UNIVERSITI TEKNOLOGI MARA

MICROBIOLOGICALLY INFLUENCED CORROSION OF MILD STEEL AND STAINLESS STEEL BY PSEUDOMONAS AERUGINOSA IN ENRICHED ARTIFICIAL SEA WATER

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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 acknowledge 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.

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ABSTRACT

Corrosion damage in the form of pitting corrosion was observed on both mild steel ASTM 283-D and stainless steel 304 after being exposed to *Pseudomonas aeruginosa*-inoculated enriched artificial seawater (EASW) after 7 days and 14 days exposure period. To determine the difference in corrosion severity between these two steels, characterization of the samples were carried out with the following instruments; AUTOLAB Potentiostat, Field Emission Scanning Electron Microscope (FESEM), Energy Dispersive Spectrum (EDS), Infinite Focus Microscope (IFM) and Surface Roughness Profiler. Corrosion phenomenon was confirmed by the increase of corrosion rate and surface roughness values. Imaging of the pitting corrosion with FESEM and IFM together with elemental composition of the pitting with EDS confirmed the form of corrosion that took place on both steels in the presence of the bacterium. The link between biofilm and pitting corrosion was established with biofilm imaging by IFM. Determination of pitting shape by using its volume and projected area were considered to be more accurate than with pitting depth and width. In the case of control samples in sterile EASW, uniform corrosion was noticeable on mild steel but was not observed on stainless steel, which reinforced the fact that its passive chromium oxide film played a crucial role in corrosion prevention. The study revealed that pitting corrosion on mild steel was found to be more severe than those on stainless steel since its propagation in the vertical direction can cause earlier perforation of the base steel.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

An unintentional electrochemical reaction which constitutes oxidation of substrate such as metal and reduction of oxidant such as oxygen that degenerate metal to a more stable oxide state is called corrosion. It has been estimated that 5% of an industrialized nation's income has to be channelled to counteract the problems associated with corrosion, such as corrosion prevention, maintenance or replacement of products lost or contaminated (Callister, 2007). It is convenient to classify corrosion according to the manner it manifests, where the main forms of corrosion are; uniform, crevice, pitting, erosion, galvanic, selective leaching, stress corrosion and intergranular corrosion.

Microbiologically influenced corrosion (MIC), or biocorrosion, is defined as accelerated deterioration of metals owing to the presence of biofilms on their surfaces (Beech & Sunner, 2004). A renowned figure in biofilm research, Dr. Bill Costerton of Montana State University, has defined biofilm as a highly organized yet diverse growth of microorganisms on virtually any substratum. The heterogeneous biofilm formed on the metal surface provides a non-uniform coverage which leads to pitting corrosion as the main form of corrosion in MIC. Of all the eight forms of corrosion, pitting is known for its insidious nature of highly localized attack. Metallic parts can fail prematurely in service merely due to the small yet highly perforated pitting formed across the surface of the metallic part. It is highly difficult to consider pitting as a consideration in engineering design partly because of its unexpected initiation and unpredictable propagation rate. In the chemical processing industries, localized corrosion is a major cause of repeated service failures and is estimated to account for at least 90% of metal damage by corrosion (Asphahani & International, 1987).

It has been proposed that the formation of biofilm can also benefit the metal in terms of corrosion protection through the idea that biofilm can form a protective layer that impedes contact between the metal surface and corrosive constituents in the medium (Zuo, 2007), (Jayaraman et al., 1997). However, to achieve such protection