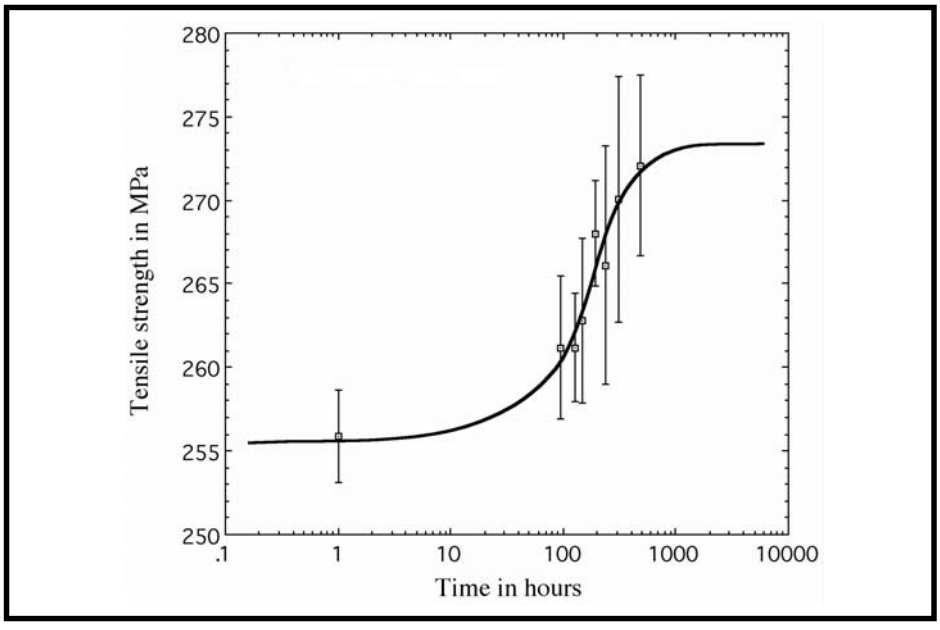
Industrial Technologies Program

Aging of Graphitic Cast Irons and Machinability

Graphite iron is used to produce automotives, mass transit, heavy transportation, municipal, energy production and process plant equipment. Given their widespread applications, improving the machinability of these alloys could significantly increase marketability. Further research improves strength by casting compositions into more easily processed compositions, while reducing scrap production due to shrinkage and machinability rejects. The use of higher carbon equivalent iron to achieve the same properties results in lower gating weight per casting (higher yield.) Ductile iron and compacted graphite iron in particular demonstrate the potential enhance energy savings.

In 1999, researchers at the University of Missouri-Rolla demonstrated that age strengthening occurs in gray cast iron. In 2002, these same researchers found that the machinability of cast iron improves with age strengthening, and have shown evidence of a precipitate formation by neutron scattering. The influence of nitrogen also suggests a nitrogen-containing precipitate. With age strengthening determined in gray cast iron, researchers have begun to look for similar results in ductile iron. Some as-cast grades of ductile iron do show age strengthening and will allow more thorough characterization of the mechanism in terms of strain hardening rate, yield strength and internal friction. Compacted graphite iron, another commercially important family will also be studied to determine whether there is age strengthening to a statistically significant extent.



Avrami Kinetic Curve for Aging Gray Cast Iron

Benefits for Our Industry and Our Nation

- *Yield improvement in iron castings, leading to significant energy savings.*
- *Reduction in iron casting size.*
- *Expanded markets for ductile iron and compacted graphite iron.*

Applications in Our Nation's Industry

This study will determine if age strengthening improves the machinability and the yield rate of ductile iron and compacted graphite iron. The success of this study will significantly increase the marketability of the alloys in the automotives, mass transit, heavy transportation, municipal, energy production, and process plant equipment industries. For example, machinable compacted graphite iron is necessary for diesel automotive market to improve fuel efficiency.

Project Description

The goal of this project is to determinate age strengthening will improve machinability of ductile iron and compacted graphite iron. Studies will be conducted to determine whether age strengthening produces a corresponding change in machinability and whether the machinability improves as it does in gray iron.

The objectives of this research are:

- Identify the mechanism by which gray iron age strengthens,
- Identify the mechanism by which age-strengthening improves the machinability of gray cast iron,
- Determine whether ductile iron and compacted graphite iron exhibit age strengthening to a statistically significant extent,
- Determine whether age strengthening improves the machinability of ductile iron and compacted graphite iron alloys and
- Reliable, economical production of age strengthened iron.

Milestones

1. Determine the effects of likely alloy factors on age strengthening of gray iron
2. Understanding strength increase and increase of machinability in gray cast iron
3. Evaluate the age strengthening of ductile iron .
4. Compacted graphite iron age strengthening evaluation
5. Determine the impact of age strengthening on machinability of ductile iron
6. Comparing ductile iron and compacted graphite iron with gray cast iron age strengthening and machinability
7. Apply sub-microstructure analysis along with internal friction measurements, quantify time temperature parameters for accelerated aging processes and laboratory validation experiments.
8. Develop improved strength prediction models based on nitrogen and aging as well as other alloy factors

Project Partners

University of Missouri-Rolla
Rolla, MO

American Foundry Society
Schaumburg, IL

Cast Metals Coalition Partnership
Charleston, SC

ASAMA Mfg., Coldwater, MI

Bremen Castings, Bremen, IN

Dalton Foundry, Warsaw, IN

Federal Mogul, Southfield, MI

Metals Technologies Inc.
Auburn, IN

Nicola Consulting, Warsaw, IN

Rochester Metal Products
Rochester, IN

St. Louis Precision, St. Louis, MO

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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