METAL CASTING

Project Fact Sheet

CONSISTENT CASTING OF HIGH STRENGTH DUCTILE IRON

BENEFITS

These research findings will greatly assist the foundry industry in producing high-strength iron consistently. When optimum microstructures are achieved, the spread in fatigue properties is reduced. Consequently, design strengths used for ductile iron castings can be raised. Increases in design strength leads to lighter weight designs.

This research will help to improve application of ductile iron castings for components in automobiles and other transportation applications. The resulting weight reduction will generate important fuel savings and reductions in emissions.

APPLICATIONS

The results of this research will enable foundries to meet ever-increasing demand for light weight, high strength castings in automotive components and other cast products. Moreover, understanding the sensitivity of late-stream inoculation practices will reduce heat-to-heat variability and increase designer confidence in metal casting as a robust manufacturing option.

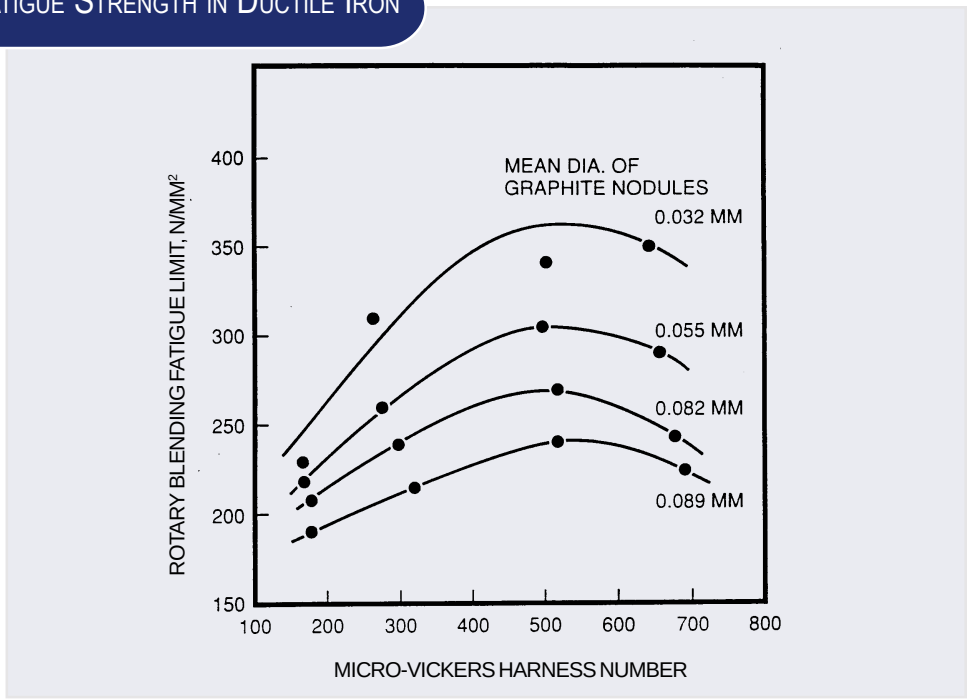
EFFECT OF LATE-STREAM INOCULATION ON MECHANICAL PROPERTIES OF PEARLITIC DUCTILE IRON

The results of this research will assist the foundry engineers to produce consistently high strength ductile iron. This will give design engineers tangible proof that metal casting can produce engineered components with added value.

Late-stream inoculation produces a dramatically higher nodule count thereby increasing strength. However, late-stream inoculation also increases the potential for producing nodule populations with distinctly large and small nodule sizes. Large nodules are believed to reduce fatigue strength. Nodules above a critical size are shown to dramatically reduce fatigue properties.

Research performed by Climax Research Services and sponsored by the American Foundrymen's Society is determining what practices lead to a wide-range nodule size distribution and to what extent does that reduce ductile iron properties. It was shown that a increase in fatigue strength of 10% or greater can be achieved by improvements in controlling nodule size distribution with late-stream inoculation. Follow-on research is providing guidelines for late-stream inoculation practice in order to improve the properties of ductile iron castings.

FATIGUE STRENGTH IN DUCTILE IRON



Correlation of fatigue strength with graphite nodule size in ductile irons of varying matrix hardness.

Project Description

Goal: The goal of this project is to determine the practices, and how sensitive these practices are, for producing a wide-range of nodule sizes and, subsequently, to what extent does it reduce ductile iron properties. Results of this project will lead to further increases in the properties of ductile iron castings and to increased application of ductile iron. Significant energy savings are possible via reduced weight in high strength, thin-walled casting designs. This research is a continuation of work initiated by the American Metalcasting Consortium (AMC) and the Defense Logistics Agency.

Progress and Milestones

- Modified 7/8-inch (22 mm) Y-block castings were poured in pearlitic ductile iron at three commercial foundries.
- Each foundry poured castings from the high end of their carbon equivalent range, i.e. greater than 4.55%CE.
- Five groups of test castings were evaluated. Mechanical testing was conducted on all five groups, and four were selected for fatigue testing. The chemical compositions were determined.
- Microstructure was characterized by percent nodularity, nodule count and ferrite content.
- Several conclusions were made from the results of this study:

    1. *Fatigue life failures initiated at large graphite nodules, nodule clusters, non-metallic inclusions, and micro-shrinkage porosity.*
    2. *High carbon equivalent led to wide ranging nodule size distributions and nodule clustering.*
    3. *Sometimes, late-stream inoculation increased nodule count without reducing nodule size. Castings with nodule counts over 260/mm^2 contained nodules over 120 µm diameter.*
    4. *All heats had comparable tensile properties, yet the fatigue limits varied by as much as 40% with late-stream inoculation practice.*
    5. *There is a need to better understand and optimize the effects of late-stream inoculation and how to maximize the properties of late-stream inoculated ductile iron has been reinforced.*

- Recommendations: Both fine and coarse nodule sizes in ductile irons increase the scatter in fatigue properties. To improve the fatigue properties of ductile iron, it is important to reduce a wide-range nodule size distribution. Increases in the design properties of ductile iron castings are achieved by reducing scatter in these properties.

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