

**UNIVERSITI TEKNOLOGI MARA**

**SYNTHESIS, CHARACTERIZATION AND  
CORROSION INHIBITION OF  
BENZOYLTHIOUREA DERIVATIVES WITH ITS  
COPPER(II) COMPLEXES ON MILD STEEL IN 1  
M HCl**

**NURUL ATIKAH BINTI NORDIN**

**MSc**

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## ABSTRACT

The benzoylthiourea derivatives with its copper(II) complexes have been successfully synthesized using microwave assisted synthesis respectively. All of the compounds were characterized using elemental analyses, magnetic susceptibility, molar conductivity, nuclear magnetic resonance (NMR), infrared (IR) and electronic spectroscopies. The influence of compounds towards the corrosion inhibition on mild steel in 1M hydrochloric (HCl) acid was investigated using potentiodynamic polarization and electrochemical impedance spectroscopy (EIS). While, the surface morphology of inhibition effects were determined by scanning electron microscope (SEM) and atomic force microscope (AFM) methods to prove the presence of protective thin layer of inhibitors onto mild steel to reduce corrosion attacks. The results of electrochemical measurements show the inhibition efficiency is directly proportional to the concentration of the inhibitors. The polarization measurements showed the entire compounds act as mixed type inhibitors. Throughout the polarization measurements, L1 and L1Cu had the highest percentage of inhibition efficiency among the ligands and complexes which was 82.21% and 82.20%. The trend of inhibition efficiency of ligands was  $L1 > L4 > L3 > L5 > L2$  while the maximum inhibition efficiency of thiourea complexes are found as  $L1Cu > L4Cu > L3Cu > L5Cu > L2Cu$ . In EIS spectroscopy measurements, L4 and L1Cu had the highest inhibition efficiency which was 74.86% and 82.19% respectively. The inhibition efficiency of L1 (82%) is higher than L2 (71%) due to the presence of electron donating and electron withdrawing group as substituents in molecules. The effects of withdrawal electrons from the ring performed the benzene less electron rich and less likely to react with an electrophile compared to electron donating. The adsorption of inhibitors onto the surface of mild steel obeys Temkin and Frumkin adsorption isotherm.

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# TABLE OF CONTENTS

|  | <b>Page</b> |
|--|-------------|
| <b>CONFIRMATION BY PANEL OF EXAMINERS</b>                | <b>ii</b>   |
| <b>AUTHOR'S DECLARATION</b>                              | <b>iii</b>  |
| <b>ABSTRACT</b>  | <b>iv</b>   |
| <b>ACKNOWLEDGEMENT</b>                                   | <b>v</b>    |
| <b>TABLE OF CONTENTS</b>                                 | <b>vi</b>   |
| <b>LIST OF TABLES</b>                                    | <b>ix</b>   |
| <b>LIST OF FIGURES</b>                                   | <b>xi</b>   |
| <b>LIST OF SCHEMES</b>                                   | <b>xiv</b>  |
| <b>LIST OF ABBREVIATIONS</b>                             | <b>xv</b>   |
| <br>   |             |
| <b>CHAPTER ONE: INTRODUCTION</b>                         | <b>1</b>    |
| 1.1 Research Background                                  | 1           |
| 1.2 Corrosion Studies                                    | 1           |
| 1.2.1 Thiourea Derivatives and Their Complexes           | 3           |
| 1.3 Problem Statements                                   | 5           |
| 1.4 Significance of Study                                | 6           |
| 1.5 General Reaction Mechanism                           | 7           |
| 1.5.1 Nucleophilic Displacement of Thiocyanate           | 7           |
| 1.6 Objectives   | 8           |
| 1.7 Scope and Limitation of Study                        | 9           |
| <br>   |             |
| <b>CHAPTER TWO: LITERATURE REVIEW</b>                    | <b>13</b>   |
| 2.1 Corrosion Inhibitors                                 | 13          |
| 2.1.1 Organic Compounds as Corrosion Inhibitors          | 14          |
| 2.1.2 Thiourea Derivatives as Corrosion Inhibitors       | 15          |
| 2.1.3 Thiourea Derivatives with Transition Metals        | 20          |
| 2.1.4 Mechanism of Corrosion Inhibition in Acidic Medium | 23          |

# CHAPTER ONE

## INTRODUCTION

### 1.1 Research Background

The environmental pollution due to corrosion problems became more complicated nowadays. The worst pollution's problem was occurred involving industrial water supply and circulation system is corrosion. In fact, corrosion is an occurrence that occurs naturally in our environment. It commonly happens on the surface of metal under various conditions involving moderate acid concentrations and temperatures. Based on the previous researches, it stated some of inhibitors can be added to the acid media to reduce the rate of corrosion (S. D. Shetty & Shetty, 2008).

Several researchers reported the inhibition effect depends mainly on some physico-chemical and electronic properties of the organic inhibitors which is related to its functional groups, steric effects, electronic density of donor atoms, and orbital character of donating electrons, etc. (Yadav et al., 2014). Meanwhile, Karthik, Tamilvendan, & Venkatesa Prabhu, (2014) have specified the inhibitors containing nitrogen (N), oxygen (O) and sulphur (S) can reduce the rate of metal dissolution. Thiourea derivatives have two atoms of nitrogen, an atom of sulphur and oxygen structurally which is being a good inhibitor for resolving towards corrosion problems.

### 1.2 Corrosion Studies

Corrosion is the irreversible damage or destruction of living tissues or materials due to chemical or electrochemical reactions. It is also known as the electrochemical process which is metallic structures slowly damaged due to anode dissolutions. As known, active metals like mild steel, Zn, Cu and Al are employed in several industries for fabrication resolutions due to their low cost and easy availability whereas surface are promptly damaged in acidic media (Sundaram & Sundaravadivelu, 2016). A steel alloy with high carbon content is mild steel which is in fact much harder for structural processes. The industrial fields commonly used mild steel and carbon steel has caused numerous potential