

Inhibition Efficiency of Vitamin B1 and Ascorbic Acid for Iron B500 in Acidic Media

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Abstract -Vitamin B1 and ascorbic acid are used as corrosion inhibitor for mild steel in acidic media. The corrosion inhibition of iron B500 in 1M H₂SO₄ by vitamin B1 and ascorbic acid has been studied by using weight loss method with different concentration of vitamin B1 and ascorbic acid. The results showed that the rate of corrosion mitigate from 0.203 mm/year in blanc solution in 0.00385 mm/year in presence of 1g/L inhibitor ascorbic acid and in 0.002419 mm/year in presence of 1g/L inhibitor vitamin B1. The weight loss measurements showed that inhibition efficiency for vitamin B1 was 98.81% and 98.09% for ascorbic acid. Vitamin B1 and ascorbic acid are good as green and non-toxic inhibitor for mild steel corrosion in acidic environments.

Key words: Ascorbic acid, vitamin B1, mild steel, weight loss method

1. Introduction

Low carbon steel is one of the most materials used in industry due to the structural and mechanical properties. Corrosion of low carbon steel in acidic media is a complex problem, too. Corrosion inhibitors are widely used to control low carbon steel corrosion in acidic media.

Used of organic corrosion inhibitors non-toxic and cheap to inhibit the corrosion of steel in acidic media is an effective choice. Many researches studies have reported that organic compounds having heteroatoms with high electron density such as P, S, N, O or those containing multiple bonds are effective inhibitors for the corrosion of metals [1]. The interest on vitamins as eco-friendly corrosion inhibitors have been increasing due to the low cost and simple preparation [2][3].

Two vitamins B1 and C (ascorbic acid) have various therapeutic effects and good solubility in acidic solution. The presence of π electrons as well as O, S, and N atoms in the molecular structure of vitamin B1 and C (ascorbic acid) is expected to cause an easier electron transfer from the functional groups to the mild steel surface which provides greater adsorption ability and inhibitory efficiency. In the other side, the large size and high molecular weight of vitamin B1 molecule could also contribute to its inhibitory efficiency [4], [5].

In this study, we have recently focused on the inhibitory efficiencies of vitamin B1 and ascorbic acid, which are not toxic. The anti-corrosion performance of vitamin B1 and ascorbic acid was evaluated by weight loss method.

2. Experimental

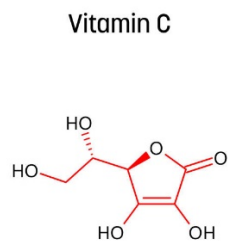
The material under investigation is iron B500, manufactured in Elbasan, which has the following composition:

Table 1: Composition of low alloy carbon steel tested

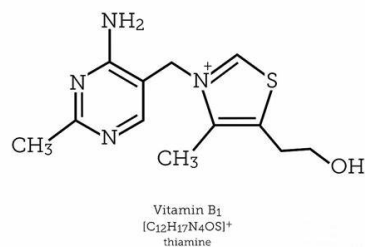
Elements %	C	Si	Mn	Cr	Ni	Cu	P	S
Iron B500	0.224	0.152	0.68	0.110	0.102	0.318	0.021	0.027

2.1 The environment

The environment in which we worked was 1M H₂SO₄ for iron B500. Corrosive solutions (Blank) were prepared from 96% sulfuric acid. The inhibitors used are vitamin B1 and ascorbic acid. The concentrations used are: 0.25 g/L; 0.5 g/L; 0.75 g/L; 1 g/L.



Ascorbic acid



Vitamin B1

Fig. 1. The structure of ascorbic acid and vitamin B1

2.3 Weight loss measurements

For weight loss studies the samples were prepared by cutting of them from a steel bar. Cylindrical samples of iron B500 were prepared on a lathe, with a length of 38 ± 4 mm and a diameter of 7 ± 1 mm. On the top of them we drilled a hole with a diameter of 3 mm as shown in Figure 2.



Fig. 2: Preparing of the sample for the weight loss measurements

The samples were then polished using different grades of abrasive paper from 200 up to 1200, washed with distilled water, degreased with acetone and dried before immersing them into the test solution. The experiment was carried out in a closed glass vessel using a pure of stream of nitrogen inside the solution. The sample were immersed in 1M H₂SO₄ for 24 hours at room temperature with absence and presence of different concentration of vitamin B1 and acid ascorbic. The specimen was withdrawn, rinsed with distilled water, washed with acetone, dried and weighed. The cleaning of corrosion products is done in an ultrasonic bath with the solution prepared from the mixture with a ratio 1: 1 HCl and water in which we have dissolved 1g urotropin, then via distilled water and acetone for 5 minutes. For the best result the sample are weight twice.

Corrosion rate in form of mm/year for the sample is calculated from the equation [6,7]:

$$V_{(mm/vit)} = \frac{87.6 \cdot \Delta m}{d \cdot A \cdot t} \quad (1)$$

Where: Δm - the difference of weight in mg;
 d - the density in g/cm³;
 A - the surface of sample in cm²;
 t - the time of exposure of the sample in hours

The percentage of inhibition efficiency (IE %) was calculated as follows [8]:

$$\text{Inhibitor Efficiency (\%)} = [(CR_{\text{uninhibited}} - CR_{\text{inhibited}}) / CR_{\text{uninhibited}}] \times 100 \quad (2)$$

Table 2: Composition of solution for weight loss method

No.	Blank	Concentration of vitamin B1 (g/L) and ascorbic acid			
		0.25	0.5	0.75	1
1	+				
2	+	+			
3	+		+		
4	+			+	
5	+				+

3. Results and discussions

The aim of experiment was to study the corrosion rate and the percentage of inhibition efficiency of vitamin B1 and ascorbic acid.

The results of weight loss measurement in form of corrosion rate and protection efficiency in absence and different concentration of inhibitor vitamin B1 and ascorbic acid are given in table 3.

Table 3: Corrosion rate and inhibition efficiency of vitamin B1 and ascorbic acid in a H₂SO₄ solution for iron B500.

Sample	Media	Corrosion rate (mm/year)		Inhibition Efficiency (%)	
		Vit.B1	Ascorbic acid	Vit.B1	Ascorbic acid
1	Blank (1M H ₂ SO ₄)	0.002503	0.002503	0	0
2	0.25g/L	0.002939	0.043051	98.54871	78.74072
3	0.5g/L	0.0027	0.031299	98.66684	84.54399
4	0.75g/L	0.002514	0.004086	98.75872	97.98245
5	1g/L	0.002419	0.00385	98.8056	98.0987

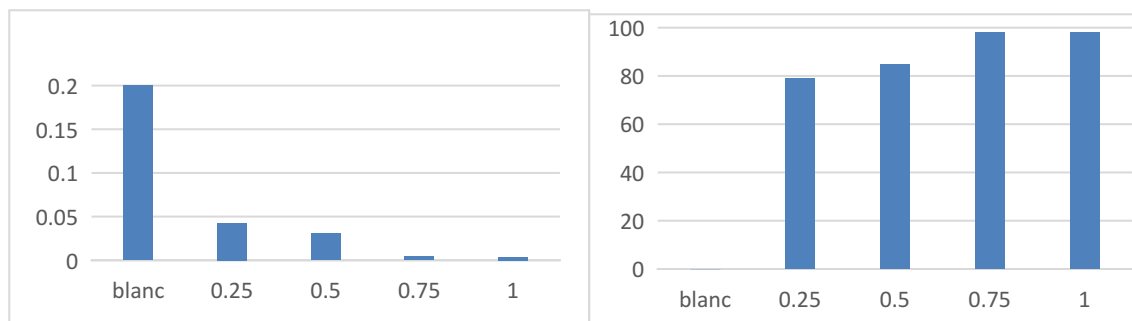


Fig. 3. Corrosion rate and inhibition efficiency in various concentration of ascorbic acid

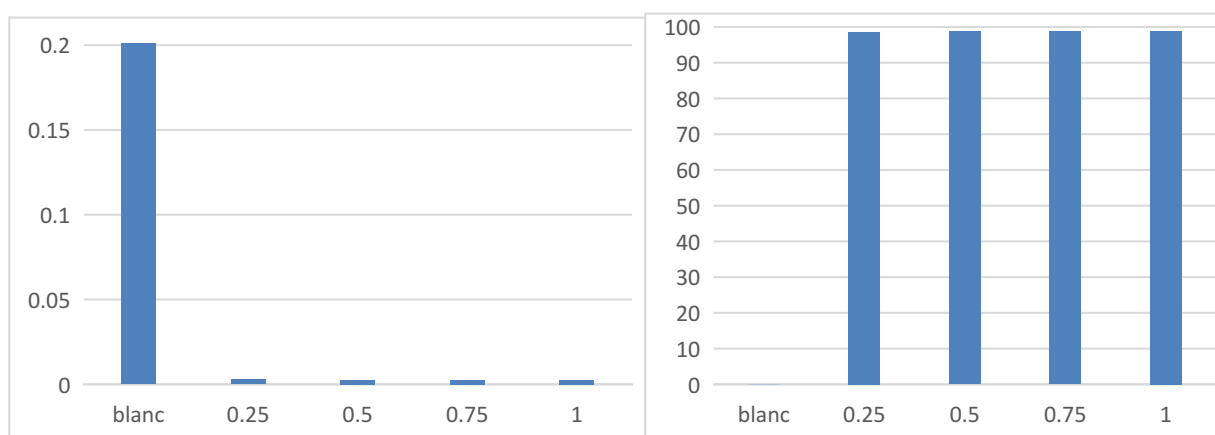


Fig. 4. Corrosion rate and inhibition efficiency in various concentration of vitamin B1

As showed the graphs in figure 3, the increase in the concentration of ascorbic acid from 0.25g/L to 1g/L resulted in decreasing of corrosion rate for iron B500 sample in acidic media. The corrosion rate is 0.203 mm/year and 0.00385 mm/year in blanc and in presence of 1 g/L ascorbic acid, respectively. So used different concentrations of ascorbic acid inhibit mild steel corrosion in a H_2SO_4 solution.

The graph in figure 3 shows the trend of the inhibition efficiency. The inhibition efficiency is 78.74% and 98.09% in presence of 0.25g/L and 1g/L ascorbic acid respectively, which showed an increasing in inhibition efficiency.

In figure 4 are shown the graphs for corrosion rate and inhibition efficiency for iron B500 in absence and in presence of different concentration of vitamin B1 as inhibitor. The graph in figure 4 clearly shows that the presence of vitamin B1 decrease significantly the corrosion rate and increase the inhibition efficiency even in small concentration. The corrosion rate decrease from 0.203 mm/year in blanc solution in 0.0024 mm/year in presence of 1 g/L vitamin B1. The inhibition efficiency is 98.806% in presence of 1g/L inhibitor vitamin B1.

The presence of oxygen, sulphur and nitrogen atoms, and many π electrons, on both vitamin B and C molecules, which are conducive to producing a passivation layer on the metal surface through active sites, improve the adsorption capacity and inhibition effect. With the increase of vitamin concentration, the polar group of the vitamin molecules was more strongly adsorbed on the steel surface. For both inhibitors the inhibition efficiency is increasing when the higher concentration of the extract was used [1], [9], [10]. The inhibition efficiencies at 1 g/L for vitamin B1 and ascorbic acid are almost same which indicate that these vitamins can effectively prevent mild steel from dissolving in 1M H_2SO_4 medium probably through their adsorption on the mild steel surfaces [11].

4. Conclusion

Vitamin B1 and ascorbic acid can be used as corrosion inhibitors for mild steel in 1M H₂SO₄ solution. The higher concentration of inhibitors is the lower corrosion rate and the higher corrosion inhibition efficiency.

Weight loss experiment shows that maximum inhibition efficiency is 98.81% in presence 1g/L vitamin B1 and 98.09% in presence of 1g/L ascorbic acid.

The results showed that the vitamin B1 and the ascorbic acid have same effectiveness in preventing corrosion of mild steel in 1M H₂SO₄ acid solution.

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