CORROSION BEHAVIOUR OF DUCTILE CAST IRON

MOHAMED ASSNOUSI ALI

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Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

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To my late mother, my late father, my brothers and sisters
for their support and care

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ABSTRACT

In this investigation the corrosion behavior of ductile cast iron as function of the microstructure and electrolyte solution has been conducted. The change in microstructure of the ductile cast iron is obtained by austenetising at different temperatures of 850°C, 900°C,950°C and 1000°C for 90 minutes followed by water quench. Corrosion tests included both immersion tests and electrochemical test. Corrosion rates measured from the immersion test using the weight loss method revealed that the cast iron investigated suffer less corrosion when exposed to sodium hydroxide compared to sodium chloride and that the corrosion rates are not significantly affected by the microstructure of the material. Observation of the corrosion attack also showed that the type of corrosion is that of uniform instead of localized. The low corrosion rates of the ductile iron are probably the results of the high Si content in the ductile iron, which provide a thin and protective hydrate layer. This observation is reconciled with previous research which investigated high Si containing ductile cast irons.

ABSTRAK

Dalam kajian ini, ciri- ciri kakisan besi tuang mudah tempa sebagai fungsi terhadap mikrostruktur dan larutan elektrolit telah dijalankan. Perubahan mikrostruktur besi tuang mudah tempa didapati dengan proses austenising pada suhu yang berbeza iaitu 850°C, 950°C dan 1000°C untuk 90 minit, diikuti dengan lindap kejut di dalam air. Ujian kakisan termasuklah ujian rendaman dan elektrokimia. Kadar kakisan diukur melalui ujian rendaman menggunakan teknik kehilangan jisim. Ini telah menunjukkan, besi tuang mudah tempa mengalami kakisan yang sedikit apabila didedahkan kepada Sodium Hidrokside berbanding Sodium Kloride dan kadar kakisan tidak dipengaruhi secara jelas oleh mikrostruktur bahan. Pemerhatian terhadap serangan kakisan juga telah menunjukkan bahawa jenis kakisan adalah secara menyeluruh dan bukan secara tertumpu. Kadar kakisan besi tuang mudah tempa yang rendah, mungkin disebabkan oleh kandungan Silikon yang tinggi di dalam bahan, yang mana ia menghasilkan lapisan pelindung hydrate yang nipis. Secara keseluruhannya, kajian ini disokong oleh kajian sebelum ini berkenaan kandungan Silikon yang tinggi dalam besi tuang mudah tempa.

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CHAPTER 1

Introduction

1.1 General Review of the Research

Ductile iron also known as nodular cast iron or spheroid-graphite (SG) cast iron contains nodules of graphite, embedded in a matrix of ferrite or pearlite or both, the graphite separates out as nodules from iron `during solidification because of the additives like `cerium (Ce) and magnesium (Mg) introduced into the molten iron before casting. These nodules act as crack arresters, thereby improving the mechanical properties of ductile iron.

The formation of graphite nodules during solidification causes an internal expansion of ductile iron as it solidifies, and is responsible for the absence of shrinkage defects in most ductile iron castings. The major difference in the structure of ductile and grey iron is the flaky and spheroid graphite in the grey and ductile iron respectively. However, the spheroid graphite in ductile iron does not weaken the matrix and hence its mechanical properties are superior to those of grey iron and comparable to that of steel [1].

The corrosion resistance of ductile cast iron is attributed to the formation of a thin passive barrier film of hydrated oxides of silicon on the metal surface. The film develops with time due to the dissolution of iron from the metal matrix leaving behind silicon which hydrates due to the presence of moisture. The passive hydrated silicon film is thought to bridge over and form an impervious barrier layer on a fine grained high silicon cast iron with spheroidal graphite areas much more readily than on a high silicon cast iron with coarse graphite flakes.

While a lot is known on the effect of alloyed elements on the mechanical properties of ductile cast iron, not much is known of the effect of microstructure, and the corrosion behavior of these materials, in natural and acidic environments. Hence the need to investigate the effect of heat treatment on the microstructure and corrosion resistance of as-cast ductile iron, in Sodium Chloride and Sodium Hydroxide solutions.[1,2]

1.2 Problem Statement of the Research

While much is known about the effect of alloying elements on the mechanical properties of cast irons, little is probably known about their corrosion resistance. The corrosion resistance of (DCI) is related to its microstructure which is determined by heat treatment parameters (austenitising temperature and austenitising time)

Thus, the aim of this research is to assess the relationship between the heat treatment, corrosion behavior and microstructure of ductile cast iron. .

1.3 Objective of the Research

To investigate the influence of heat treatment process on the microstructure and corrosion behavior of Ductile Cast Iron in neutral and acidic environments.

1.4 Scope of project of the Research

The scope of this project is as follows:

(a) Heat treatment of ductile cast iron which includes:

(i) Austenitization

(ii) Quenching

(b) Corrosion test measurement by:

(i) Immersion test (ASTM G67)

(ii) Electrochemical test (ASTM G5)

(c) Corrosion performance and analysis of samples