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PROTECTION OF ALUMINIUM, MILD STEEL AND CARBON STEEL IN 3 M SULFURIC ACID MEDIUM BY ACETAMINOPHEN: HETEROCYCLIC COMPOUND AS ANTICORROSION AGENT

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Abstract: The corrosion inhibition effect of heterocyclic compound (Acetaminophen) on aluminium, mild steel and carbon steel in 3 M sulfuric acid (H_2SO_4) medium was examined through gasometric and weight loss technique. The results show that, the metal corrosion rate (aluminium, mild steel and carbon steel) was greatly decreased with a rise in the Acetaminophen concentrations. The increase in the solution temperature leads to slightly decrease the protection efficiency of the Acetaminophen. The slight deviation observed in the gasometric and weight loss results. The different technique and condition is the main reason for the observed deviation in the results. The Acetaminophen protects the metal from 3 M sulfuric acid system in the order of carbon steel > mild steel > aluminium.

Keywords: Acetaminophen, H_2SO_4, Gasometric, Weight loss, Corrosion rate

Introduction

Sulfuric acid mainly used in several industries for many applications. The industrial important metal such as aluminium, mild steel and copper metals widely contact with sulfuric acid solutions during several industrial operations. Hence, metals undergo corrosion. The metal corrosion can be presented by use of corrosion inhibitors. Heterocyclic compounds signify a robust class of corrosion inhibitors [i-iii]. The corrosion inhibition property of heterocyclic compounds containing electron rich elements is widely reported. The presence of N, S, P and O in the heterocyclic compounds plays very important role in the metal corrosion inhibition property [iV-Viii]. The special elements in the heterocyclic compounds play vital role in the adsorption process. The adsorption process leads to the formation of protective film on the metal surface which blocks the movement of corrosive ions towards active metal sites. Even though many heterocyclic compounds exhibit good corrosion inhibition property, their practical application is still needed [iX-X]. Hence, in this investigation, Acetaminophen drug is selected to study the corrosion inhibition property on the aluminium, mild steel and carbon in 3 M sulfuric acid system. Acetaminophen is used to treat menstrual periods, headaches, backaches and to reduce the fever. The presence of N, O and electron rich

species **[Fig. 1]** present in the Acetaminophen plays very important role in the biological reactions.

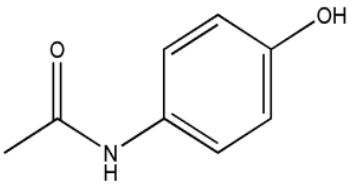

Figure 1 Acetaminophen drug used in the present investigation

The corrosion inhibition property of Acetaminophen drug on aluminium, mild steel and carbon steel in 3 M sulfuric acid was examined through gasometric and weight loss techniques.

Experimental section

Preparation of metal sample

The 99 % purity of aluminium, mild steel and carbon steel metals used for the present investigation. The 3 M H_2SO_4 prepared as per the standard procedure. Before performing the gasometric and weight loss technique, the aluminium, mild steel and copper metals are cleaned with different grades of emery papers and washed with acetone. The Acetaminophen drug of 1 mg, 2 mg, 3 mg and 4 mg concentrations was prepared for the corrosion studies.

Gasometric studies

The efficiency of the corrosion inhibitors was evaluated by gasometric method. Gasometric experiment measures the amount of hydrogen gas evolved in protected and unprotected systems at different solution temperatures with a specified exposed period. Hence, in this investigation, gasometric technique selected and studied corrosion inhibition property of Acetaminophen drug at 303 K, 313 K, 323 K and 333 K with an immersion period of one hour. The effect of immersion time on the corrosion inhibition property was examined at 303 K with 1, 2, 3, 4, 5, and 10 hour immersion period. The volume of hydrogen gas evolved in protected and unprotected systems was recorded and protection efficiency can be calculated as per the following equation;

$$\text{Corrosion inhibition efficiency} = \frac{V_a - V_p}{V_a},$$

Where, V_a= H_2 gas evolved in the absence of the corrosion inhibitor and V_p= H_2 gas evolved in the presence of the corrosion inhibitor.

Weight loss technique:

The protection efficiency of the heterocyclic compound was examined through weigh loss (mass loss) technique due to its high reproducibility and high reliability. The aluminium, mild steel and carbon steel was immersed in 100 ml of 3 M sulfuric acid system without and with Acetaminophen drug of 1 mg, 2 mg, 3 mg and 4 mg concentrations. The weight loss technique carried out at 303 K, 313 K, 323 K and 333 K. The effect of the contact time was studied at 303 K with an immersion period of 1, 2, 3, 4, 5 and 10 hours.

The protection efficiency can be calculated by the equation below,

$$\text{Protection efficiency (\%)} = \frac{(W_1 - W_2)}{W_1} \times 100$$

Where, W_1= Weight loss of metal in free 3 M sulfuric solution and W_2=Weight loss of metal in protected 3 M sulfuric acid solution.

Results and discussion

Gasometric studies

Tables 1 and 2 shows that, the presence of Acetaminophen drug reduces the corrosion rate of the aluminium, mild steel and carbon steel in the 3 M sulfuric acid system. Inspection of data in the **Table 1** reveals that, the corrosion of aluminium, mild steel and copper in the presence of Acetaminophen drug further decreases with a rise in the Acetaminophen concentration from 1 mg to 4 mg of Acetaminophen drug. The presence of Acetaminophen drug forms a protective layer on the aluminium, mild steel and carbon steel in the 3 M sulfuric acid system. The formed protective layer blocks the evolution of hydrogen gas on the aluminium, mild steel and carbon steel in the 3 M sulfuric acid system. Temperature studies show that, the increase in the solution temperature from 303 K to 313 K, 323 K and 333 K enhance the corrosion rate (decreases the protection efficiency), this nature is due to the desorption of adsorbed protective layer on the aluminium, mild steel and mild steel in the 3 M sulfuric acid system. The maximum protection efficiency observed at 303 K with immersion time of one hour. The contact time studies show that, the increase in the contact time from one hour to two, three, four, five and ten hours show that, the increase in the contact time decreases the protection efficiency which is due to instability of protective film at higher immersion time. The Acetaminophen drug inhibits the aluminium, mild steel and carbon steel in the order of aluminium < mild steel < carbon steel.

Table 1. Gasometric results at 303 K

Contact time (hours)	Aluminium	Mild steel	Carbon steel
	Protection efficiency (%)	Protection efficiency (%)	Protection efficiency (%)
1	78.533	81.237	83.000
	79.516	84.000	86.000
	80.517	85.735	87.766
2	83.008	86.638	91.333
	76.008	78.837	82.325
	77.539	79.000	85.348
3	78.515	83.537	86.511
	79.111	84.514	90.232
4	73.008	75.537	80.582
	73.418	76.038	81.941
	76.001	78.008	83.689
5	77.000	80.438	85.242
	71.001	71.837	78.583
	72.298	72.387	80.560
10	73.315	73.401	83.031
	74.411	76.837	84.019
	68.008	68.783	76.870

69.001	69.001	78.095
70.711	71.083	79.591
71.535	73.085	80.816
63.301	67.004	72.200
63.438	68.000	74.330
64.411	70.001	75.161
65.512	71.414	76.823

Table 2. Gasometric results at different solution temperatures with immersion period of one hour

Solution temperature (K)	Aluminium	Mild steel	Carbon steel
	Protection efficiency (%)	Protection efficiency (%)	Protection efficiency (%)
303	78.533	81.237	83.000
	79.516	84.000	86.000
	80.517	85.735	87.766
	83.008	86.638	91.333
	73.058	78.805	79.428
313	74.411	79.001	80.857
	75.508	80.008	83.428
	76.001	81.057	85.428
	71.114	76.001	77.317
323	72.115	76.008	78.780
	73.418	77.125	80.487
	74.411	78.024	82.682
	69.938	73.008	71.881
333	70.111	74.516	73.150
	71.508	75.008	76.532
	72.001	76.018	78.435

Weight loss studies:

Tables 3 and 4 shows that, the weight loss of aluminium, mild steel and carbon steel in 3 M sulfuric acid system decreases with a rise in the concentration of Acetaminophen drug from 1 mg to 4 mg. The weight loss of metal in bare system is high compared to the inhibited system, which clearly indicates the corrosion inhibition property of Acetaminophen drug. The decrease in the weight loss of metal in the 3 M sulfuric acid system is due to formation of an invisible protective film on the aluminium, mild steel and carbon steel. The formed protective layer blocks the direct attack of sulfuric acid solution on the metal surface. The presence of O and N atoms in the Acetaminophen plays very important role in the aluminium, mild steel

and carbon steel corrosion process in the 3 M sulfuric acid system. The increase in the solution temperature from 303 K to 333 K and immersion time from one hour to ten hours (at 303 K) decreases the protection efficiency of the Acetaminophen, which is due to dominant desorption process. The results obtained from the gasometric and weight loss technique are in good agreement. The Acetaminophen drug metal corrosion in the order of aluminium < mild steel < carbon steel.

Table 3. Weight loss results at 303 K

Contact time (hours)	aluminium	Mild steel	Carbon steel
	Protection efficiency (%)	Protection efficiency (%)	Protection efficiency (%)
1	78.803	80.200	83.870
	79.911	83.415	86.129
	80.456	86.618	86.774
	82.295	87.715	90.322
	76.005	77.800	81.081
2	77.515	79.913	84.594
	77.500	84.408	89.189
	79.001	85.518	91.621
	73.001	75.518	78.571
3	74.008	77.041	81.428
	76.001	79.010	85.000
	77.115	81.413	87.857
	72.001	70.538	77.358
4	73.411	72.215	79.056
	73.715	74.400	80.943
	75.500	77.813	82.452
	69.915	69.918	76.562
5	70.159	70.315	77.968
	71.113	70.115	79.375
	73.311	72.008	81.093
10	63.315	68.115	71.360
	63.410	69.903	75.927
	64.411	71.113	79.638
	65.500	72.215	80.685

Table 4. Weight loss results at different solution temperatures with an immersion period of one hour

Solution temperature (K)	Aluminium	Mild steel	Carbon steel
	Protection efficiency (%)	Protection efficiency (%)	Protection efficiency (%)
303	78.803	80.200	83.870
	79.911	83.415	86.129
	80.456	86.618	86.774
313	82.295	87.715	90.322
	74.415	78.815	80.000
323	75.510	79.905	82.571
	76.118	81.115	85.428
	77.110	82.115	87.714
333			
	72.200	76.005	76.046
	73.315	76.114	77.441
	74.415	77.120	80.465
	75.000	79.010	81.860
	69.008	74.113	69.215
	67.011	76.001	72.352
	70.000	76.119	74.117
	71.001	77.114	75.882

Conclusion

The protection efficiency of the Acetaminophen drug towards inhibition of aluminium, mild steel and carbon steel in 3 M sulfuric acid system was screened by using the gasometric and weight loss technique. The studied Acetaminophen drug act as good corrosion inhibitor towards aluminium, mild steel and carbon steel in 3 M sulfuric acid system and the protection efficiency follows in the order; carbon steel > mild steel > aluminium. The protection efficiency increases with rise in the Acetaminophen concentration and decreases with rise in the solution temperature and contact time. The corrosion inhibition property of Acetaminophen is due to adsorption process. The results obtained from the gasometric and weight loss technique are in good agreement.

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