THE EFFECT OF ELECTROCHEMICAL CORROSION ON METALS RELATED TO PETROLEUM INDUSTRY AND ITS ENVIRONMENTAL IMPACT

by

Ali Gomaa Ali Abd El-Aziz

B.Sc. in Electric Power Engineering, Ain Shams University, 1980
M.Sc. in Environmental Science (Engineering Department),
Ain Shams University, 2005

A thesis submitted as Partial fulfillment
of
The Requirements for the Doctor of Philosophy Degree
in
Environmental science

Department of Environmental Engineering
Institute of Environmental Studies and Researches
Ain Shams University

2011

APPROVAL SHEET

THE EFFECT OF ELECTROCHEMICAL CORROSION ON METALS RELATED TO PETROLEUM INDUSTRY AND ITS ENVIRONMENTAL IMPACT

by

Ali Gomaa Ali Abd El-Aziz

B.Sc. in Electric Power Engineering, Ain Shams University, 1980

M.SC. in Environmental science (Engineering Department)
Ain Shams University, 2005

This Thesis Towards a Doctor of Philosophy Degree in Environmental Science has been Approved by:

Name	Signature
1- Prof. Dr. Mohamed Yousef Al-Kady Prof. of Chemistry – Ain Shams University	.....
2- Prof. Dr. Saad El-Deen Mohamed Desouky Prof. of Petroleum Engineering, Egyptian Petroleum Research Institute	.....
3- Prof. Dr. Ibrahim El Desouki Helal Prof. of Electric Power Engineering – Ain Shams University	.....
4- Prof. Dr. Ali Ahmed El-Bassoussi Prof. of Chemistry, Egyptian Petroleum Research Institute	.....

2011

THE EFFECT OF ELECTROCHEMICAL CORROSION ON METALS RELATED TO PETROLEUM INDUSTRY AND ITS ENVIRONMENTAL IMPACT

by

Ali Gomaa Ali Abd El-Aziz

B.Sc. in Electric Power Engineering, Ain Shams University, 1980

M.SC. in Environmental Science (Engineering Department), Ain Shams University, 2005

A thesis submitted as Partial fulfillment

of

The Requirements for the Doctor of Philosophy Degree

in

Environmental science

Department of Environmental Engineering Science

Under the supervision of:

1- **Prof. Dr. Ibrahim El Desouki Helal** .....
Professor of Electrical Power Engineering, Faculty of Engineering, Ain Shams University

2- **Prof. Dr. Ali Ahmed El-Bassoussi** .....
Professor of Chemistry, Egyptian Petroleum Research Institute

3- **Mohamed Saaid Abd-Elhaliem** .....
Professor of Chemistry, Faculty of Engineering, Ain Shams University

4- **Prof. Dr. Ismial Abd-Alrahaman Aiad** .....
Professor of Chemistry, Egyptian Petroleum Research Institute

2011

DEDICATION

To my son….Shady

One day….Hopping that this modest thesis will encourage you to precede a magnificent and superior work.

ACKNOWLEDGMENT

The author wishes to express his sincere thanks and gratitude to **Prof. Dr. Ibrahim El Desouki Helal**, Professor of Electric Power Eng., Faculty of Eng., Ain Shams University for brilliant ideas that help put this work together, for his supervision and constant support throughout the course of this thesis. The author is greatly indebted to **Prof. Dr Ali A. El Bassoussi**, Professor of Petroleum Chemistry, Egyptian Petroleum Research Institute (EPRI) for suggesting the topic of the present research, continuous support as well as for valuable guidance**.** The author would like to thank Prof. Dr. **Mohamed S. Abd-Elhaliem**, Professor of Engineering Chemistry, Faculty of Eng., Ain Shams University, and Prof. Dr. **Ismial A. Aiad**, professor of Petroleum Chemistry, EPRI, for their help and advice throughout this work.

The author expresses his sincere thanks for **Prof. Dr Ahmed El-Sabagh**, Director Manager of the Egyptian Petroleum Research Institute, EPRI for providing the experimental facilities and his support and encouragement.

Special thanks go to **Prof. Dr. Magda Ebeid** for her sincere kindness and encouragement. Thanks are extended to all **Teaching Staff** at the Environmental Eng. Dept., Institute of Environmental Studies and Researches, Ain Shams University for their valuable lecturers.

Great and sincere thanks go to **Prof. Dr. Ahmad Abdel Aziz** Professor of Aut. Eng., Ain Shams University for his precious advice, continuous support and his valuable guidance. Many thanks for all my colleagues at EPRI for their help and support during this work especially, **Dr. Eng. Eman M. Noami** for her valuable help, support and tremendous effort.

Abstract

In our present study we are concerned with the electrochemical behavior of the steel alloy in the formation waters which delivered from different areas in the western and eastern desert in Egypt.

Two different types of steel samples, which utilized in the pipeline manufacture, were used in our experimental studies. On the other hand, six formation water samples were under test, three from the eastern desert and the other three from the western desert.

Our study was divided into three parts. In the first part the Open Circuit Potentials (OPC) were measured against standard calomel electrode (SCE).The variation in the OCP from cathodic to anodic and vice versa, explains the active behavior of the corrosion at the interfacing layer between the metal and solution.

In the second part, we studied the variations of the weight loss for the two coupons corresponding to the time of immersion. The obtained data showed three stages, the first was characterized by the increase in weight loss by time, the second clarified sharp decrease in weight loss by time, and the third stage revealed sudden increase in weight loss.

In the third part of the study, the measurements of the potentiodynamics were completely carried out and the obtained data clarified that the coupons immersing for long time leads to rapidly corrosion and formatted $Fe(OH)_2$ which responsible for the corrosion rates. Therefore, one important reason for the increasing of corrosion rate value attributed to the initial formation of pits on the surface of the steel.

CONTENTS

LIST OF TABLES

LIST OF FIGURES