UNIVERSITI TEKNOLOGI MARA

INVESTIGATION ON PHASES TRANSFORMATION AND MECHANICAL PROPERTIES OF DUCTILE IRON BY NEW HEAT TREATMENT PROCESS

MOHD FAIZUL IDHAM BIN MOHD ZULKIPLI

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science

Faculty of Mechanical Engineering

September 2013

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non- academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Mohd Faizul Idham Bin Mohd Zulkipli
Student I. D No	:	2009594351
Programme	:	Master of Science in Mechanical Engineering
Faculty	:	Faculty of Mechanical Engineering
Thesis Title	:	Investigation on Phases Transformation and Mechanical Properties of Ductile Iron by New Heat Treatment Process
Signature of Student	:	.....
Date	:	September 2013

ABSTRACT

This study was conducted to investigate quantitatively and qualitatively the matrix compositions and transformations, and to evaluate the correlation between microstructure constituent and material hardness on each sequential stage of new heat treatment process at different temperatures. In addition, the influence of new heat treatment temperature on impact and tensile properties is analyzed. Ductile iron produced by CO_2 sand casting method was heat treated by new heat treatment cycle that comprised combination of modified annealing, austenitizing and tempering processes. The new heat treatment process performed was divided into three stages: first stage consists of modified annealing (as-annealed condition); second stage consists of modified annealing and austenitizing processes (as-austenitized condition); and third stage consists of modified annealing, austenitizing and tempering processes (as-tempered condition). A series of microstructure analysis tests, including optical microscopy, X-ray diffractometry, and scanning electron microscopy equipped with energy dispersive X-ray, was applied. Mechanical tests including tensile (ASTM E8M), impact toughness (ASTM-E23-1990) and Vickers hardness test were performed. The results suggest that heat treatment temperature influences the matrix and volume fraction of each phase of ductile iron. Annealing included in new heat treatment process does influence the hardness of ductile iron. Moreover, microstructure constituents have good correlation with mechanical properties. It is proven that, hardness could be estimated using mixture law of hardness for each microstructure constituent. Tensile strength and hardness of ductile iron decrease with decreasing volume fraction of martensite. Increasing ferrite volume fraction results an increasing impact toughness and elongation. The ductile iron treated using this practice is corresponds and equipotential with ADI 'grade 1' (ASTM standard A897-90).

ACKNOWLEDGEMENTS

With The Name of Allah The Merciful and The Benevolent.

Alhamdulillah, here I would like to show my utmost gratitude to Allah s.w.t because I was able to complete this thesis with the required criteria. I would like to special thanks first and foremost my advisor Dr. Bulan Abdullah on her guidance and tolerance all through these years. You have oriented and supported me with promptness and care, and have always been patient and encouraging in times of new ideas.

Besides my advisor, my sincere thanks also go to my co-advisor, Associate Professor Dr. Syarif Junaidi, a senior lecturer of Faculty of Engineering & Built Environment, Universiti Kebangsaan Malaysia (UKM), who always shares his knowledge, insightful comments, and hard questions. To work with you has been a real pleasure to me, with heaps of fun and excitement.

Instead, I also would like to acknowledge the Universiti Teknologi MARA, Malaysia and Ministry of Higher Education for the financial support given to this work and also for the Young Lecturer Scheme scholarship given to me.

I would also like to express my sincere gratitude to lecturers, technicians, colleagues and fellow students for the valuables support and cooperation in running the tests and sharing the knowledge.

For the last words, I would like to thank my beloved parents and family because of their infinite moral support throughout the period of completing this thesis. All steps I done am very beneficial for me.

TABLE OF CONTENTS