CHAPTER I
INTRODUCTION

Some microorganisms in the environment system may be harmful to environment. For example, the hydrogen sulfide which is a product of sulfate-reducing bacteria (SRB) will react with metal ions in the water to produce metal sulfides. These metal sulfides are insoluble leading to the dark color of sludge. Additionally, H_2S can be converted to sulfuric acid that jeopardize concrete and steel within wastewater environments which can be devastating. Moreover, SRB can provide a corrosion problem when metal structures are exposed to water which contains sulfate.

Sulfate reducing bacteria (SRB) and acid-producing bacteria (APB) in particular have been known to contribute to the microbiologically influenced corrosion (MIC) of engineered alloys including steels (Soword *et al.*, 2014). SRB species have been the focus of many corrosion studies because they are known to cause corrosion in pipeline systems associated with fossil fuels and be particularly problematic due to the production of corrosive hydrogen sulfide (Setareh *et al.*, 2006). Production of sulfide in various industrial situations and various natural environments can have ecological and economic impacts due to corrosive and toxic properties. For more than 75 years, the microbiological origin of sulfide in oil fields has been recognized. The dissimilatory reduction of sulfate by the anaerobic respiratory process of a diverse group of microorganisms including the sulfate-reducing bacteria (SRB) produces most of the sulfides. Oil- bearing formations that are subject to seawater injection during secondary oil recovery are often the sites of significant hydrogen sulfide production. Oil production, transportation pipelines, storage tanks and quality of the gas and oil produced are all affected by the corrosive properties of sulfides (Almeida *et al.*, 2006). The presence of molecular hydrogen and SRB-produced hydrogen sulfides enhance anodic dissolution, and have a brittleness effect on steels. In contrast, APBs induce corrosion by metabolism of an organic substance, such as a carbon source and hydrogen as an electron donor resulting in secretion of corrosive organic acids (Little *et al.*, 1991). Therefore, early detection of the presence of these microorganisms is necessary to protect the manufacturing systems from bacteria-induced corrosion. In this study, an electrochemical biosensor is investigated to detect the bacteria rapidly without the pre-treatment of test samples even at a very low concentration.

Electrochemical biosensors have been the subject of the basic as well as applied research for nearly fifty years. A biosensor was first applied to the fast glucose assay for blood samples of diabetes. At present, there are many proposed and already commercialized detection devices based on the biosensor principles (Miroslav *et al.*, 2008). In biosensing, the measurement of properties of biological systems generally occurs through binding between the sensing element and target molecules (analytes), whereby in electrochemical sensing the electrical signal produced in the binding is measured through a transduction element. Biosensing devices employ a variety of recognition elements. Biorecognition elements are enzymes, antibodies, nucleic acids, cells and microorganisms. For example, an immunosensor uses antibodies, antibody fragments or antigens to monitor binding events in bioelectrochemical reactions. The most typical part of electrochemical biosensors is the presence of suitable sensing elements in the biorecognition layer providing electroactive substances for detection of target molecules with a physico-chemical transducer that receives and transfers the measurable signal (Grieshaber *et al.*, 2008).

The purpose of this thesis is to investigate an electrochemical biosensor that detects microorganisms in environmental system. The sensor was made by immobilizing antibodies on a self-assembled monolayer (SAM) formed on a gold electrode. In addition, SAMs with different alkyl chain lengths were studied in order to compare the effects of SAM's height on sensing efficiency. Electrochemical techniques such as cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) were used to evaluate the characteristics of sensors using potassium chloride, potassium ferricyanide and potassium ferricyanide trihydrate as redox probes. Finally, the sensors were tested with varying concentrations of bacteria.