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Comparative Analysis of Corrosion Inhibition Properties of *Allium Cepa* Extract on Mild Steel and Zinc

Chinweuba A.J
Pure and Industrial Chemistry Department,Anambra State university, Uli
Email aryzrazy@yahoo.com

Abstract
Investigation into corrosion efficiency of *Allium cepa* extract on the corrosion of mild steel and zinc in 2.0M H_2SO_4 solution was carried out.
The effectiveness of using *Allium cepa* extracts as corrosion inhibitor was characterized in terns of metal weight loss, corrosion rate and inhibition efficiency. The results showed that as the concentration of *Allium cepa* extract increases the rate of corrosion of the two metals decreases. The inhibition efficiency was also found to increase with increase in concentration of the extract. The inhibition efficiency increases up to a maximum of 97.7% for mild steel and 89.1% for zinc in 2.0M H_2SO_4 which was encouraging. The results confirmed that *Allium cepa* extract could serve as a good corrosion inhibitor for both metals in acidic media.
Key words: Corrosion, *Allium cepa*, inhibitors, extract.

1.0 Introduction.

White onion(*Allium cepa* .) is a member of the Alliceae family and belongs to genus Allium. There are about 450 species of Allium, some examples are *Allium porniun L, Allium ascalonium L*, *Allium ursnum L*, and many others. Allium plants are widely distributed over Europe, Asia, America and Africa and have been used over the year as species, vegetables and medically for treatment of some disease like Asthma, cardiovascular diseases, cancer and hyperlipemia (Griffiths, 2002). *Allium cepa* extract had been reported to have anti-inflammatory, anti-microbial, anti-fungal, anti-thrombatic and anti-pidaemie properties (Akaranta et al 2009).
The protection of metal against corrosion is a major industrial problem. The use of inhibitors is one of the best options of protecting metals against corrosion. Several inhibitors in use are either synthesized from cheap raw materials chosen from compounds having hetero atoms in their aromatic or long chain carbon system. Some organic compounds can adsorb on the metal surface, block the active site and thereby reduce the corrosion rate considerably(Pandion, 2009). Some of the synthetic organic compounds that show good anti-corrosive activity, are highly toxic to cause hazards to both human and the environment during their application (Obot, 2009). The environmental hazards caused by the use of synthetic inhibitors had always been a global issue.
The recent trend in finding environmental friendly corrosion inhibitor is of global concern. However, some researchers have studied the use of plant extract as corrosion inhibitors and found them to be environmental friendly, readily available, renewable , and acceptable source of a wide range inhibitor(Anuradha. et al. 2008).
Plant extracts are rich sources of molecules which have appreciable high inhibition efficiency and hence termed 'green inhibitors' (Raja et al,2008). These inhibitors are biodegradable and do not contain heavy metals or toxic compounds.(Sharma et al; 2009). The successful use of natural occurring substances to inhibit the corrosion of metals in acidic and alkaline environment have been presented by some researchers. The natural corrosion inhibitor assayed in this research work was Allium cepa extract. The effectiveness of Allium Cepa as a corrosion inhibitor on two metals(zinc and steel) was tested in acidic medium.

2.0 METHODS

2.1 Preparation of Extract

White onions were obtained from Nkpor market in Anambra State. They were cut into pieces, ground using an electric blender. The ground mix was squeezed to obtain the liquid extract, then filtered using muslin.500ml of the stock solution was stored in a plastic bottle and 5ml of ethanol was added to preserve the extract.

2.2 Preparation of metal specimen

Zinc and mild steel sheets were cut into 5×4cm and 4×3cm dimension respectively suitable for the experiment. A hole was drilled on each plate for easy handling. Zinc plates were used without further polishing while mild steel plates were washed with concentrated hydrochloric acid to remove rust. The mild steel plates were further degreased in acetone and dried in an electric oven. Both metals were stored in a desiccator till the time for corrosion study.

2.3 Weight loss mearsurement experiment.

Five different volumes of the liquid extract(50ml,40ml,30ml,20ml,10ml) were poured into five different plastic bowls containing 100ml of 2M H_2SO_4 and a sixth plastic bowl has 100ml in it without the extract (the control). The above set up was prepared in two batches each for a particular metal specimen. The metal were tied in triplicate weighed using an electronic weighing balance and their initial weights were recorded. They were

completely immersed into each of the plastic bowl containing the corrosion mixture (environment). The metal specimen were retrieved at two days interval, washed with distilled water, dried and reweighed. This was done for 8days. The difference in weight of the specimen was taken as the weight loss.
The corrosion rate was calculated using the equation (Akaranta et al, 2013)

$$\text{Corrosion rate (mmpy)} = \frac{87.6*W}{D*A*T}$$

mmpy= millimeter per year
W = weight loss (mg)
D = Density (g/cm)
A = Area of specimen (cm^2)
T = Time in hours.

The inhibition efficiency was calculated using the equation (Akaranta et al, 2013)

$$\%IE = \frac{W_1-W_2}{W_1}$$

W_1= corrosion rate in the absence of inhibitor
W_2 = Corrosion rate in the presence of inhibitor.

3.0 Results and discussion

Mild steel and zinc corrosion behavior in 2M H_2SO_4 were investigated in the absence and presence of *Allium cepa* extract using weight loss method.
Variation of weight loss with time for zinc and mild steel specimens in 2M H_2SO_4 solution containing different volumes of *Allium cepa* extract are shown in tables 2 and 3. From the results it was observed that as the volume of the extract increased from 10ml to 50ml, the weight loss of the metal decreased. Weight loss with immersion time for zinc and mild steel specimens in 2M H_2SO_4 (Blank that is the control) when compared with those containing the inhibitor (extract) showed a remarkable decrease in weight loss which signified corrosion inhibition. However, comparing the weight losses in the two metals(zinc and mild steel), it was observed that zinc recorded higher weight loss than mild steel which signified that zinc corroded more than the mild steel in the media.(Anuradha et,al 2008).
The result of the corrosion rates of zinc and mild steel immersed in solution of 2M H_2SO_4 and various volumes of *Allium cepa* extract are shown in tables 4 and 5. From the results it was observed that the rate of corrosion was higher in zinc than in mild steel and highest corrosion rate was recorded in the control experiment. However, the corrosion rate generally decreased gradually with immersion time and this could be attributed to the formation of oxide film on the metal surface by the that created a barrier between the metal surface and the corrosive environment.(Obot,2009).
Tables 6 and 7 showed the results of the inhibition efficiencies for the two metals (zinc and mild steel) in 2M H_2SO_4 in the absence and presence of *Allium cepa* extract respectively. It was observed that inhibition efficiency increased with increase in volume of *Allium cepa* extract and decreased with increase in immersion time, that is, the inhibition efficiency is directly proportional to the volume of inhibitor and inversely proportional to time.

4.0 Conclusion.

Based on the experimental results the maximum inhibition efficiency for mild steel was 95.7% and 89.1% for zinc.
The ideal volume where *Allium cepa* extract exhibited maximum inhibitory reaction was 50ml for the two metals studied, which was quite encouraging and could be possibly be used for industrial purposes. It was confirmed that *Allium cepa* extract could be used as natural corrosion inhibitor for zinc and mild steel.
Table1: Properties of metals specimen

Metal specimen	Density (g/cm^3)	Area(cm^3)
Mild steel	7.85	24
Zinc	7.14	40

Table2: Weight loss of mild steel specimen in different concentrations of *Allium cepa* extract in 2M H_2SO_4 at different time interval.

Volume extract (ml)	Volume 2.0M (ml)	Initial weight metal specir	Final weight of metal specimens (g)			
			48hrs	96hrs	144hrs	196hrs
0	100	17.5	7.50	7.31	7.25	7.20
10	100	17.8	16.28	14.79	14.17	13.39
20	100	17.2	16.15	15.05	14.22	13.81
30	100	17.3	16.57	15.67	14.75	14.66
40	100	16.9	16.40	15.29	14.88	14.73
50	100	16.3	15.87	15.31	14.80	14.34

Table 3: Weight of zinc specimen in different concentrations of *Allium Cepa* extract in 2M H_2SO_4 at different time interval.

Volume extract (ml)	Volume 2.0M (ml)	Initial weight of specimen(g)	Final weight of metal specimens (g)			
			48hrs	96hrs	144hrs	196hrs
0	100	5.68	-	-	-	-
10	100	5.56	4.71	4.32	3.95	3.54
20	100	6.20	5.42	5.12	4.82	4.54
30	100	5.65	4.99	4.80	4.49	4.24
40	100	6.09	5.46	5.37	5.02	4.82
50	100	5.36	4.74	4.57	4.40	4.24

Table 4: Weight loss of mild steel specimen in different concentrations of *Allium cepa* extract in 2M H_2SO_4 at different interval.

Volume of (ml)	Weight loss (g)			
	2 days	4 days	6 days	8 days
0	10.00	10.19	10.25	10.30
10	1.52	3.01	3.63	4.41
20	1.05	2.15	2.98	3.39
30	0.73	1.63	2.53	2.64
40	0.50	1.63	2.02	2.17
50	0.30	0.99	1.50	1.96

Table 5: Weight loss of zinc specimen in different concentrations of *Allium Cepa* extract in 2M H_2SO_4 at different interval.

Volume extract (ml)	Weight loss (g)			
	2 days	4 days	6 days	8 days
0	5.68	5.68	5.68	5.68
10	0.85	1.24	1.61	2.02
20	0.78	1.08	1.38	1.66
30	0.66	0.85	1.16	1.41
40	1.44	0.72	1.07	1.27
50	0.62	0.79	0.96	1.12

Table 6: Corrosion rate of mild steel specimen in different concentrations of *Allium cepa* extract in 2M H_2SO_4 at different interval.

Volume extract (ml)	Corrosion rate (mmpy) (10^{-3})			
	2 days	4 days	6 days	8 days
0	96.87	49.33	33.01	24.94
10	14.72	14.58	11.72	10.68
20	10.17	10.41	9.62	8.21
30	7.07	7.89	8.17	6.39
40	4.84	7.89	6.52	5.26
50	4.17	4.79	4.84	4.75

Table7: Corrosion rate of zinc specimen in different concentrations of *Allium Cepa* extract in 2M H_2SO_4 at different interval.

Volume extract (ml)	Corrosion rate (mmpy) (10^{-3})			
	2 days	4 days	6 days	8 days
0	36.12	18.14	12.01	9.07
10	5.43	3.96	3.43	3.23
20	4.98	3.43	2.94	2.65
30	4.22	2.72	2.47	2.25
40	9.20	2.30	2.28	2.03
50	3.96	2.52	2.04	1.79

Table 8:Percentage inhibition efficiency of mild steel specimen in different concentrations of *Allium Cepa* extract in 2M H_2SO_4 at different interval.

Volume extract (ml)	Inhibition efficiency (%)			
	2 days	4 days	6 days	8 days
10	84.8	70.4	64.7	57.0
20	89.4	78.9	64.7	57.0
30	92.7	84.0	75.3	74.3
40	95.0	84.0	75.3	74.3
50	95.7	90.3	85.4	80.9

Table 9: Percentage inhibition efficiency of zinc specimen in different concentrations of *Allium Cepa* extract in 2M H_2SO_4 at different interval.

Volume extract (ml)	Inhibition efficiency (%)			
	2 days	4 days	6 days	8 days
10	85.0	78.1	71.7	64.4
20	86.3	80.9	75.7	70.8
30	88.4	84.1	79.6	75.2
40	74.2	87.3	81.2	77.6
50	89.1	86.1	83.2	80.3

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