An Investigation of Usage Eco-friendly Corrosion Inhibitor in Acidic Environment

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Abstract

Corrosion is a major concern in the industrial application of ferrous alloys, this is as a result of the enormous cost involved in damages, maintenance and corrosion control. Stainless steels have high corrosion resistance capacity because of the existence of chromium, as a result of the high cost of traditional corrosion inhibitor, science turned to green corrosion inhibitor to try to compensate for it. In this regard we used a lot Cactus oil in acidic media (H_2So_4 –Hcl) for 4 sample, Variable rates and varying periods of time it was found that the corrosion rate decreases and the best result is a corrosion rate of 0.0001 iron within Hcl in 72 hr ,H_2So_4) within 72 hr.

Keywords: Corrosion inhibitor, Cactus oil, corrosion rate, Hcl, H_2So_4.

1. Introduction

Almost all metals and alloys are unstable in the Earth's atmosphere and therefore susceptible to corrosion. Corrosion deterioration of metallic alloys by chemical interaction with their environments is one of the major sources of industry overhead costs because of maintenance and repair of damaged and worn-out equipment and parts. In general, a good portion of the loss can be avoided by proper corrosion control and monitoring. One of the best methods to reduce the rate of metallic corrosion is by the addition of inhibitors in which even small concentrations can result in decrease of the corrosion rate of metallic surface [1- 6]. However, there are conditions aiding the selection of a suitable inhibitor substance. These include, the cost and amount of the inhibitor required, long term toxicological effects on the environment, the inhibitors' ability to treat the corroded surfaces, the inhibitor's availability and stability in the environments. In various industries, mild steel has been used extensively as a building material owing to its cost effectiveness, and high mechanical strength [1, 2]. Although, through electrochemical and chemical reactions it has been very reactive with the environmental constituents and hence, component metal loss arises as a result of corrosion. Corrosion occurs as a result of cross section losses, having lower ductility, ultimate strength and yield strength. It decreases the life span of structures resulting into structural vulnerability leading to structural failure [1]. Various efforts have been previously carried out to reduce unfavorable reactions mostly through frequently occurring industrial developments such as acid pickling, acid descaling, and acid cleaning etc. of which the utilization of corrosion inhibitors is one of the best methods [3]. Globally, corrosion problems mostly occurs in industries as a result of service and environmental conditions. Corrosion might not have immediate negative effect on the material but it affect the physical appearance, mechanical behavior and strength resulting into significant operational complications [4]. In industries, acidic solutions are largely used for acidizing, de-scaling, chemical cleaning and acid pickling for steel, the most frequently used is hydrochloric acid. Naturally, these occur in corrosive environment resulting into intense corrosion complications experienced in industrial processes. Acid corrosion inhibitors was applied extensively to minimize or prevent loss of material associated with the acid [5]. Mild steel is frequently used as a raw material for construction of pipelines, buildings and bridges [6], its pre-mature failure and deterioration has resulted into a gross expenditure of several billions of dollars globally [7]. Since mild steel is an essential part of infrastructural facilities which includes pipelines, port facilities and bridges, these cost expenditure include replacement, maintenance and loss of productivity. The use of paint coatings has been applied to create a protective barrier. The use of pigments inhibiting corrosion is an essential constituent in paints. Over time, these pigments percolate from the coatings thereby inhibiting the concealed metal substrate, which breaks particularly in paint coating [8]. The most efficient pigment inhibiting corrosion used for different alloys and metals, e.g. mild steel, has compounds of metal chromates in its oxidation state (Cr^{+6}) [6] for example strontium chromate. Chromate compounds behaves in a method of either reducing or blocking both cathodic and anodic rate of reaction. In addition, (Cr^{+6}) has been reported as an occupational carcinogen related to sinus, naser and lung cancer [2]. In recent decades, various alternative inhibitors have been considered as substitutes for chromates, including metallic ions (rare earth metals and zinc), oxyanions (phosphates, molybdates and nitrates) and organic compounds (carboxylates). All have demonstrated some extent of inhibition effectiveness [8]. Mild steel corrosion by atmospheric conditions is a broad topic that have been researched by different authors. Various researchers have reviewed the corrosion process. A huge quantity of these information is obtainable on mild steel by atmospheric corrosion at mid and short term .Various studies have been conducted on the use of organic corrosion inhibitors, it has frequently been applied in various control measures such as its effectiveness to impede corrosion of mild steel in seawater .Usually, the use of inhibitors as a preventive mechanism against corrosion is principally attributed to inhibitor molecular adsorption which result to surface modification of the mild steel and formation of subsequent protective laye. Several kinds of inhibitors has been utilized as an effective means of inhibiting corrosion in various electrolytic media for mild steels. These media include sea water, hydrochloric and sulfuric acid concentrations. This manuscript reviews corrosion inhibitors as building evidence for Mild Steel [7].

2-Materials and Methods

2.1. Materials

At this stage, small square iron pieces of standard known dimensions are used as shown in the Figure (1.1). They are prepared before use so that they have equal polished faces for all samples to give close results that were placed in different corrosive environments.

They are placed on a sensitive scale to measure their weight as shown in Figure (1.2), and then placed in clean flasks containing acid solutions to measure their weight before and after corrosion over a period of three days, and then measure their weight after adding green oils to these solutions.

Figure (1.1) showing the samples

Preparation of solutions and samples 2.3

To carry out these experiments, we prepare a set of clean flasks of a known size, as well as an amount of Hcl - H_2so_4 known focus . We have selected about 8 fine and evenly polished iron parts samples. The length and width are approximately 2 cm. Then calculated the weight using a sensitive scale. The weights were as follows:

wg	**NO**
9	**1**
9	**2**
9	**3**
9	**4**
9	**5**
9	**6**
9	**7**
9	**8**

Put these samples in clean flasks and we also used 4Hcl -type acid flasks Samples (1-4) and . were placed Four more flasks containing H_2so_4 (5-8)

3.Experimental procedure

This experiment is simple, effective, and reliable to determine the desired value which represents the intensity of corrosion that is already occurred upon the corroded metal , it is as follows :-

The sample is polished and pre-weighed mild iron specimens were immersed in 1000ml Hcl with and without watercress as corrosion inhibitor corrosion inhibitor was supplied from almadena company by different concentration 2 ml , 4 ml , 6 ml immersion time was varied from 24, 48, 72, h. The corrosion rate was measured by weight loss The samples are taken out at end of time, then cleaned with acetone and its weight is calculated by the sensitive balance.

Calculation corrosion rate(CR)

$$C.R = \Delta w / At$$

$\Delta w = w_f - w_i$

Effect of time

The effect time was studied for different times (24 , 48 , 72 hr) in presence and absence corrosion inhibition

Table.1. shows the C.R without corrosion inhibitor in Cl

Sample no	Time hr	C R g/$cm^{2.}$.h	Time hr	C R g/$cm^{2.}$.h	Time hr	C R g/$cm^{2.}$.h
1	24	0.004	48	0.0006	72	0.002
2	24	0.007	48	0.0005	72	0.001
3	24	0.006	48	0.0005	72	0.00007
4	24	0.004	48	0.0006	72	0.0002

Table.2. effect of 2 ml of *Cactus oil*

Sample no	Time hr	C R g/$cm^{2.}$.h	Time hr	C R g/$cm^{2.}$.h	Time hr	C R g/$cm^{2.}$.h
1	24	0.001	48	0.0001	72	0.00001
2	24	0.0002	48	0.0003	72	0.00003
3	24	0.001	48	0.0002	72	0.0003
4	24	0.001	48	0.001	72	0.0001

Table.3. effect of 4ml of *Cactus oil*

Sample no	Time hr	C R g/$cm^{2.}$.h	Time hr	C R g/$cm^{2.}$.h	Time hr	C R g/$cm^{2.}$.h
1	24	0.0006	48	0.0001	72	0.00002
2	24	0.0001	48	0.00004	72	0.0001
3	24	0.0002	48	0.0002	72	0.0001
4	24	0.001	48	0.0001	72	0.0002

Table.4.effect of 6ml of *Cactus oil*

Sample no	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h
1	24	0.0003	48	0.0002	72	0.0002
2	24	0.0004	48	0.0001	72	0.0001
3	24	0.001	48	0.0002	72	0.0001
4	24	0.0004	48	0.0003	72	0.0001

Table 5 shows the C.R without corrosion inhibitor in H_2SO_4

Sample no	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h
5	24	0.004	48	0.0005	72	0.001
6	24	0.008	48	0.0004	72	0.001
7	24	0.011	48	0.001	72	0.0002
8	24	0.001	48	0.001	72	0.004

Effect of concentration of *Cactus oil*

Table 6 . effect of 2 ml of *Cactus oil*

Sample no	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h
5	24	0.00077	48	0.00071	72	0.00163
6	24	0.00131	48	0.00091	72	0.00131
7	24	0.0010	48	0.0013	72	0.00196
8	24	0.00167	48	0.00054	72	0.00128

Table 7 . effect of 4 ml of *Cactus oil*

Sample no	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h	Time hr	C R g/cm$^{2.}$.h
5	24	0.000656	48	0.00042	72	0.00196
6	24	0.000145	48	0.0021	72	0.00019
7	24	0.000968	48	0.00081	72	0.00127
8	24	0.00164	48	0.00053	72	0.00018

Table 8. effect of 6 ml of *Cactus oil*

Sample no	Time hr	C R g/cm$^{2\cdot}$.h	Time hr	C R g/cm$^{2\cdot}$.h	Time hr	C R g/cm$^{2\cdot}$.h
5	24	0.000937	48	0.000937	72	0.000146
6	24	0.0021	48	0.00208	72	0.000114
7	24	0.00118	48	0.00118	72	0.00173
8	24	0.00145	48	0.00145	72	0.00041

Result &Discussion

By Looking at the previous results, we find that the corrosion rates in (HCL) without corrosion inhibitor are greater than after adding the inhibitor, so we find that the highest corrosion rate in 24 hours without corrosion was for the sample 3 0.007 gm/cm$^{2\cdot}$.h and after adding 2ml inhibitor it was for the sample 1 0.001 gm/cm$^{2\cdot}$.h .In 48 hr, the highest corrosion rate was 0.006 gm/cm$^{2\cdot}$.h for sample 4 and after the inhibitor it became 0.001 gm/cm$^{2\cdot}$.h for sample 4. After 72 hr it was 0.002 gm/cm$^{2\cdot}$.h for sample 1 and after they added the inhibitor 0.0001 gm/cm$^{2\cdot}$.h . In the same way when changing the concentration of corrosion inhibitor to 4ml and 6ml , we find that the highest corrosion value when adding 4 ml was 0.001 gm/cm$^{2\cdot}$.h at 24 hours for sample 4 and 0.0001 gm/cm$^{2\cdot}$.h for sample 4 at 48 hr 0.0001 gm/cm$^{2\cdot}$.h for sample 2 at 72 hr and for 6ml was0.001 gm/cm$^{2\cdot}$.h for sample3
In 24 hr and 0.0002 gm/cm$^{2\cdot}$.h for sample 2 and 0.0001 gm/cm$^{2\cdot}$.h in72 hr.

By Looking at the previous results, we find that the corrosion rates in (H_2SO_4) without corrosion inhibitor are greater than after adding the inhibitor, so we find that the highest corrosion rate in 24 hours without corrosion was for the sample 7 0.011 gm/cm$^{2\cdot}$.h and after adding 2ml inhibitor it was for the sample 8 0.00117 gm/cm$^{2\cdot}$.h .In 48 hr the highest corrosion rate was 0.001 gm/cm$^{2\cdot}$.h for sample 7 and after the inhibitor it became 0.00013 gm/cm$^{2\cdot}$.h for sample 7. After 72 hr it was 0.001 gm/cm$^{2\cdot}$.h for sample 6 and after they added the inhibitor 0.00019 gm/cm$^{2\cdot}$.h for sample 6 . In the same way when changing the concentration of corrosion inhibitor to 4ml and 6ml , we find that the highest corrosion value when adding 4 ml was 0.00104 gm/cm$^{2\cdot}$.h at 24 hr for sample 8 and 0.00164 gm/cm$^{2\cdot}$.h for sample 6 at 48 hr 0.00196 gm/cm$^{2\cdot}$.h for sample 5 at 72 hr and for 6ml was 0.00108 gm/cm$^{2\cdot}$.h for sample 6 in 24 hr and 0.00158 gm/cm$^{2\cdot}$.h for sample 7 and 0.00173 gm/cm$^{2\cdot}$.h in72 hr for sample 7.

Conclusions

- At the end of the study we find the following: -
- 1.*Cactus* oil can used as Corrosion Inhibitor in 10M(Hcl –H_2so_4) .
- 2- After using the corrosion inhibitor, we find that the corrosion rate decreases with the passage of time and the concentration of the corrosion inhibitor increases
- 3.The highest value for corrosion rate in Hcl was 0.001 $gm/cm^2.h$ after adding 4ml from inhibitor obtained in absences of corrosion inhibitor in 24 hr.
- 4.The highest value for corrosion rate in H_2so_4 was 0.0117 $gm/cm^2.h$ after adding 2ml from inhibitor obtained in absences of corrosion inhibitor in 24 hr.
- 5.The lowest value for corrosion rate in Hcl was 0.0002 $gm/cm^2.h$ after adding 6ml from inhibitor obtained in absences of corrosion inhibitor in 72 hr.
- 5.The lowest value for corrosion rate in H_2so_4 was 0.000146 $gm/cm^2.h$ after adding 6ml from inhibitor obtained in absences of corrosion inhibitor in 72 hr.

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