iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XI **Month of publication:** November 2017

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XI November 2017- Available at www.ijraset.com

Corrosion of Mild Steel by Acid Vapors and Its Prevention by Vapors of VCIs at Different RH (80% to 100%)

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Abstract: ***Corrosion of mild steel panels is caused by various environmental factors like different gaseous materials humidity required oxygen for oxidation. Maximum corrosion have been reported from the range of RH is 80% to 100%.Metal is deteriorated and form corrosion is the form of rusted materials. Most of electronic assemblies are packed in wooden boxes which produced acidic vapor which increased rate of corrosion formation corrosion product will increase. Humid atmosphere that causes rusting. It may be brown or black depends on oxygen supply in closed boxes .If the materials are wrapped with VC is soaked paper it can be protect by the vapors' of anthraquinone, m-dinitrobenzene, alaninetheorem and some other related amino acids.***

Key Words: Amino acids, wrapped paper, mild steel panel's ferrous metal, Alanine,

I. INTRODUCTUION

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 ara 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 (about0.0004 mm thick) and quite invisible surface film but it can take place in different environment. Composite material means combination of more than one material with various properties. The properties of the composite are different from earlier individual materials. Within the composite .it is still feasible to easily tell the isolate materials apart. The materials which are used to produce composite do not tend to blend or absorb each other. Man-made composite materials are available and also they exist in nature . Fiberglass was the first modern composite and was developed in the late 1940s and is still the most common composite [1]. It fulfills about 65 percent of the demands of all the composites produced today and is used for surfboards, boat hulls, sporting goods, car bodies, swimming pool linings, and building panels.

Peoples have been using composite materials for thousands of years [2], for example, mud bricks.the materials which are madeup of composite .in uncorroded and metal inbuilt with composites can be corroded

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 organic inhibitors, including slashing compounds and pickling inhibitors, and vapour phase inhibitors 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 [3-5]. In the type of vapour phase process various type of material are widely used such as poly aniline [7-10], Polypyrrole [10] and poly acetylene [11].Heavy effort have been deployed to find suitable corrosion inhibitor for organic origin in various corrosive media [12-14]. In acid media, nitrogen based materials and their derivatives, sulphur containing compounds, aldehyde, thioaldehydes, acetylene compounds and various alkaloids. The acetic acid which is 98% pure can increases the rate of corrosion within 24 hours .if the humidity is 80% to !00% RH.[15] To reduce the corrosion problem in environment inhibitive effects of

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II. MECHNISMS OF CORROSION

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 $Fe \rightarrow Fe^{++} + 2e$

$Fe \rightarrow Fe^{+++} + 3e$

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

Reaction Cathodic $H_2O + O + 2e \rightarrow 2OH$

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 Fe (OH) 3, the flaky, reddish brown substance that is known as rust.

III. MATERIAL AND METHODS

A. 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 smoothened. 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.

B. 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 vapors. The samples were with drawn after a specified time and the extent of corrosion was determined by weight gain or weight loss 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.

C. 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 H_2SO_4 31.39 % by volume
For 40%RH H_2SO_4 25.90 % by volume
For 60%RH H_2SO_4 20.80 % by volume
For 80%RH H_2SO_4 14.55 % by volume

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For 100%RH H_2SO_4 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.

D. 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.

E. 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 (Wu) and in the presence of VCI (Wi) 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 desiccators.

Table.No.1
Protection of ferrous metal when wrapped with m-dinitrobenzene incorporated 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	0.002	48.8	80	52.6	85
2	0.02	126.0	38	184.2	40
3	0.2	338.1	58	400.2	69
4	2.0	666.6	78	665.4	79

Table.No.2
Protection of ferrous metal when wrapped with m-dinitrobenzene incorporated paper and exposed to acetic acid vapors of different concentrations 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	0.002	48.8	88	56.5	94
2	0.02	228.4	72	450.2	67
3	0.2	523.5	48	603.4	75
4	2.0	833.0	65	798.0	77

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Table.No.3
Protection of ferrous metal when wrapped with Anthroquinone incorporated paper and exposed to acetic acid vapors' 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	0.002	1.1	99	5.8	97
2	0.02	1.1	99	12.8	97
3	0.2	24.4	96	68.4	94
4	2.0	18.8	97	30.5	98

Table.No.4
Protection of ferrous metal when wrapped with Anthroquinone incorporated paper and exposed to acetic acid vapors of different concentrations 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	0.002	14.4	96	45.12	91
2	0.02	24.4	94	65.8	92
3	0.2	37.6	95	119.5	90
4	2.0	767.5	60	758.8	69

IV. RESULT AND DISCUSSION

TableNo.1 depicted the protection of ferrous metal, wrapped with m-dinitrobenzene incorporated paper and exposed to acetic acid vapors of different contraptions (0.002 to 2.0 cc) at 80% RH for two months and four months. Result shows that at lower concentration (0.002cc) of acetic acid the percentage protection obtained was of the order 80% during entire exposure time of two months and four months. At highest concentration (2.0cc) the protection obtained during two months was 38% and during four months was 78%.Table.No.2 depict the protection of ferrous metal when wrapped with m-dinitrobenzene incorporated paper and exposed to acetic acid vapors at different concentrations (0.002 cc to 2.0 cc) at 100 % RH for two moths and four months. Results show that performance of m-dinitrobenzene was better at 100% RH than at 80% RH during the entire exposure time of two months and four months. AT lower concentration of acetic acid (0.002 cc), the percentage protection obtained was 72 % during two months and 67% during four months. AT higher concentration (1.0 cc). The percentage protection obtained was 65% during two months and 77% during four months. Table No. 3. Depict the protection of ferrous metal when wrapped with anthraquinoine incorporated paper and exposed to acetic acid vapours of different concentrations (0.002 cc to 2.0 cc) at 80% RH. Results show that anthraquinone is highly efficient volatile corrosion inhibitor even when incorporated in craft paper. It afforded 100% protection at lower concentration of acetic acid (0.002%). Weight loss obtained during two months was 1.1 mg/dm^2. At higher concentration 0.2% , the percentage protection obtained was 98 %. Table No. 4. Depict the protection of ferrous metal when wrapped with alanine incorporated paper and exposed to acetic acid vapours of different concentrations (0.002 cc to 2.0 cc) at 80% RH. Results show that Alanine incorporated paper in highly effective at 80% RH in all concentrations for acetic acid during the entire exposure tiem of two

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months and four months. It afforded 95% to 99% protection. The maximum weight loss obtained at highest concentrations (2.0 cc) acetic acid and during longest time duration (4months) was 758.8 mg/dm^2 only.

V. CONCLUSIONS

From the above data it shows that mostly wood are vapours producing materials which contains cellulose on hydrolysis it produced the vapour of formic acid and acetic acids the vapours are corrosion accelerating materials. On packaging most of the woods materials are used which is compactable with transportation. Most of the electronic assemblies are transported and packed by wood which produced acidic vapours.mainly mango woods, Jamun woods, Mahua woods, Eucalyptus woods, kathal woods .If the vapours of protective materials are used so corrosion product will be least and materials can be protected.

VI. ACKNOWLEDGEMENT

Authors are thankful to the Director, Indian Institute of technology Kanpur, India for providing infrastructure facilities to carry out this work and also thankful to Director Naraina College of Eng.&Technology, Penki, Ratanpur, Kanpur for providing Lab Facilities.

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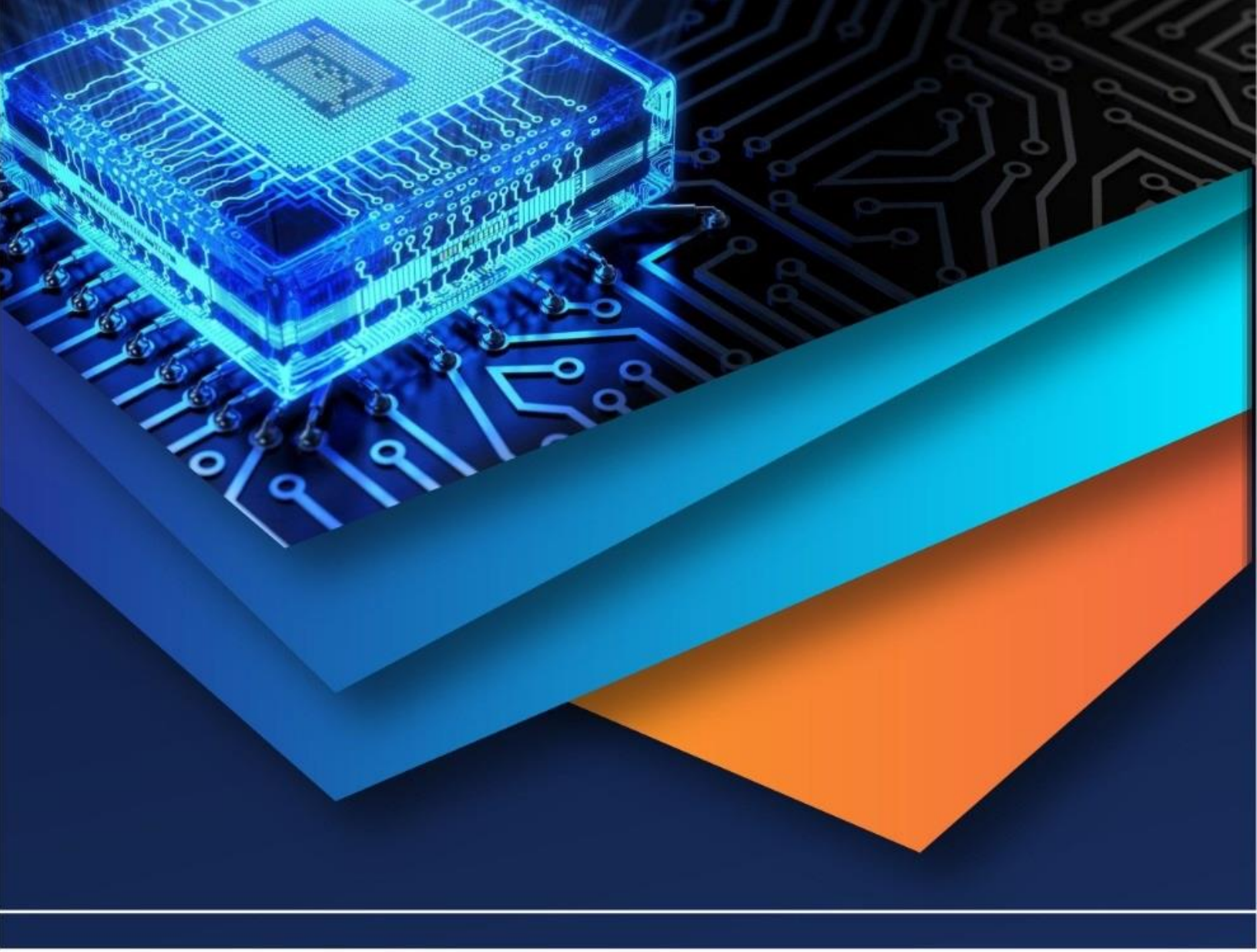

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