the steel, aluminum, and plastics industries to perform rigorous comparison studies to test cycle time, productivity, and energy savings.

Economics and Commercial Potential

The die casting and permanent mold industries purchased approximately $1.5 billion in tooling in 1996, as reported by the North American Die Casting Association. Additional data indicates that approximately 1.6 percent of the cost of a tool can be attributed to energy costs, translating into approximately $24 million in energy costs for tooling.

Commercial potential for the process appears promising, with opportunities to reduce costs in steel, aluminum, magnesium, plastic, and other casting materials. With strong partnerships in both the metal parts investment-casting and plastics industries, this highly-efficient technology could have immediate global investment-casting impacts once anticipated benefits are demonstrated through testing.

Industry of the Future—Metalcasting

The metalcasting industry – represented by the American Foundrymen's Society (AFS), North American Die Casting Association (NADCA), and the Steel Founders' 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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