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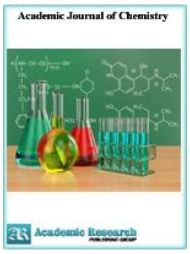

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Corrosion in Mild Steel Prevention by Vapor Phase Process as Plasma Impulse (Anthracene Metadinitro Benzene and Naphthalein)

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Abstract: It is the process of prevention of corrosion of mild steel from vapors emitted by packing woods. It was observed that the passive film on mild steel surface has been presented. The passive film is stabilized by continued exposure to the passivating environment The vapor of anthrocene and naphthalene some other related substances are deposited over the surface of mild steel .This is vapours phase process damage of various electronic equipments due to corrosion small assemblies and big boilers are corroded coating is affected but a very small range big range of protection is only vapour phase process like diposition of plasma material at the surface of mild steel these are vapour emitting substance reach where coating is not possible plasma pulse are important in growth of thin film over the surface.

Keywords: Mild steel; Anthrocene; Naphthalene; Meta dinitrobenzene; Vapour phase process.

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. As more as corrosion product is formed, 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 (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 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.

A method for the difficult but positive detection of iron oxide on the surface of iron phosphatized surfaces and other phosphatized surfaces and industrial cleaning of cold rolled steel prior to coating should be developed.

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 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. 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/cm^2 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]. On the basis of plasma polymerizations is an inexpensive processing route. Electron Microscope (SEM).

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1.1. 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.

1.2. 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.

1.3. 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 applications.

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.

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 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/dm^2 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 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
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.

$$I = \frac{Wu - Wi}{Wu} \times 100$$

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 experiments inside sealed desiccators and for visual inspection, we took photographs of corroded and protected panels.

Table-1. Protection of mild steel due to Anthracene for different time durations at different RH.

S.No.	Time (Days)	100% RH		80% RH		60% RH	
		wt loss (mg/dm^2)	Protection %	wt loss (mg/dm^2)	Protection %	wt loss (mg/dm^2)	Protection %
1	15	0.0	100	2.9	83	1.7	85
2	30	0.0	100	4.3	84	3.0	77
3	45	7.0	77	8.0	79	8.0	79
4	60	8.0	79	10.4	78	10.0	79

Fig-1.

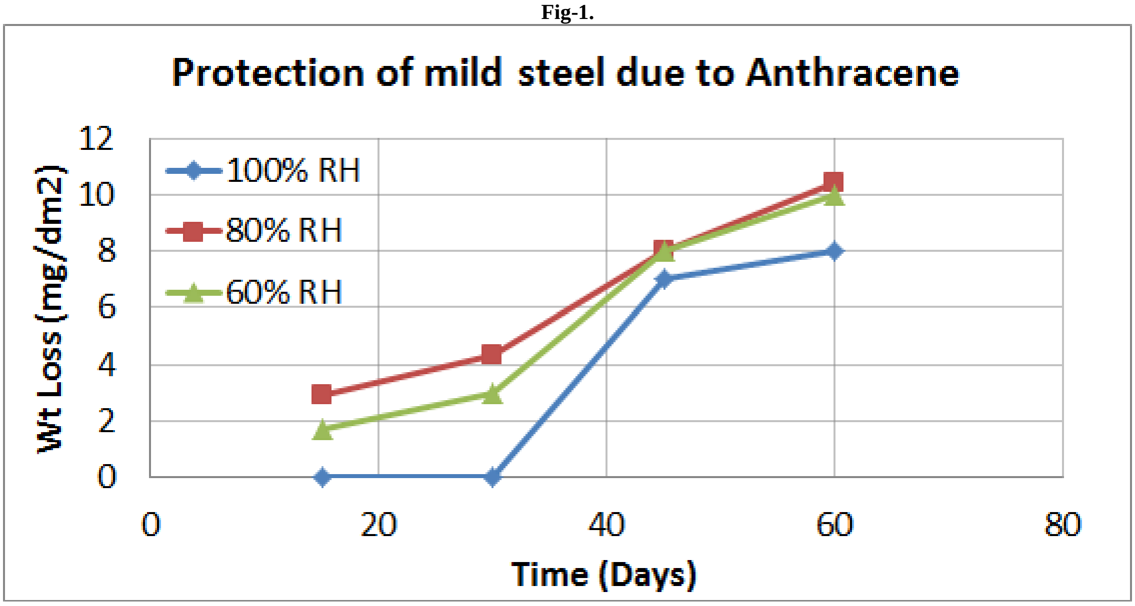

Fig-2.

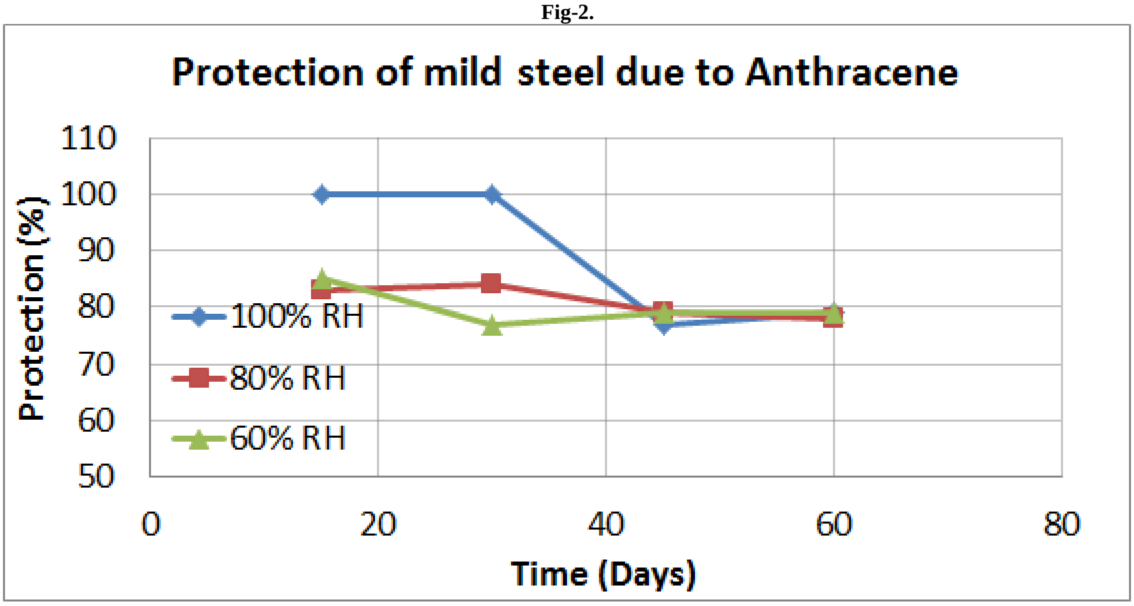

Table-2. Protection of mild steel due to Naphthalene for different time durations at different RH.

S.No.	Time (Days)	100% RH		80% RH		60% RH	
		wt loss (mg/dm^2)	Protection %	wt loss (mg/dm^2)	Protection %	wt loss (mg/dm^2)	Protection %
1	15	1.7	88	0.0	100	5.0	55
2	30	6.0	72	4.1	85	5.5	57
3	45	11.9	60	11.9	69	8.0	71
4	60	16.0	58	19.7	58	11.0	65

Fig-3.

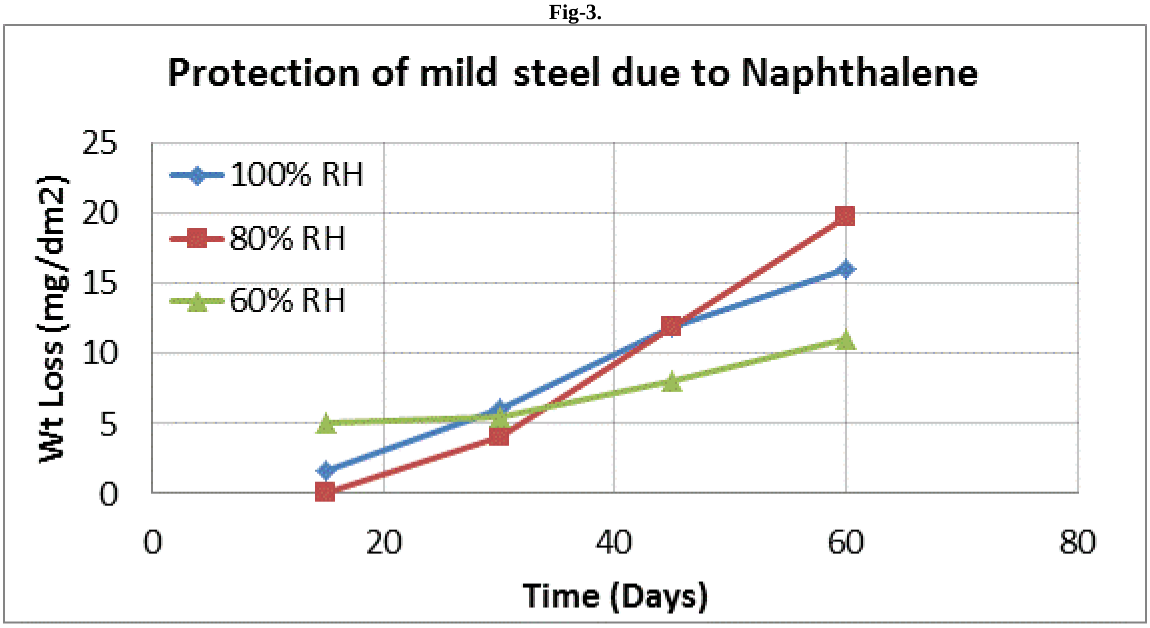

Fig-4.

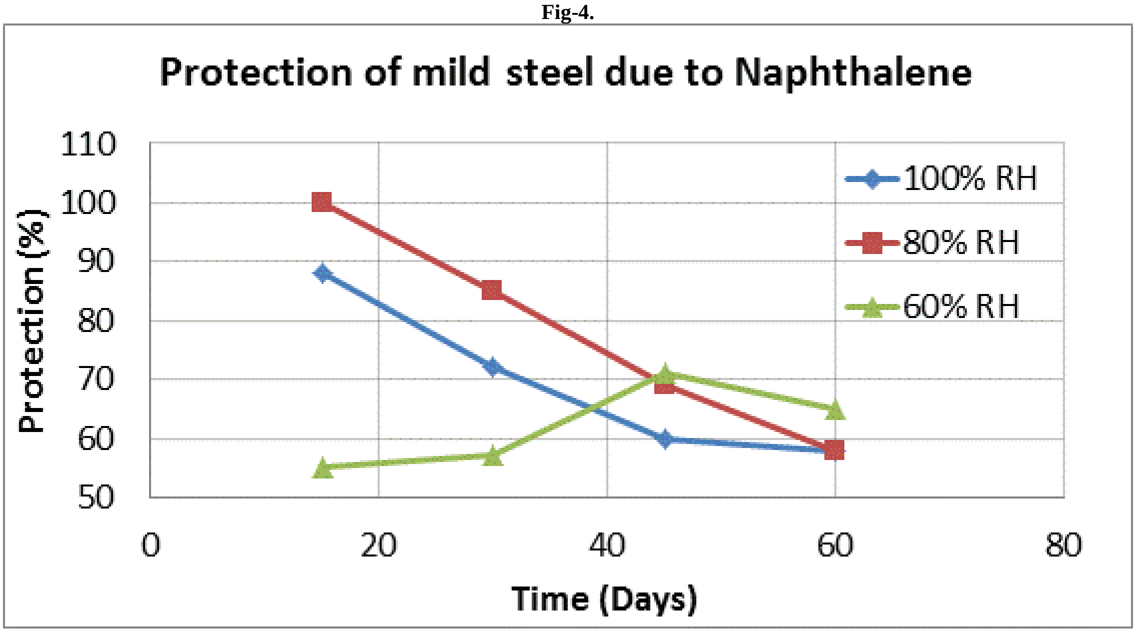

Table-3. Protective effect of m-dinitrobenzene on corrosion due to vapours emitted by Kathal wood.

S.No.	Time (months)	80% RH		100% RH	
		wt loss (mg / dm^2)	Protection %	wt loss (mg / dm^2)	Protection %
1	1	2.4	95	7.3	77
2	2	14.4	74	9.7	78
3	4	28.0	62	19.5	65
4	6	30.0	79	24.4	64

Fig-5.

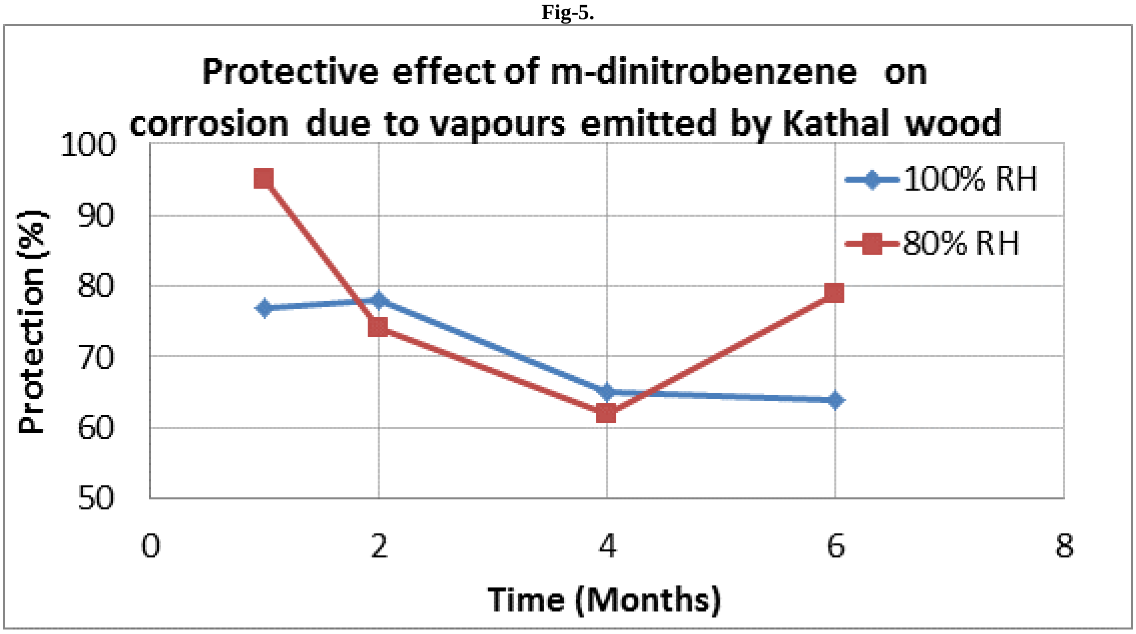

Fig-6.

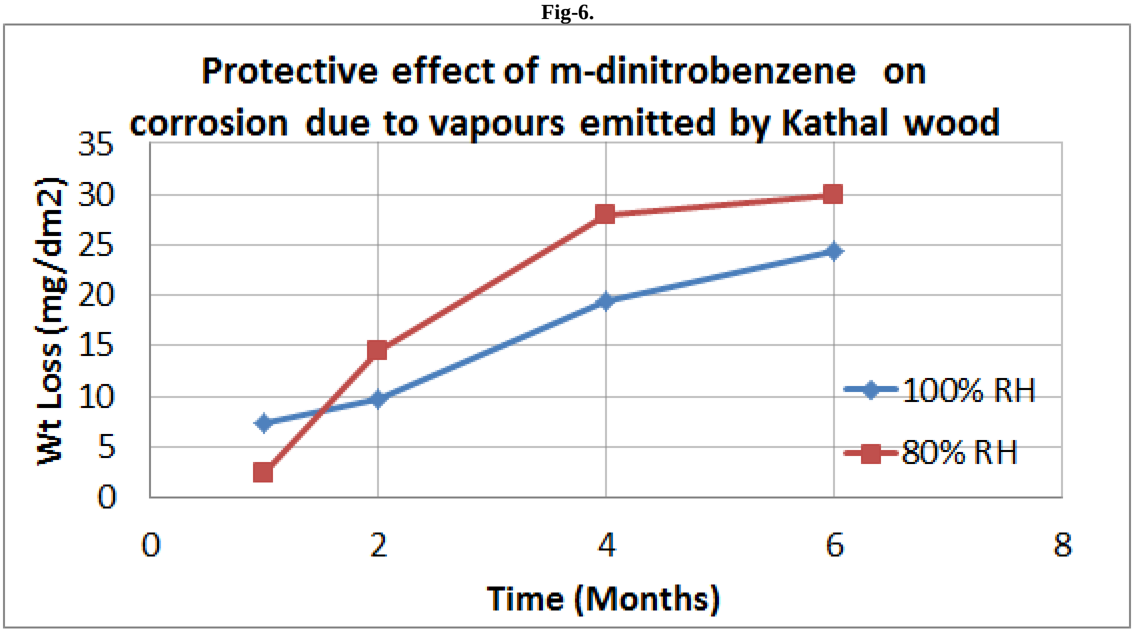

Table-4. Percentage protection afforded by m-dinitrobenzene and Anthraquinone on corrosion of mild steel by acetic acid vapours (0.001%) at different RH.

S.No.	Time (months)	m-dinitrobenzene inhibitor				Anthraquinone Inhibitor			
		80% RH		100% RH		80% RH		100% RH	
		wt loss (mg/dm^2)	Protection %	wt loss (mg/dm^2)	Protection %	wt loss (mg/dm^2)	Protection %	wt loss (mg/dm^2)	Protection %
1	1	9.0	97	22.4	95	7.0	97	21.2	96
2	2	16.2	97	25.2	96	15.2	96	26.8	96
3	4	20.2	98	33.4	97	18.2	98	29.6	97
4	6	30.1	99	54.1	98	25.2	99	55.0	99

Fig-7.

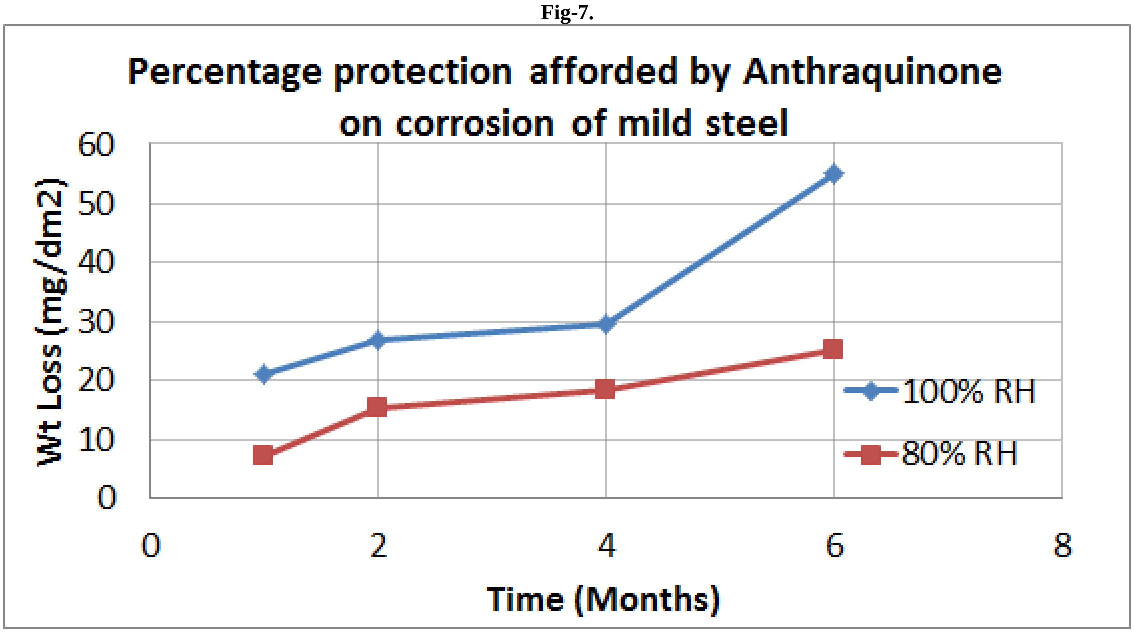

Fig-8.

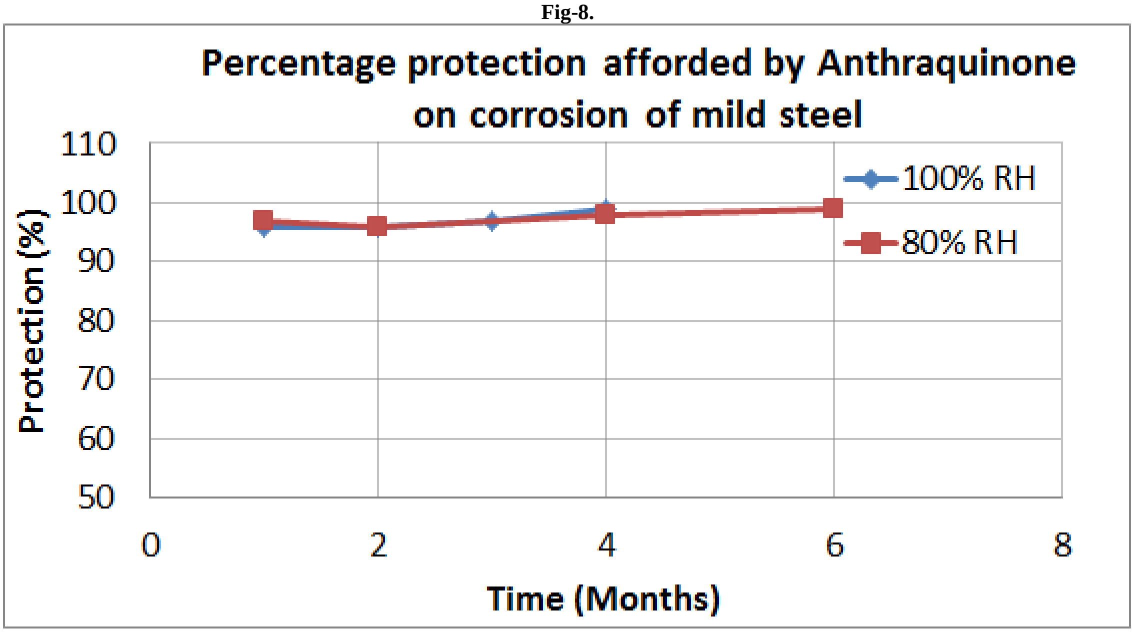

Table-5.

S.N.	Experimental Condition	Thickness	Average deposition
1	13Pa, 50 plasma pulses	32.78	0.66
2	13Pa, 100 plasma pulses	98.80	0.99
3	27Pa, 50 plasma pulses	88.64	1.77
4	27Pa, 100 plasma pulses	157.5	1.57
5	40Pa, 50 plasma pulses	236.4	4.72
6	40Pa, 100 plasma pulses	314.7	3.15

3. Results and Discussion

3.1. Meta Dinitrobenzene

Table.3, Fig.5 & Fig.6 depict the protective performance of m-dinitrobenzene for mild steel corrosion at different RH (100% RH to 60% RH) for time durations of 15 days to 60 days. Results show that m-dinitrobenzene appears to be a very good volatile corrosion inhibitor for mild steel at 100% RH. In shorter durations (up to 30 days) it afforded complete protection and panels were completely rust free. In 45 days the percentage protection obtained was 95% and the weight loss was 1.4 mg/dm^2. When mild steel was exposed for 60 days, the percentage protection decrease to 86% and weigh loss increased to 52 mg/dm^2. At 80% RH, the inhibitor efficiency was less than that at 100% RH. Percentage protection obtained during 15 days was 87% and during 60 days it was 77%. The weight loss increased from 2.4 mg/dm^2 to 11.0 mg/dm^2 during a period of 15 days to 60 days. At 60% RH, the inhibitor efficiency was 91% during 15 days, which gradually reduced with increased exposure time and was 71% during 60 days. Thus it shows that under aggressive conditions inhibitor efficiency of m-dinitrobenzene was between 75% to 100%.

3.2. Naphthalene

Table.2, Fig.3 & Fig.4 depicts the protective performance of Naphthalene for mild steel corrosion at different RH (100%RH to 60% RH) for time durations of 15 days to 60 days. Results show that the inhibitor efficiency obtained at 80% RH was better than that at 100% RH. Weight loss obtained during 15 days to 30 days was also less at 80% RH than that at 100% RH, although the weight loss in uninhibited system was greater as 80%RH than that at 100% RH. In shorter durations, during a period of 30 days, the protective performance was 85% and above at 80% RH, 72% and above at 100% RH and approx 55% at 60% RH. The inhibitor efficiency obtained was not so good during longer exposure time i.e. 45 days to 60 days. It was between 58% to 70% at all humidities. protection was 78% in 15 days and 61% at 60 days. The weight loss obtained increased from 2.4 mg/dm^2 at 15 days to 12.0 mg/dm^2 at 60 days.

3.3. Anthracene

Table.1, Fig.1 & Fig.2 depict the protective performance of Anthracene for mild steel corrosion at different RH (100% RH to 60% RH) for time durations of 15 days to 60 days. Results show that at 100% RH inhibitor completely protected mild steel corrosion up to 30 days. There was no rust spot on the panels. The inhibitor efficiency reduced to 77% and 79% during 45 days and 60 days respectively. The weight loss obtained was 7.0 mg/dm^2 during 45 days ant 18.0 mg/dm^2 during 60 days. At 80% RH percentage protection obtained was 83% and 84% during 15 days and 30 days respectively which reduced to 79% and 78% during 45 days and 60 days respectively. The weight loss obtained ranged between 2.9 mg/dm^2 to 10.4 mg/dm^2 during 15 days to 60 days. At 60% RH, the percentage protection ranged from 85% to 79% and weight loss ranged between 1.7 mg/dm^2 to 10.0 mg/dm^2 during the exposure time 15 days to 60 days. Couple of Anthraquinone and metadinitrobenzene. Combined protection of mild steel by both the VCI has been exposed in Table.4, Fig.7 & Fig.8. Depicted that the use of couple VCI is very protecting agent for the mild steel due to corrosion emitted by acid vapors. Particularly by the acetic acid and formic acid. The deposition of material on the surface of mild steel is discussed in the data given in table. Pascle deposition over the surface in measurement discussed in given Table.5.

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, naphthaline and anthracene of metal and inhibitor molecules these are more effective.

Investigation shows that VCI provides very effective corrosion protection processes for the mild steel materials such as boilers and feeders. VCl can apply in the powder form at the time of manufacturing of mild steel equipments.

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

As per to the testing data. VCI is compatible. VCI can also lower the corrosion rate.

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

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