

DESIGN OF IMPRESSED CURRENT CATHODIC PROTECTION FOR  
STEEL IMMERSED IN FRESHWATER

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## DEDICATION

*To my beloved parents, siblings and friends for their endless loves and supports...*

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## ABSTRACT

Impressed current cathodic protection (ICCP) and coating give the optimum protection against corrosion for steel immersed in freshwater. This project presents the results of a study on the effectiveness of coating, impressed current cathodic protection and different environment conditions in preventing corrosion of steel. Experimental tests were carried out on coated and bare steel plates with ICCP and without ICCP by immersing in stagnant and flowing freshwater for one month. The results demonstrated that for coated and bare steel with ICCP and different variable resistance, the values of the potential are sufficient to protect the bare and the coated steel  $-840\text{mV}$  to  $-875\text{mV}$ . For coated steel without ICCP immersed in stagnant freshwater the potential has changed from  $-702\text{ mV}$  to  $-630\text{mV}$ , but for the bare sample the change in potential was about  $-10\text{mV}$  this may be due to oxide layer formed on the metal surface. For coated steel without ICCP immersed in flowing freshwater the drop in potential was about  $-50\text{mV}$  and the bare steel with the same condition was about  $-100\text{ mV}$ . A good agreement was observed for corrosion rate between weight loss measurement ( $4.29\text{ mpy}$ ) test and electrochemical test ( $4.27\text{ mpy}$ ) for bare steel in stagnant freshwater. The location of the reference electrode has significant implications for the control the potential change of ICCP system, the corrosion potential increases at the top of the sample ( $60\text{cm}$  below the water) and decrease when the sample was immersed further down to  $1\text{ meter}$  in the water level.

## ABSTRAK

Salutan dan perlindungan katod arus bekasan (ICCP) dapat memberikan perlindungan yang optimum pada keluli apabila direndam di dalam air bersih. Projek ini bertujuan untuk mengkaji kesan salutan dan perlindungan katod arus bekasan dan keadaan persekitaran yang berbeza pada kakisan keluli. Kajian dijalankan selama sebulan di dalam air genang dan air yang mengalir dengan menggunakan dua jenis keluli iaitu keluli bersalut dan tanpa salutan. Ia dibahagikan kepada dua bahagian iaitu dilengkapi sistem ICCP dan tanpa sistem ICCP. Keputusan kajian menunjukkan nilai upaya pada keluli tanpa salutan dan keluli bersalut yang dilengkapi sistem ICCP adalah mencukupi untuk melindungi keluli- keluli tersebut (-840mV hingga -875mV). Manakala keputusan nilai upaya pada keluli bersalut tanpa sistem ICCP yang direndam di dalam air genang berubah dari -702 mV kepada -630mV. Berlainan pada keluli tanpa salutan iaitu hanya -10mV disebabkan kehadiran lapisan oksida. Keputusan nilai upaya untuk keluli bersalut tanpa dilengkapi sistem ICCP di dalam air mengalir adalah -50mV, manakala bagi keluli salutan adalah -100 mV. Keputusan ujian kehilangan berat dan juga ujian elektrokimia tidak memberikan perbezaan yang ketara nilai kadar kakisan pada keluli tanpa salutan di dalam air genang iaitu (4.29) mpy untuk ujian kehilangan berat dan (4.27) mpy untuk ujian elektrokimia. Kedudukan elektrod rujukan juga memberikan kesan pada nilai upaya di dalam sistem ICCP ini. Nilai upaya kakisan meningkat apabila kedudukan elektrod rujukan berada di atas sampel (60sm dari paras air) dan menurun apabila diletakkan di bahagian bawah air iaitu (1 meter dari paras air)

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# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Introduction**

This section discuss about the introduction of the study which are background of the study, purpose and objective of the study, significant of study and scope of study.

### **1.2 Background of the Study**

Corrosion can be defined as destruction or deterioration of the material because of the reaction with the environment. Most of the materials which undergo corrosion are metal, so some insist definition of the corrosion should be specific to the metal. Mars G. Fontana [1] suggest that all material including ceramic, polymer and other non-metallic material which contributes into the corrosion reaction should be taken care.

Corrosion weakens strength and cause failure on material. Protection materials from undergoing corrosion become crucial especially tropical country like Malaysia which has high humidity. Cost of the corrosion in United State is around USD\$ 40 billion or RM 140 million annually. Protection need to be done onto the material so that reduce corrosion rate so that less materials and money being wasted.