Prevention of Mild Steel Corrosion by Vapors of Different Packaging Woods

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Abstract: *Corrosion produced by packaging woods for the transportation of different electrical and electronic equipments. Woods used for packaging are mainly Katahal, Jamun, Chir, Mahua, Mango. All these woods are producing acid vapours Acetic acid and formic acid these are factors which accelerate corrosion in mild steels. By using wrapped brown paper. These are treated with vapors of organic compounds which make a layers between surface of metal and environment. VCI treated paper wrapped over the surface of mild steel which checks the accretion of rate of corrosion production.*

Keywords: Corrosion, Vapors, organic compounds, wrapped

1. Introduction

Corrosion Problem is well-known problem in worldwide. 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 .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 slashing compounds and pickling inhibitors, and vapour phase inhibitors 3 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. There is trends to replaced some widely used inhibitor such as chromates, in application where toxicity, environmental damage, and pollution caused by these chemicals are important consideration [1-3]. 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 of0.01 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 [4-6]. In the type of vapour phase process various type of material are widely used such as polyaniline [7-9], Polypyrrole [10] and poly acetylene [11].Heavy effort have been deployed to find suitable corrosion inhibitor for organic origin in various corrosive media . In acid media, nitrogen based materials and their derivatives, sulphur containing compounds, aldehyde, thioaldehydes, acetylenic compounds and various alkaloids

Mechanism 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.
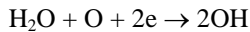
Reaction Anodic
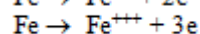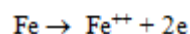
$$Fe \rightarrow Fe^{++} + 2e$$
$$Fe \rightarrow Fe^{+++} + 3e$$

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. 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

2. Material and Methods

2.1 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.

2.2 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 withdrawn 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.

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 80%RH H_2SO_4 14.55 % by volume
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.

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 1 inch □ 1 inch □ 2 inches 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 (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. Keeping in mind the above standard, we planned our experiment mild steel due to Anthracene for different RH
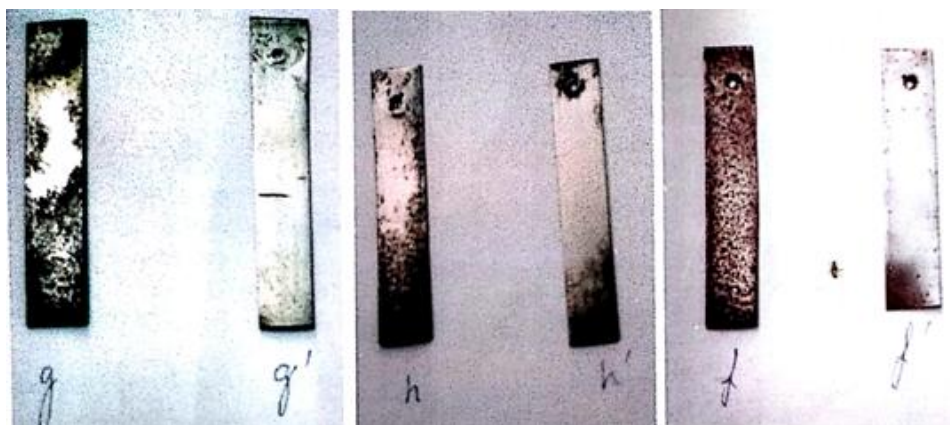
Corrosion due to:
g- Jamun wood exalation
g'- Jamun wood exalation + Anthraquinone
h- Kathal wood exalation
h'- Kathal wood exalation + Anthraquinone
f- Mango wood exalation
f'- Mango wood exalation + Anthraquinone

Photo No. 4: Inhibitive effect of Anthraquinone on corrosion due to different woods exhalation

Table 1: Protective effect of Anthraquinone on corrosion Due to vapors emitted by Kathal wood

S. No.	Time in months	80% RH		100% RH	
		Wt loss (mg/dm^2)	% protection	Wt loss (mg/dm^2)	% protection
1	1	7.30	79	5.00	84
2	2	10.50	81	12.20	72
3	4	15.70	79	14.70	73
4	6	22.00	84	16.20	76

Table 2: Protective effect of Anthraquinone on corrosion due to vapors emitted by Mango wood

S. No.	Time in months	80% RH		100% RH	
		Wt loss (mg/dm^2)	% protection	Wt loss (mg/dm^2)	% protection
1	1	1.20	97	8.4	66
2	2	2.00	97	12.50	60
3	4	12.20	88	14.00	70
4	6	24.4	79	20.00	60

Table 3: Protective effect of Anthraquinone on corrosion due to vapors emitted by Jamun wood

S. No.	Time in months	80% RH		100% RH	
		Wt loss (mg/dm^2)	% protection	Wt loss (mg/dm^2)	% protection
1	1	7.00	79	11.20	46
2	2	12.20	76	15.20	45
3	4	12.20	86	24.60	44
4	6	24.4	83	34.20	44

3. Results and Discussion

It is clear from the table 1 and photos no.4 dipicted protective effect of Anthraquinone on mild steel corrosion due to vapors emitted by Kathal wood at 80%RH and 100%RH, during periods of one month to six months. Results shows that Athraquinone protected mild by 72% to 84% at both the humidities (80%RH and 100%RH) and during entire ranged of exposure time (one months to six months). At 80% RH the percentage protection was approx 80% and weight loss obtained increased from 7.3 mg/dm^2 to 22.00 mg/dm^2 during a periods of one months to six months. At 100% RH the percentage protection was 84% during one months which reduced to approximately 75% during two to six months. Wt loss increased from 5.00 mg/dm^2 to 16.2 mg/dm^2 during a period of one months to six months in photo 4(h) shows the corrosive effect of vapors emitted by kathal wood and panel (h′) shows its protection by Anthraquinone.

Table No 2 photo 4, depict protective effect of Anthraquinone on mild steel corrosion due vapors emitted by mango wood at 80%RH and 100%RH during a periods of one months to six months. Results shows that Anthroquinone is good corrosion inhibitor for the corrosion of mild steel due vapors emitted by mango woods at 80%RH.It afforded 80% to 97% protection.The percentage

protection decreased with increased exposure time being 97% during one and two months,88% during four months and 79% during six months, Anthraquinone is not so effective at 100% RH; the percentage protection ranged between 60% to 70% being 66% during one months and 60% during six months .The wt loss obtained at longer exposure time four months and six months was of the same order at both the humidities being approximately effect of mango wood exhalents and (f) panel (f′) shows the protection afforded by Anthraquinone.

Table No 3 photo 4, depict protective effect of Anthraquinone on mild steel corrosion due vapors emitted by Jamun wood at 80%RH and 100%RH during a periods of one months to six months. Results shows that Anthroquinone is good corrosion inhibitor for the corrosion of mild steel due vapors emitted by Jamun woods at 80%RH.It afforded 76% to 86% protection. During one months protection afforded was79% and during six months protection afforded was 83%.The weight loss ranged from 7.00 mg/dm^2 to 24.40 mg/dm^2 during a periods of one months to six months.the percentage protection afforded at 100% RH was very poor, It wasthe order of 55%.Wt loss increased from 11.20 mg/dm^2 to34.20 mg/dm^2 during a periods of one months to six months. In photo to no.4 (g) shows the corrosive effect of Jamun Wood and (g′) shows the protective effect of Anthraquinone.

4. 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 carried out by using meta dinitrobenzene, anthraquinone, Investigation shows that VCI provides very effective corrosion protection processes for the mild steel materials such as boilers and feeders and small electrical & electronics instruments. VCl can apply in the powder, vapors and wrappers to protect the material at manufacturing level up to the marks.

It is confirmed that VCI provides protection to the metal located at few centimeters from the VCI source. As put inside the dessicators. Most of the packaging woods are used along with VCI pouches. As per to the testing data. VCI is compatible. VCI can also lower the corrosion rate.

5. Acknowledgement

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