METAL CASTING

Project Fact Sheet

Yield Improvement and Defect Reduction in Steel Castings

Benefits

- Increased casting yield of 10% from current practices.
- Cumulative energy savings of two trillion Btu per year by 2010.
- Energy cost savings of $1.3 million a year.
- Reduced carbon dioxide emissions to the atmosphere.
- Increased capacity and productivity for steel foundries.
- A wider use and new application of steel castings.

Applications

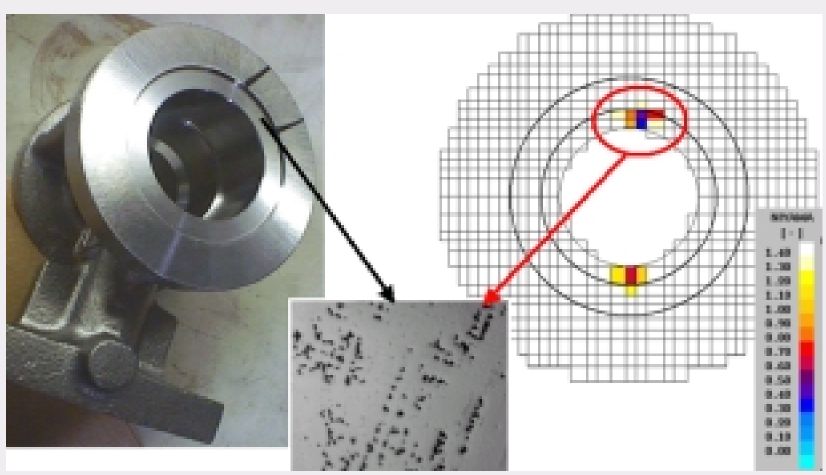
The results of this research can be applied throughout the steel foundry industry in the near term. Ultimately this research will be applicable throughout the metal casting industry for other alloys.

Enabling Production of Higher Quality Steel Castings

Most steel foundries must melt about twice as much steel as will be shipped as finished product. The additional metal is primarily present in risers, which provide feed metal that helps prevent holes or voids from forming inside the casting as it solidifies. This research is identifying techniques for decreasing the size and number of risers required to produce quality castings. It will also develop models to predict the formation, growth and motion of re-oxidation inclusions during the pouring of steel castings.

The University of Iowa and industry partners will develop new feeding rules for high alloy steel castings by conducting a limited amount of high alloy casting trials, and then correlating the results of these trials with extensive casting simulation. The project will also look at unconventional yield improvement and defect reduction techniques, examining both riser pressurization and filling with a tilting mold. Optimizing the method for riser pressurization will reduce shrinkage porosity defects and increase yields in steel castings. Tilting the mold during filling will enable metal to flow smoothly into the cavity, creating less splashing and air entrainment. This will lessen the formation of troublesome re-oxidation inclusions that normally occur in castings created with a typical gravity pour through the sprue. Finally, this research will develop models to predict the formation of re-oxidation inclusions during the pouring of steel castings, the subsequent advection and buoyant movement of the inclusions, and their final characteristics and location in the solidified casting. This will result in substantial benefits to steel foundries, primarily due to the ability to redesign the metal delivery system to avoid inclusions before any castings are actually poured.

Simulation of Porosity Formation



Numerical simulation results for a steel valve indicate the presence of microporosity, as was found in the gasket.

Project Description

Goals: To develop techniques that will improve casting yield by 10% from current practices while maintaining quality, and to develop techniques that will improve yield by 25% on an optimized casting system. Specific objectives are to:

- Develop new feeding rules for risering of high-alloy steel castings and provide the new rules to foundries through a new manual for risering of high alloy steel castings.
- Develop yield improvement and defect reduction technologies for steel casting including (i) riser pressurization and (ii) filling with a tilting mold.
- Develop a model for the prediction of re-oxidation inclusion formation during steel casting.

Progress and Milestones

- Research to date has established new feeding rules for the risering of carbon/ low-alloy steel castings. This work resulted in more consistent and widely applicable feeding rules that can improve casting yield by up to 10%. These low-alloy feeding rules have been published in a new risering manual for low-alloy steel castings.
- Preliminary casting trials were performed at several foundries using high-alloy steel. These trials indicated that the presently available feeding rules for high-alloy steel are overly conservative and too limited in scope.
- In the current project, feeding rules for high-alloy steel will be developed through casting trials and computer simulation. Yield improvements with these new rules are expected to be of the same order as for the new low-alloy rules mentioned above. The new high-alloy rules will be written into a new risering manual for high-alloy steel castings.
- Casting trials performed at Harrison Steel Castings investigated the external application of pressure, in the form of compressed argon, to the riser during solidification to improve the feeding of steel castings. This pilot study laid the groundwork for this portion of the project. Riser pressurization has been reported to increase feeding distances in the casting of low-carbon steel, cast irons, and aluminum alloys using both permanent and sand molds. With increased feeding distances, the occurrence of shrinkage defects is reduced and the casting yield is improved.
- Unconventional and defect-reduction techniques will be developed through studies of riser pressurization and filling with a tilting mold. This will be conducted through various trials and simulations, using both simple shape castings and actual production castings.
- After a thorough literature review, researchers will develop models to predict re-oxidation inclusion formation, growth and motion during steel casting. Results from the model will be tested through actual casting trials.

Project Partners

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Steel Founders' Society of America, Barrington, IL
American Centrifugal, Birmingham, AL
Harrison Steel Castings, Attica, IN
Keokuk Steel Castings, Keokuk, IA
Missouri Steel Castings, Joplin, MO
Pennsylvania Foundry Group, Hamburg, PA
Sivyer Steel Corporation, Bettendorf, IA
Stainless Foundry and Engineering
Milwaukee, WI
Magotteaux, Braintree, MA
Richmond Foundry Co., Richmond, TX
The Sawbrook Steel Castings Company
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Southern Alloy Corporation, Sylacauga, AL
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