شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

INFLUENCE OF THERMAL TREATMENTS ON STRUCTURE AND PROPERTIES OF FERRITE - MARTENSITE STEEL

By

Omar Abolfotoh Abdelnaby Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Metallurgical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2019

INFLUENCE OF THERMAL TREATMENTS ON STRUCTURE AND PROPERTIES OF FERRITE - MARTENSITE STEEL

By

Omar Abolfotoh Abdelnaby Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Metallurgical Engineering

Under the Supervision of

Prof. Dr. Mohamed Raafat El-koussy

Professor of Metallurgy
Mining, Petroleum and Metallurgical Department
Faculty of Engineering, Cairo University

Prof. Dr. Nahed Ahmed Abdel-Raheem

Professor of Metallurgy
Mining, Petroleum and Metallurgical Department
Faculty of Engineering, Cairo University

Prof. Dr. Mohamed Ezzat Abd El-Azim

Professor of Metallurgy
Nuclear Metallurgy Department
Egyptian Atomic Energy Authority

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2019

INFLUENCE OF THERMAL TREATMENTS ON STRUCTURE AND PROPERTIES OF FERRITE - MARTENSITE STEEL

By

Omar Abolfotoh Abdelnaby Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Metallurgical Engineering

Approved by the
Examining Committee

_____
Prof. Dr. Mohamed Raafat El koussy, **Thesis Main Advisor**

_____
Prof. Dr. Nahed Ahmed Abdel-Raheem, **Advisor**

_____
Prof. Dr. Mohamed Ezzat Abd El-Azim, **Advisor**
Egyptian Atomic Energy Authority

_____
Prof. Dr. Waleed Khalifa, **Internal Examiner**

_____
Prof. Dr. Ali Mohamed Nasr El-dein, **External Examiner**
Egyptian Atomic Energy Authority

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2019

Engineer's Name: Omar Abolfotoh Abdelnaby Mohamed
Date of Birth: 15/11/1988
Nationality: Egyptian
E-mail: Omer_151188@yahoo.com
Phone: 01019029011
Address: Al Sharkiya – Minia El Qamh

Registration Date: 1 / 10 / 2015
Awarding Date: / / 2019
Degree: Master of Science
Department: Mining, Petroleum and Metallurgy Department

Supervisors:
Prof. Dr. Mohamed Raafat El koussy
Prof. Dr. Nahed Ahmed Abdel-Raheem
Prof. Dr. Mohamed Ezzat Abd El-Azim

Examiners:
Porf. Dr. Mohamed Raafat El koussy (Thesis main advisor)
Prof. Dr. Nahed Ahmed Abdel-Raheem (Advisor)
Prof. Dr. Mohamed Ezzat Abd El-Azim (Advisor)
Egyptian Atomic Energy Authority (EAEA)
Prof. Dr. Waleed Khalifa (Internal examiner)
Prof. Dr. Ali Mohamed Nasr El-dein (External examiner)
Egyptian Atomic Energy Authority (EAEA)

Title of Thesis:

INFLUENCE OF THERMAL TREATMENTS ON STRUCTURE AND PROPERTIES OF FERRITE - MARTENSITE STEEL

Key Words:
Dual phase steel; Intercritical treatment; quenching; Tempering; Dynamic strain aging

Summary:

The main purpose of this thesis is to study the effect of different heat treatments on structure and properties of ferrite-martensite (0.15 % C) dual phase (DP) steel. Two different kinds of DP steel were produced from the as received low carbon hot rolled steel with ferrite/pearlite microstructure using two different techniques, i.e., direct quenching (DQ) and intermediate quenching (IQ). DQ and IQ heat treatments included normalizing and hardening respectively of the as received steel at 950 ^{o}C then intercritical heat treatment between 740 and 800 ^{o}C then quenching in ice cooled water. The martensite volume fraction of the DQ dual phase steel increased from 16.3 % to 42.6 % when the intercritical heat treatment temperature increased from 740 ^{o}C to 800 ^{o}C. Hardness of DP steel was studied. It was found that hardness of either DQ or IQ dual phase steel (242 and 270 VH10 respectively) is higher than that of the as received steel (145 VH10). Tensile properties of DP steel were studied. Stress–strain curves of DQ and IQ dual phase steel showed a continuous yielding behavior unlike the normalized steel that showed a yield point. Besides continuous yielding, DQ and IQ dual phase steel have higher yield and ultimate tensile strength, initial rate of work hardening, but lower elongation and yield to ultimate tensile strength ratio than the normalized steel. Effect of testing temperature from 25 - 500 ^{o}C on the tensile properties of IQ -760 ^{o}C dual phase steel was studied. Stress – strain curves showed a continuous yielding behavior at all temperatures except at 300 - 400 ^{o}C due to dynamic strain aging happened. Effect of tempering from 100 to 500 ^{o}C on structure and properties of IQ-760 ^{o}C DP steel was studied. The effect of banded structure on room temperature impact toughness of DP steel was studied. It was found that the impact toughness of DQ and IQ dual phase steel both intercritically heat treated at 760 ^{o}C has greatly increased after the removal of banding to be 95 and 114 J respectively after being 10 and 25 J in the presence of banded structure.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Date: / /

Signature:

Dedication

Most importantly, none of this could have happened without my family. My father, my mother and my wife, who offered me encouragement through everything limited devotion to correspondence. They did not let me and I am forever grateful. This dissertation stands as a testament to your unconditional love and encouragement.

Acknowledgments

First and foremost, I have to thank my research supervisors, Prof. Dr. Mohamed Ezzat Abd El-Azim, Prof. Dr. Mohamed Raafat El koussy, Prof. Dr. Nahed Ahmed Abdel-Raheem and Dr. Ezzat El-Shazly. Without their assistance and dedicated involvement in every step throughout the process, this thesis would have never been completed. I would like to thank them for their support and understanding over the past years.

My gratitude to my main supervisor, Prof. Dr. Mohamed Ezzat Abd El-Azim at Nuclear Metallurgy Department - Egyptian Atomic Energy Authority for the continuous support, patience, motivation, and immense knowledge. His suggestions and discussions were very fruitful and he was very patient with my knowledge gaps. His guidance helped me in performing the experimental work and writing of this thesis. Working with Prof. Dr. Mohamed Ezzat Abd El-Azim was an extraordinary experience.

I would also like to show gratitude to Prof. Dr. Mohamed Raafat El koussy, Prof. Dr. Nahed Ahmed Abdel-Raheem in metallurgy department at faculty of engineering, Cairo University whose teaching style and wide knowledge for different topics during my master courses made a strong impression on me and I have always carried positive memories of their classes with me.

I am very grateful to Prof. Dr. Omayma Hasan Ibrahim at Nuclear Metallurgy Department - Egyptian Atomic Energy Authority for her support and help in my present work by accomplishing the impact toughness tests to my specimens. Special thanks for Prof. Dr. Ali Mohamed Nasr El-dein at Nuclear Metallurgy Department - Egyptian Atomic Energy Authority for his support and help in my present work by accomplishing the V-notch of my impact specimens.

I would also like to thank Dr. Moubarak Abdelraheem Sayed at the Central Laboratory – Nuclear Research Center for his help in my present work by accomplishing the scanning electron microscopy of my specimens. I must also thank Eng. Hayam Abo Khasha for giving me the retreat to have this thesis rushed to the printer. I do not forget Mr. Eslam Ouda and Madam Samar Said Amin, technicians at Nuclear Metallurgy Department - Egyptian Atomic Energy Authority for their efforts in preparing and testing my specimens.

TABLE OF CONTENTS

List of Tables