THE EFFECT OF SOIL RESISTIVITY ON CORROSION BEHAVIOUR OF COATED AND UNCOATED LOW CARBON STEEL

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This study is especially dedicated to my beloved Mommy and Daddy

Brothers and sisters,

Beloved fiancé,

Abdul Hakim Amir Abdullah

for everlasting love, care, and support...

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ABSTRACT

Underground pipeline and steel structure are usually expected to have a long working life. Pipeline made of steel normally corrodes in soil if remain unprotected. Thus the aim of this project is to determine the effect of soil properties and content on the corrosion behaviour of low carbon steel. Soil and water samples were taken along Bekok, 50km water pipeline in Yong Peng. The samples used in this research is low carbon steel both coated (with bitumen) and uncoated. Moisture, pH and the resistivity of soil are the parameters that involve in determining the corrosivity of the soil. The concentrations of the soil parameters are found to have the following properties: pH (1.76- 5.6), temperature (25-50°C), moisture contents (20 – 40%), and resistivity (<1000 Ω.cm). Corrosivity of the soil samples were evaluated using the American Water Works Association (AWWA) C 105 numerical scale. The resistivity measurement shows that the value decrease by increasing the water content and ionic concentration. The corrosion rate of low carbon steel in soil test solution has been investigated using electrochemical test method (Tafel slope). The result shows that the corrosion rate of the steel increases considerably at very low acidic pH environment (pH 1 to 2) and corrosion current density increase with temperature in the range of 25 to 50°C. Immersion test indicated that the highest corrosion rate of the steel sample was observed in soil containing the lowest pH value 1.76. Based on visual inspection, it is found that uncoated sample has higher corrosion rate than coated steel sample.

ABSTRAK

Saluran paip dan struktur keluli dalam tanah lazimnya dijangka mempunyai jangka hayat yang panjang. Saluran paip diperbuat daripada keluli lazimnya akan terkakis di dalam tanah jika tidak dilindungi. Tujuan projek ini adalah untuk mengkaji kesan sifat tanah terhadap kelakuan kakisan keluli karbon rendah. Sampel air dan tanah diambil di beberapa kawasan di sepanjang saluran paip Bekok di Yong Peng. Kajian ini menggunakan dua jenis sampel iaitu keluli karbon rendah bersalut (bitumen) dan tanpa salutan. Parameter yang dikaji ialah seperti berikut; kelembapan tanah, kesan pH, kerintangan dan juga kandungan klorida. Di dalam kajian ini, kandungan kepekatan yang di jalankan adalah seperti berikut: pH (1.76- 5.6), suhu (25-50℃), kandungan kelembapan (20 – 40%), dan sifat kerintangan tanah (<1000 Ω.cm). Sifat kakisan pada tanah telah dinilai berdasarkan ukuran skala menurut urutan angka *American Water Works Association* (AWWA C 105). Teknik pengiraan daya rintangan tanah telah menunjukkan bahawa sifat kerintangan tanah akan menurun apabila kandungan air dan juga kepekatan ionik di dalam tanah meningkat. Ujian elektrokimia mengunakan teknik kecerunan Tafel telah digunakan untuk mengetahui kadar kakisan keluli karbon rendah di dalam larutan tanah tersebut. Keputusan kajian menunjukkan kadar kakisan meningkat secara mendadak apabila terdedah kepada persekitaran berasid rendah (pH 1-2). Keputusan ini juga menunjukkan ketumpatan arus kakisan meningkat apabila suhu menigkat dalam julat 25 kepada 50°C. Manakala untuk ujian rendaman pula, keputusan menunjukkan kadar kakisan yang tertinggi adalah pada sampel tanah yang mempunyai nilai pH 1.76. Berdasarkan pemeriksaan visual, sampel keluli tanpa salutan didapati mempunyai kadar kakisan yang tinggi berbanding keluli bersalut.

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CHAPTER 1

INTRODUCTION

1.1 Background of the Research

Fundamental cause of deterioration of pipeline buried underground soil is soil corrosion. Pipeline corrodes in soil by complex electrochemical process because of the presence of different soil electrolyte. Bekok water pipeline, managed by Syarikat Air Johor (SAJ) in conjunction with RANHILL Malaysia has been chosen as the area of study. This water pipeline is made by carbon steel protected with bitumen coating have been installed with cathodic protection (ICCP) system. The system is specified by minimum potential of -850mV in reference to $Cu/CuSO_4$ electrode. A periodic is conducted to make sure the ICCP system is effective as corrosion protection along the 50 km water pipeline. The potential difference between soil and pipeline shows that it is less than -850mV ($Cu/CuSO_4$), which affect the cathodic protection system. Resistivity of the soil maybe the cause of the problem and it is the major study in determining the effect of corrosion behaviour.

1.2 Objective of the Research

The main objective of this research is to study the corrosivity of the soil based on American Water Works Association AWWA C 105 standard numerical scale. Besides that, it is also to determine the effect of water content on the resistivity of the soil.

1.3 Scopes of Research

Scopes of the research are as follows;

(a) Literature review on soil corrosion and corrosion protection.
(b) Experimental set-up on soil corrosion and corrosion protection.
(c) Selection of soil samples and materials for the specimen.
(d) Corrosion test on coated steel buried in soil**.**
(e) Analysis of results using optical microscope, SEM and XRD.