Corrosion Studies

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The **protection of metal** in corroding media can be obtained when the potential of the metal changed to more negative values. Brown and Hoar said this negative potential change is essential for the cathode area to raise their potential to the anodic area potential which is at more negative potential than the cathodic area potential, while Wagner has said that the potential of the metal must be negative and the difference must be about 200 mV. But there is no definite method to indicate the exact amount (c. d.) required for the protection of metals, and the influence of foreign materials like inhibitors on the cathodic protection. First of all the meaning of the cathodic protection is to be understood before proceeding to the studies. Cathodic protection is one of the ways of protecting metals, in which metal to be protected is made cathode and certain amount of current is applied using an auxiliary electrode as anode. Hull cell, which is used in electro-deposition, was made use of for finding the exact protection current.

The following equation for the current density is used for Hull cell :

$$I = I_a\ (27.7 - 48.7\ \text{Log}\ L)$$

L in inches and I is in Amps per square foot.

In the studies 5% sulphuric acid with different inhibitors was used. Sharp lines were obtained between the attacked and unattacked portions of metals and the current density corresponding to this sharp line was determined using the above equation. In order to find the effect of the current density and its ability to protect metal the experiment was repeated with individual specimen applying the protection current obtained from the Hull cell equation. The results gave 99% protection and therefore the validity of the equation is held. The current density for iron in 5% sulphuric acid is 1500 ma/dm^2.

In the second part of the experiment study was made of the effect of the inhibitors on the protection currents, on the potentials at the protection currents, and the action of inhibitors under impressed currents. It was found that there is a marked difference in their behaviour when current is applied. The inhibitor efficiencies of these inhibitors in 5% sulphuric acid solutions were determined and they are given below :

Inhibitors used 0.01%	Inhibition efficiency %
Thiourea	95
B-naphthol	7
Quinoline	7
Gelatin	50

It can be seen from the above figures that the inhibitor efficiency is very high in the case of thiourea and gelatin, while the inhibitor efficiency of quinoline and B-napthol is very low. Now we can compare the inhibitor action on the protection current density.

5% Sulphuric Acid	1500	mA/dm^2
,, Acid Quinoline[0.01]	800	,,
,, Acid B-naphthol	1100	,,
,, Acid Thiourea	500	,,
,, Acid Gelatin	1400	,,

It can be inferned from the above figures that the current density required for the protection of metal is changed in the presence of inhibitors and change is to reduce the protection current. Thiourea reduces the protection current to a greater extent than the other inhibitors. Now when compared with the efficiencies we find that the inhibitors behave quite differently in the presence of impressed current. Thiourea which gives the maximum efficiency gives maximum reduction in the protection current. Gelatin which gives 50% inhibition gives very poor reduction in the protection current. Quinoline, which gives very poor efficiency, gives greater reduction in protection current than the gelatin and so is the case with B-naphthol.

The open circuit potential at the cathodic protection current for four different inhibitors are given below :

5% Sulphuric acid	-740 mV
,, Quinoline	-560 ,,
,, B-naphthol	-740 ,,
,, Thiourea	-720 ,,
,, Gelatin	-680 ,,

Among them, quinoline is good in reducing the protection current. Quinolines are known to be effective at more negative potentials and therefore cationic type of inhibitors are quite effective in reducing protection current. To base the open circuit potential as criteria for cathodic protection is not a sure indication as it is influenced by the presence of foreign materials like inhibitors.

Studies on Aluminium : Many types of aluminium are used in the industries for holding purposes or containers. Therefore it is essential to protect the aluminium when aluminium is quite susceptible to corrosion. It is with this view that the problem of protection of aluminium was taken up. The types of aluminium studied were 2S, 3S, 26S, 57S, 65S.

All these alloys could be protected with the cathodic protection. The cathodic currents varied with the constituents present in the aluminium. These alloys contain copper, manganese, and magnesium as the main alloying constituents. The corrosion currents and their protection currents are given below :

Type	Corrosion current mA/Sq. cm.	Protection current mA/Sq. cm
23S	6.146	0.4306
57S	0.5401	0.06890
3S	—	0.05042
26S	0.8507	0.004015
65S	0.5002	0.6113

Corrosion currents in all cases greater than the protection currents. If the current required for the protection of the metal is equal to the current required for the rise of cathodic potential to anodic potential, then the protection current for the metal must be equal to or greater than the corrosion current. However, the cases are reported where the protection currents are less than the corrosion. **Marsch** explained this finding on the basis of **chunck** dissolution, which is the mechanical dissolution of metal. Here also it was found to be chunck dissolutions. Among the alloys the copper containing alloy gives less protection current and maximum by the magnesium containing alloys. On the other hand when the current is not applied the magnesium alloy gives less corrosion current than the other alloys. Manganese containing alloys are better than the magnesium alloys under impressed conditions and give less protection current. Some of the inhibitors like gelatin and dextrin are tried with some of the above alloys and the findings so far show that the inhibitors are quite effective, and reduce currents required for the cathodic protection.

Studies on Electrolytic cleaning :

To find out the exact current density at which the cleaning can be obtained, Hull cell technique was used From this a suitable current density was obtained. An alkaline electrolytic bath at 90 to 100°C was used, and a cycle of cathodic cleaning followed by the anodic cleaning was used. It was found that cathodic cleaning followed by anodic cleaning is better than either cathodic cleaning or anodic cleaning. At the end of 20 minutes experiment a bright and clean surface was obtained. Sodium chloride bath is used at 90 to 100°C. The bath was chosen out of an alkali salt and a detergent.

Soil Corrosion :

Soil corrosion is very important for the oil pipe lines, which are buried in the soil.

In these studies on the cathodic protection of oil pipe line, it was found that the polarisability of the soil is more important than the pipe-to-soil potential or the resistivity of the soil in predicting the corrosivity of soil The sacrificial type of protection was effective. Cathodic protection by the impressed current was also important and found quite effective.

Paint Studies : It is found that the cathodic protection current was reduced by the coat of a paint. Very little currents of the order of 1 ma/sq. feet were quite sufficient. Secondly this method increased the life of the paint.

Mechanism of inhibitors : Many mechanisms are available for inhibitor action, based on chemisorption, over potential, absorption, and electron transfer. In the following studies, the inhibitor action is interpreted on the basis of exchange current density and slope of the tafel lines. In the study attempt was made to find the variations in exchange currents and the tafel lines, which were obtained round about the protection currents, where the evolution of hydrogen predominates.

The observations are given below:

	C. P. C. D. mA/sq. cm.	*Ex. C.D. mA/sq. cm.*	*Slope in volts*
5% sulfuric acid	15	2 3	0.61
Thiourea	5	0.26	0 39
Gelatin	14	2.34	0 51
Quinolin	8	0 25	0 20

It is found that the inhibition is brought about (for iron) by the change in the exchange currents and the slope of the lines.

Acknowledgement : *I am very thankful to Dr. Rajagopalan and Mr. N. Subramanian for their interest in the work. I am also thankful to Director for his encouragement.*

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