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TESTING OF SMALL SCALE CATHODIC PROTECTION BY IMPRESSED CURRENT FOR UNDERGROUND REBAR IN THE LAB

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Abstract - *Corrosion protections have become prominent in many industries to reduce the loss of materials from corrosion. Among many methods of corrosion control, anodic and cathodic protections are noteworthy. Impressed current cathodic protection method was utilized to reduce the corrosion rate of buried mild steels available in Bangladesh. Tests were carried out on steel bars with ICCP and without ICCP and a good agreement was observed in corrosion rate both by weight loss and ICCP methods.*

Keywords: Corrosion, Cathodic protection, Impressed current, Mild Steel.

1. INTRODUCTION

Corrosion is defined as the deterioration of a material because of destructive chemical or electrochemical reactions commencing with metal in various environments [1, 2]. A corrosion cell consists of anode, cathode, electrolyte and metallic connections between anode and cathode. Corrosion occurs as the current from the anode site pass through the environment to reenter at a cathode site.

Numerous methods for controlling the corrosion are available, for instance, cathodic protection, anodic protection, chemical inhibitors, pH control, and many more. Among many methods of corrosion control concentration was given to the impressed current cathodic protection (ICCP) method which is one type of cathodic protection (CP) method. ICCP is normally used for large structures and requires an external power supply. Main advantages for using ICCP systems are unlimited current output capacity, adjustable output capacity and relatively lower cost in current consumption with respect to cathodic protection current [1,2].

2. PRINCIPLES OF CATHODIC PROTECTION

Cathodic protection uses the technique to supply sufficient electrons that is going out or will be lost due to the reaction with environments. In other words, he principle of cathodic protection is that by connecting an external anode for the metal to be protected and by passing external current making all areas of the metal surface cathodic [1]. The external anode may be a galvanic anode where the current is a result of the potential difference between the two metals, or it may be an impressed current anode where the current is impressed from an external dc power source.

During the measurement and control of corrosion, potential and current density plays a vital role. Normally without any protection methods, the current density and the potential are quite high as shown in Figure 1. The anodic reactions are being controlled by anodic current and cathodic reactions are controlled by cathodic current [1].

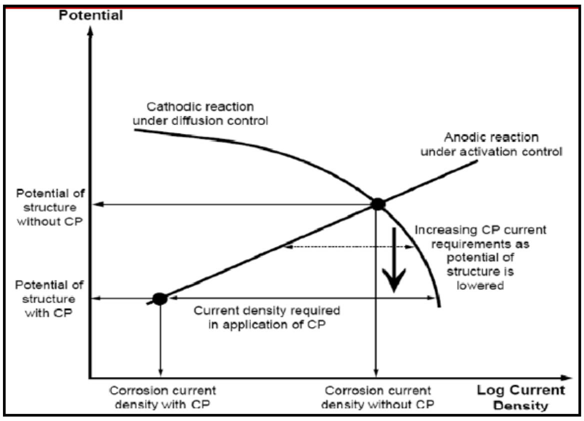

Fig. 1: Principle of cathodic protection [1]

Cathodic protection is classifies as impressed current cathodic protection and sacrificial anode cathodic protection. Both types of cathodic protection have anodes, a continuous electrolyte from the anode to the protected structure, and an external metallic connection [1].

Adoption of ICCP system is usually cost effective for long term large structures and minimized corrosion damage. In an ICCP system, an external source of electrons is provided to supply sufficient electrons to the metal and electrolyte combination to have negligible corrosion [3]. Figure 2 shows an impressed current cathodic protection system having anodes (Inert or zero or low dissolution) and an external power source (DC source) to impress current from the external anode to the cathode surface [4].

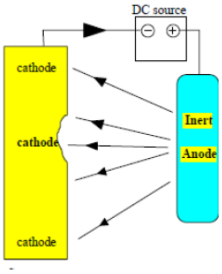

Fig. 2: Impressed current setup [4]

Normally the continuous supply of electrons at different quantity is provided from the anode and can also be regulated by controlling the current provided. Impressed current cathodic protection (ICCP) is widely employed in conjunction with surface coatings to control the corrosion of the underwater structures. Power supply is controlled through a reference electrode which measures surface potential at the vicinity. The processes involved in cathodic protection are essentially electrochemical phenomena at the interfaces between the soil and the cathodic structure (and the anodic surfaces). The output current of ICCP system is influenced by a number of factors such as, surface condition, coatings and the presence or of flow [5].

3. EXPREMENTAL SETUP AND RESULTS

Mild steels, buried under soil, were selected as the underground metals for the cathodic protection. Anodes were supplied with a current of 100 mA so that higher current densities in the soil cannot reduce the anode life. The number of anodes needed to meet the current density and total circuit resistance was determined by available standard equations.

Corrosion rate was measured by weight loss method where a known specimen is exposed to the corrosive environment for a specific period and difference between the initial and final weight gives the corrosion rate. Immersion test was conducted according to ASTM G31-72. Corrosion rate at different conditions of soil was carried out by conventional immersion test for the exposure period of 20 days. The initial weights for the bare sample were 106.7 gm and the initial weights for the steel sample in aerated environment were 107.6 gm.

The surface areas of the specimens before and after the ICCP test in Fig.3 (a) and (b) reveal that most of the metal surface has changed due to the reaction of ions in the electrolyte and metal surface. Corrosion rate of samples by weight loss and due to application of ICCP for the underground mild steel are shown in Table 1.

Fig. 3(a) : Unprotected Mild Steel

Fig. 3 (b) Protected by Impressed Current

Table.1 Corrosion rate of samples

Underground mild steel			
Sample with ICCP		Sample without ICCP	
Weight loss (g)	Corrosion rate (mpy)	Weight loss (g)	Corrosion rate (mpy)
0.1	6.35	0.9	16.35

4. CONCLUSIONS

The results show that there is significant reduction in the corrosion rate both by weight loss and ICCP methods. However, the temperature and soil resistivity showed changes during the measurement and application of ICCP in the lab and outside environment. Moreover, additional research is required to evaluate the effect of the life time of the anodes and the feasibility of the experiments and processes involved in the environment of Bangladesh.

5. REFERENCES

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