Effect of Inoculant on Wear Volume Loss of Gray Cast Iron: A Review

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Abstract— When inoculants are added to gray cast iron small graphite particles can be formed in the complex diffusion zone around the dissolving particles. The inoculants such as ferrosilicon with RE added to the grey cast iron tensile strength and hardness decreases which helps in improving machinability at good significant hardness whereas wear volume loss increases by addition of an Inoclant. As an inoculant contains the deoxidizing agent which leads to reduce the oxygen content in the gray cast iron results changes in microstructure.

Key words: Inoculant, Wear Volume, Gray Cast Iron

I. INTRODUCTION

The production of quality castings requires the casting surface to be clean and free from defects. In some grey cast iron components which are cast in sand moulds, the metal sometimes penetrates into the mould, producing difficulties in cleaning the components. The defect causes very high costs due to component rejection and increased fettling in the casting industry. Most of the grey iron foundries around the world have problems with metal penetration on applicable components [1]. The inoculation effect of Sr inoculants was better than that of FeSi75 inoculant, showing twice as much chill reduction ability as that of FeSi75 inoculant and leading to more uniform microstructure. The RE inoculant had very strong inoculation effect, and is an excellent desulfurization agent and deoxidant [2]. Foundries are often confused by the extensive range of both inoculants and modularizing agents that are available from the ferroalloy producers. Most inoculants are based on ferrosilicon's containing about 70-75% Silicon, or on ferrosilicon - graphite mixtures. In flake irons the normal levels of inoculant ladle addition raise the silicon content by about 0.2%, whereas in ductile irons larger additions are used, raising Si level by around 0.5%. Inoculants grades containing around 45-50% Si are also used where pick up of Si must be limited[4].

II. LITERATURE REVIEW

REN Fengzhang et.al.(2009) Effect of FeSi75+RE and FeSi75+Sr inoculants on mechanical properties, machinability and sensibility of gray cast iron used in cylinder block were investigated. Izudin Dugic et.al. had observed using low inoculant additions of 0.05 %, using pouring temperature above 1390 °C. No penetrations, bulb formations or shrinkage could be found on the castings. M. Mohd Rashidi et.al.(2013) have studied that increasing inoculation did decreased carbide formation led to improved tensile value and decreased hardness value. Moreover, inoculation led to uniform distribution of graphite resulted in lower corrosion rates.

III. PROCESSES IN WHICH INOCULANTS ARE USED

A. *Machining*

Modern demands on cutting tool performance have increased as progress in material development has lead to the appearance of new materials with enhanced properties but usually of poor machinability. Machinability of such steels is of great economic importance as well[3].

B. *Casting*

The composition of the inoculant, containing different elements, as well as inoculant amount have been shown to play an important role in solidification of cast iron. Three different inoculant amounts and different pouring temperatures were used on a commercial casting[1].

IV. INOCULATION THEORIES

A. *Silicate Slime Theory*

The addition of silicon produces clouds of nuclei of silica or silicates which nucleate solidification to produce Type A graphite.

B. *Gas Theory*

Since silicon and other elements contained in the, inoculation alloys are deoxidizing agents, it is argued that the reduction of the oxygen content produced by the addition effects the change in microstructure. Evidence is found that nitrogen and hydrogen are also involved in graphite distribution.

C. *Undercooling Theory*

Type D and Type E graphite irons, called abnormal irons, are a result of undercooling during solidification, and nucleation resulting from late additions prevents this undercooling and produces desirable Type A graphite[4].

V. EFFECT OF FESI & RE INOCULANT ON GRAY CAST IRON

A. *Effect on Hardness*

It can be observed that for both the SiC and FeSi treated cast irons, the increased melt pouring temperature increases both the fluidity and chill depth and slightly increases the hardness of cast irons, while SiC treated cast irons exhibit higher fluidity as well as lower chill depth and hardness than FeSi treated ones, for the whole range of pouring temperatures explored [5].Effect is as shown in Figure 1.

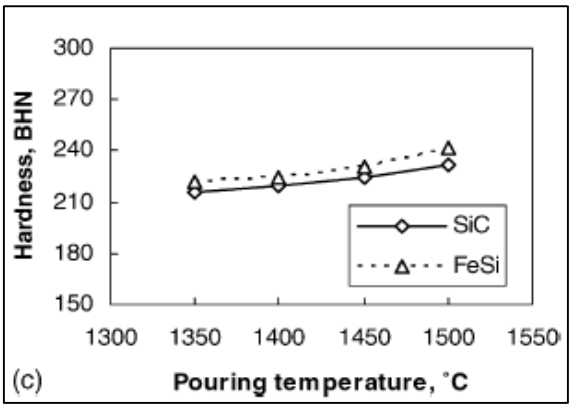

Fig. 1: hardness of gray cast iron melts poured at different temperatures [5]

B. Effect on Wear Loss

Wear loss for Ti and Nb alloyed cast irons has been compared in Fig 2. Austempered alloy shows slightly lower wear loss trend. However, the quenched and tempered alloys shows lower hardness till 400 °C and thereafter go up [6].

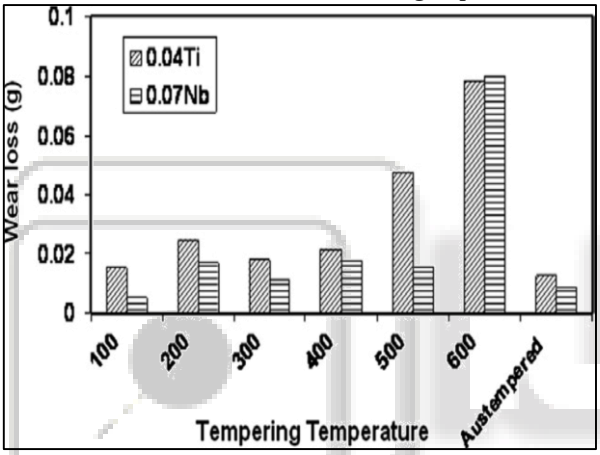

Fig. 2: Effect of strong carbide formers on wear properties of cast iron [6]

C. Effect on Microstructure

Microstructures of the hypereutectic HCCI with different amounts of titanium are presented in Fig.3. The initial state of the as-cast material without titanium addition is shown in Fig. 3

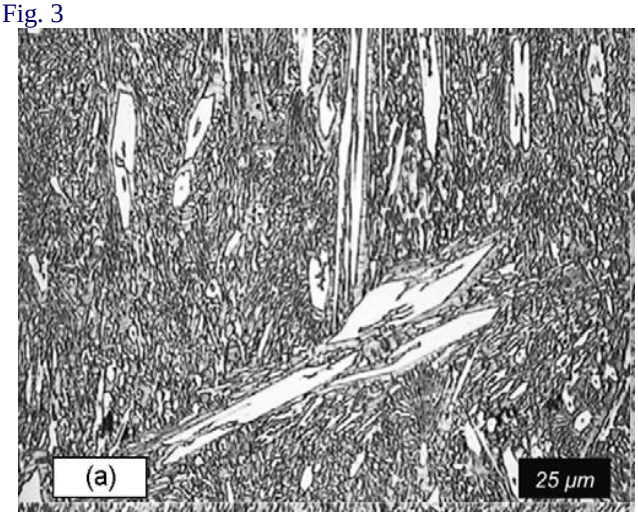

Fig. 3: Optical micrographs of ingots with different amounts of titanium addition[7]

This is a typical hypereutectic microstructure of HCCI, which consists of primaryM7C3 carbides, eutecticM7C3 carbides and eutectic austenite. Solidification of hypereutectic HCCIs begins with the nucleation of primary M7C3 carbides that start to form at approximately 1300 ◦C[7]

VI. Conclusion

In present study, various inoculants are employed to the gray cast iron. Due to addition of inoculants certain properties may change such as hardness, wear lvolume loss, microstructure, machinability. As the carbon equivalent value of a gray cast iron increases it leads to decrease the mechanical properties like tensile strength and hardness as expected. The wear volume loss has increased with respect to increasing load, speed and time with increasing addition of the inoculants.

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