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Corrosion Rate Increases in Sea Shore Areas Due to High Humidity

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ABSTRACT: Normally temperature variation alone constitute a great hazards to electronic components, yet this bears no relation to actual condition in which the equipment have to live and breath. Extremes of climate that an equipments is required to withstand can be categorised as (a) Tropical climate-Wherein high temperature is combined with high humidity. (b) Desert-climate where atmospheric humidity is very low but variation of temperature is very wide. (c) Arctic condition-Where very low temperature are in operation for long periods of the years. Large of india are tropical wet climate. In such areas there is no month with an average temperature lower than 17.8 °C. Average temperature are more typically around 26.7-27.5 °C, relative humidity is usually high and rainfall is abundant. It is never less than 30 inches an year and often exceeds 100 inch. Dew points are high, which means that a small drop in temperature is sufficient to produced 100% RH.

KEYWORDS: Desert, Arctic condition, Tropical climate, Relative humidity, Wet climate

I. INTRODUCTION

Corrosion is increases in area near the sea shore . It is mainly electrochemical process promoted by different type processes differential aeration such as accumulation of dirt, sand ,scale and other contamination because this part of metal is poorly oxygenated ,hence anodic where corrosion taking place., the area becomes lesser accessible to air and more corrosion leading to the formation of deep cavity or localized pitting in the metal. Some time partial cover of metal by block of wood and piece of glass these are working as screen part of metal from oxygen access. As a consequence, differential aeration and corrosion occurs It can be some time prevented by passivation by which a metal or alloys show high corrosion resistance due to formation of high protective, very thin film (about 0.0004 mm thick) and quite invisible surface film but it can take place in different environment .Passivation tend to maintain protective film on the surface as Ti, Cr, Al and Cr containing stainless steel alloys exhibits outstanding corrosion resistant in presence of oxygen. This is due to the formation of thin film on their surface the rate of corrosion is less when the area of cathode is smaller, when cathodic area is smaller, the demands for electrons will be less and this result is the decrease rate of dissolution of metal at anodic regions.

The concept of total corrosion control should be introduced in which corrosion control is more a daily activity at all stages of production than merely an afterthought. Good corrosion control. An inhibitor is a chemical substances that ,When added in small concentration to an environment, effectively decreases the corrosion rate there are several classes of inhibitors conveniently designated passivators¹ organic inhibitors², including slushing compounds and pickling inhibitors, and vapour phase inhibitors³ The practice of corrosion inhibitors are greatly influenced by new regulations that have been developed because of toxicity in environment effect resulting from industrial effluents .The extent chemical reduction on initial contact of passivators with metal, according to this view point, must be at least chemically equivalent to the amount of passive film formed as result of such reduction. From the passive film on iron this is in the order of 0.01 c/cm² of apparent surface. The total equivalent of chemically reduced chromate is found to be of this order and it is probably also same for the other passivators acting on iron. The amount of chromate reduced in the passivation process is arrived at from measurements [1-3]. In the type of vapour phase process various type of material are widely used such as polyaniline [4-6], Polypyrrole [7] and poly acetylene [8]. Heavy effort have been deployed to find suitable corrosion inhibitor for organic origin in various corrosive media [9-12]. In acid media, nitrogen based

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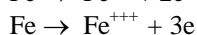
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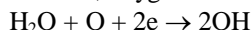
materials and their derivatives, sulphur containing compounds, aldehyde, thioaldehydes, acetylenic compounds and various alkaloids. The acetic acid which is 98% pure can increase the rate of corrosion within 24 hours if the humidity is 80% to 100% RH. [13] To reduce the corrosion problem in environment inhibitive effects of various naturally occurring substances like *Datura stramonium* [14], *Calotropis gigantea*, *Capparis deciduas* [15], *Prosopis juliflora* [16] have been evaluated as effective corrosion inhibitors.

MECHANISMS OF CORROSION

Corrosion is the deterioration of a material as a result of reaction with its environment, especially with oxygen. Although the term is usually applied to metals, all materials, including ceramics, plastics, rubber, and wood, deteriorates at the surface to some extent when they are exposed to certain combinations of liquids and /or gases. Common examples of metal corrosion are the rusting of iron, the tarnishing of silver, the dissolution of metals in acid solutions and the growth of patina on copper. Most research into the causes and prevention of corrosion involves metals, since the corrosion of metals occurs much faster under atmospheric conditions than does the corrosion of nonmetals. The cost of replacing equipment destroyed by corrosion in the United States alone is in the billion-dollar range annually. Corrosion is usually an electrochemical process in which the corroding metal behaves like a small electrochemical cell. Since the corrosion of iron by dissolved oxygen is, from an economic standpoint, the most important redox reaction occurring in the atmosphere, it will be used here to illustrate the electrochemical nature of the process. A sheet of iron exposed to a water solution containing dissolved oxygen is the site of oxidation and reduction half-reactions, which occur at different locations on the surface. At anodic areas, iron is oxidized according to the reaction. Reaction Anodic



At the same time, oxygen molecules in the solution are reduced at the cathodic areas. Reaction Cathodic



The two processes produce an insoluble iron hydroxide in the first step of the corrosion process: Generally, this iron hydroxide is further oxidized in a second step to produce $\text{Fe}(\text{OH})_3$, the flaky, reddish brown substance that is known as rust. Unfortunately, this new compound is permeable to oxygen and water, so it does not form a protective coating on the iron surface and the corrosion process continues. All metals exhibit a tendency to be oxidized, some more easily than others. A tabulation of the relative strength of this tendency is called the electromotive series of metals. Knowledge of a metal's location in the series is an important piece of information to have in making decisions about its potential usefulness for structural and other application

II. MATERIAL AND METHODS

2. Metal Studied

Mild steel panels of the size 7.5 cm × 1.25 cm (cut from single sheet) of pickled cold rolled closed annealed (18 SWG) were used in all experiments. The composition of the mild steel sheet was iron 99.74%, carbon 0.07%, silicon 0.07%, sulphur 0.044%, phosphorus 0.049%, manganese 0.023%. All panels were carefully polished with successive grades of emery paper for removing all surface defects. The final surface was brought to standard finish by polishing with 000 grade emery paper. All cuts, edges, corners and suspension holes were rounded off and smoothed.

After surface preparation panels were degreased with sulphur free toluene. This was followed by treatment with methyl alcohol to remove sweat residue and finger prints. The specimens were dried and then transferred to a vacuum desiccators in which they were allowed to remain for a period of 24 hours.

Corrosion experiments:

After surface preparation panels were weighed (weighing was done with the help of single pan weighing machine). For the identification of panels all the panels were numbered and suspension holes were made.

Weighed metal panels, were exposed to synthetic atmosphere of different humidity or corrosive vapours. The samples were with drawn after a specified time and the extent of corrosion was determined by weight gain or weight loss

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method. The de rusting was done by using appropriate de rusting solutions. The de rusting solution used was conc. HCl containing 5% stannous chloride and 2% Antimony trioxide at room temperature. After removal of corrosion product, the metal panels were washed with distilled water followed by immersion in absolute alcohol or acetone, drying with hot air, cooling in desiccators and weighing. The weight losses of specimens due to corrosion were determined by subtracting the weights of de rusted panels from their original weights.

The specimens were suspended in sealed desiccators (one liter capacity) by glass hooks with the help of glass rod fixed tightly on the inner walls of the desiccators. Care was taken to put grease on the lid properly so that once closed, the system was fully sealed.

In order to make sure that the un corroded metal was not removed from the panels by the de rusting solutions, blank was run in each case to check the amount of metal removed in the process of de rusting. It was found that metal removed from the blank did not exceed 0.1% of the total corrosion value.

It has been reported by Evans if the rust consists of Fe (OH)₂ and no other compounds, the loss in weight should be 1.69 of that of the gain in weight. Since in our study, other compounds were likely to be formed the weight increments might not give the true picture, as in many cases where the corrosion product were not of adherent type or where leaching of the corrosion product could have been possible, the weight increments were not suitable as a method for assessment of the corrosion rate. The corrosion has been measure in mg/dm² of the surface area.

Preparation of synthetic humid atmosphere:

The humid atmosphere of known RH was produced by using sulphuric acid of appropriate density, AR quality sulphuric acid was used for the purpose and the required dilution was done by distilled water. The concentration of acid for different RH was as follows:

For 20%RH H₂SO₄ 31.39 % by volume

For 40%RH H₂SO₄ 25.90 % by volume

For 60%RH H₂SO₄ 20.80 % by volume

For 80%RH H₂SO₄ 14.55 % by volume

For 100%RH H₂SO₄ 0.0 % by volume (Distilled water)

The amounts of dilute acid taken were 30cc in the desiccators of 1000 cc capacity. The sealed desiccators containing the solution were kept at room temperature for three days before the panels were introduced in them.

Preparation of other corrosive environments:

The acetic acid environment was created by taking 1cc of acetic acid of desired concentration soaked in cotton and hanging it inside the desiccators with the help of glass hooks. The environment of wood exhalations was created by hanging wet wood piece of size 7.5 cm × 1.25 cm with the help of cotton threads inside the desiccators for 7 days. Woods pieces were kept immersed in distilled water for 24 hours at room temperature before hanging.

Volatile corrosion inhibitor:

Few volatile corrosion inhibitors reported by Rajagopalan as very good inhibitors were tested at different RH. Those found excellent were used to prevent corrosion by vapours emitted by woods. They were also incorporated in ordinary brown paper to prepare VCI paper.

0.5 gm of VCI was taken in a glass plate and was kept inside the desiccators (IL) at required humidity with and without wood. The weight losses of the panels in the absence of VCI (W_u) and in the presence of VCI (W_i) were determined for different time durations. The inhibitor efficiency (I) was calculated by the following equation.

$$I = \frac{W_u - W_i}{W_u} \times 100$$

Majority of the state and Industrial standards, for evaluation of the performance of vapor corrosion inhibitors, used the Federal Standard No. 101C, Method 4031, (Corrosion inhibiting ability of VCI vapours). This test is applied for testing of the VCI films, papers and powders and is included in Japanese Industrial Standards JISZ 1519, JISZ 1535 JISK 2246. According to this test the VCI material is placed inside a Jar that serves as a test chamber. The Jar contains water glycerin solution of different strength, which produces different relative humidity. There is also a metal specimen inside the Jar. This specimen does not contact the VCI material. For non-VCI material this condition will cause corrosion. If the material contains an adequate amount of VCI, metal surface remains protected. According to German Military Standard TL 8135, Corrosion protection provided by the VCI material is graded by visual inspection of the metal specimen. Some material specimens are used in dessicator.

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TABLE NO.1

Corrosion of paper wrapped mild steel due to different concentration of acetic acid for different time durations at different RH

S.No.	Amount of Acetic Acid (cc)	Wt loss (mg/dm ²)			
		80%RH		100%RH	
		2 months	4 months	2 months	4 month
1	0.001	119	153	402	651
2	0.01	146	173	514	973
3	0.1	275	707	641	1254
4	1	1168	1615	1372	2475

TABLE NO.2

Protection of mild steel when wrapped with Anthracene incorporated paper and exposed to acetic acid vapours of different concentration of acetic acid.at 80 % RH

S.No.	Amount of Acetic Acid (cc)	Two months		Four months	
		Wt loss (mg/dm ²)	% Protection	Wt loss (mg/dm ²)	% Protection
		1	0.001	24.4	79
2	0.01	87.0	40	94.2	45
3	0.1	119.5	56	200.0	71
4	1.0	331.8	71	349.5	78

TABLE NO.3

Protection of mild steel when wrapped with Anthracene incorporated paper and exposed to acetic acid vapours of different concentration of acetic acid at 100% RH.

S.No.	Amount of Acetic Acid (cc)	Two months		Four months	
		Wt loss (mg/dm ²)	% Protection	Wt loss (mg/dm ²)	% Protection
		1	0.001	48.8	87
2	0.01	114.6	77	229.2	76
3	0.1	268.5	58	305.0	75
4	1.0	429.0	68	424.0	82

TABLE NO.4

Protection of mild steel when wrapped with Anthraquinone in corporate paper and exposed to acetic acid vapours of different concentrations at 80%RH.

S.No.	Amount of Acetic Acid (cc)	Two months		Four months	
		Wt loss (mg/dm ²)	% Protection	Wt loss (mg/dm ²)	% Protection
		1	0.001	0.0	100
2	0.01	0.0	100	1.4	99
3	0.1	12.2	95	34.1	95
4	1.0	9.76	99	30.5	98

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III. RESULT AND DISCUSSION

Table No.1 it is depicted that corrosion at 100% RH is greater than 80%RH. Both during two months and four months. The corrosion rate increases with increase with concentration of acetic acid and also with time. In the percentage of 0.001 cc acetic acid during two months, the weight loss obtained was 119 mg/dm² at 80%RH and 402 mg/dm² at 100%RH. During four months weight loss obtained was 153 mg/dm² at 80%RH and 651 mg/dm² at 100%RH. In the presence of 1 cc acetic acid during two months the weight loss obtained was 1168 mg/dm² at 80%RH and 1372 mg/dm² at 100%RH.

Table No.2 Depicted that protection of mild wrapped with anthracene incorporated paper and exposed to acetic acid vapours of different concentration (0.001cc to 1 cc) at 80% RH at two months and four months result shows that lower concentration of acetic acid and percentage protection obtained was order of 80% during entire exposure time of two months and four months. At highest concentration (1.0 cc) the protection obtained during two months was 71% and during four months was 78%.

Table No.3 Depicted that protection of mild wrapped with anthracene incorporated paper and exposed to acetic acid vapours' of different concentration (0.001cc to 1 cc) at 80% RH at two months and four months result shows that lower concentration of acetic acid and percentage protection obtained was order of 80% during entire exposure time of two months and four months. Results showed that performance of anthracene was better at 100% RH than that of 80%RH during entire exposure time of two months and four months. At lower concentration of acetic acid (0.001 cc). The percentage protection obtained was 87% during two months and 92% during four months. At higher concentration (1.0 cc). The percentage protection obtained was 68% during two months and 82% during four months.

Table No.4 This table depicted the protection of mild steel when wrapped with Anthraquinone incorporated paper and exposed to acetic acid vapours of different concentrations (0.001 cc to 1.0cc) at 80% RH. Result showed that Anthraquinone is highly efficient volatile corrosion inhibitor even when incorporated with craft paper. It afforded 100% protection at lower concentration of acetic acid (0.001 cc). Weight loss obtained during two months was 0.0 mg/dm² and during four months was 2.9 mg/dm². At higher concentration 0.1%. The percentage protection was 95% at 80% RH.

IV. CONCLUSIONS

VCI derivative shows good inhibition efficiency of corrosion by the formation of physical barrier between metal and corrosive environment by the interaction. The volatile corrosion inhibitor of mild steel metal carried out by using Anthracene and Anthraquinone. Most of cities in India are located at near sea. That's why acidic vapours are produced which increases the rate of corrosion formation. It is proved by testing in presence of closed chamber (desiccators) are acid vapours emitting woods which increases rate of corrosion formation at 80%RH to 100%RH. The rate of corrosion formation also increases due presence of vapours of acetic acid in 0.1% inside the test chamber.

Investigation shows that volatile corrosion inhibitors provides very effective corrosion protection processes for the Ferrous metals such as boilers, feeders and industrial pipe lines. Volatile corrosion inhibitors can apply in the powder form at the time of manufacturing of iron equipments.

It is confirmed that VCIs provides protection to the metal located at few centimeters from the VCI source.

All types of the inhibitors can used in combination with process of vapour phase process.

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