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التوثيق الالكتروني والميكروفيلم

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قسم

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Ageing Behavior of Ductile Iron with Dual Matrix Structure

A Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Mechanical Engineering
(Design and Production Engineering)

By

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Bachelor of Science in Mechanical Engineering

(Design and Production Engineering)

Faculty of Engineering, Ain Shams University, 2021

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Ain Shams University-Faculty of Engineering

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Statement

This thesis is submitted as a partial fulfilment of Master of Science in Mechanical Engineering (Design and Production Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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List of Publications

Certificate

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Abstract

Although, extensive ageing and strain ageing (bake hardening, BH) studies have been carried out on dual phase steels, the ageing behavior of the dual matrix structure (DMS) ductile iron (DI), as a potential way to improve its mechanical properties, has not been addressed until now. This thesis was designed to study the ageing behavior of the DMS-DI with ferrite – martensite matrix structure.

For produced the ferrite – martensite matrix, the intercritical region of the as-cast ductile iron with a chemical composition of 3.39 % C, 2.63 % Si, 0.33 % Mn, 0.03 % Mg, 0.01 % S, and 0.05 % P was calculated with the empirical equations and ThermoCalc software. To confirm the resulting calculations, the intercritical region verified practically using dilatometry and partial austenitizing heat treatment cycles. After defining the intercritical region, the DMS-DI with martensite volume fraction MVF of 30 % was produced by intercritical austenitizing at 780 °C followed by quenching in water to room temperature.

Ageing treatments were carried out without pre-straining at ageing temperatures of 140, 170, and 220 °C for 2 – 10000 minutes. DMS-DI was investigated by light optical microscopy (LOM) and scanning electron microscopy (SEM) for unaged and selected samples after ageing treatments. The effect of ageing conditions (ageing temperatures and times) on the mechanical properties were investigated. Microhardness measurements for ferrite and martensite were also examined as a function of ageing conditions. The increase in yield strength YS due to ageing effect was determined.

The results indicate that the ageing conditions have a small effect on the ultimate tensile strength UTS, but the total elongation TEL after fracture displays a very high fluctuation. It is shown that the yield strength increased to a maximum value of 52 MPa (~ 13 % increase) after ageing for particular time, which is found to be dependent on the ageing temperature. The peak ageing response is followed by a decrease in yield strength, that is observed to be attributed to martensite tempering as confirmed by microhardness measurements. The results also showed that the ageing process has no significant effect on the microhardness of the ferrite phase in DMS-DI with ferrite – martensite matrix.

Keywords: Dual Matrix Structure Ductile Iron; Ageing; Precipitation, Microhardness.

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