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Inhibiting Effect of Natural Plant Leaves Extract Used as Green Corrosion Inhibitor for Mild Steel in Acidic Media

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Abstract: ***Inhibition of corrosion of mild steel in hydrochloric acid by natural plant leaves extract of of Bahunia Varigata (Aapta), Azadirachta Indica (Neem), Pongamia Pinnata (Karanj), Santalum Album (Sandal Wood) and Astonia Scholaris (Saptparni) has studied using weight loss measurement. It was, found that the leaves extract act as a good corrosion inhibitor for mild steel in all concentrations of the extract. The inhibition action depends on the concentration of the leaves extract in the acid solution. Results for weight loss measurements indicate that inhibition efficiency increase with increasing inhibitor concentration. Extract of natural plants is one of the most important metallic corrosion inhibitors. They are readily available, nontoxic, environmentally friendly, biodegradable, highly efficient, and renewable. Several organic compounds with heteroatom such as N, O, S and P present in the plant extracts are, adsorbed directly onto the metals surface through polar atoms and thereby forming the protective layer. Plants represent a class of interesting source of compounds currently being, explored for use in metal corrosion protection in most systems, as possible replacement of toxic synthetic inhibitors. This paper discusses the different types of natural green plant leaves extract inhibitors for corrosion control of mild steel in acid medium.***
Keywords: Corrosion, Inhibition, carbon steel, Weight loss and natural plant leaves extract.

I. INTRODUCTION

Mild steel is widely used in many industrial applications. In most industrial processes, acidic solutions are commonly use for the pickling, industrial acid cleaning, acid descaling, and oil well acidifying [1–5]. Unfortunately, iron and its alloys could corrode during these acidic applications particularly with the use of hydrochloric acid and sulphuric acid, which results in terrible waste of both resources and money[6]. Corrosion prevention systems favor the use of environmental chemicals with low or zero environmental impacts. However, due to the health and environmental concerns. There has been an increase in formulating new inhibitors, which could be less harmful to the environment and human health but equally to achieve better corrosion protection. Therefore, green inhibitors has extensively investigated for corrosion control in recent years. These green inhibitors are natural organic compounds and can be either manufactured or extracted from medicinal plants and herbs[7]. Organic inhibitor, were applied extensively to protect metals from corrosion in many aggressive acidic media [8].Green corrosion inhibitors are biodegradable and do not contain heavy metals or other toxic compounds. Some research groups have reported the successful use of naturally occurring substances to inhibit the corrosion of metals in acidic and alkaline environment [9-11]. Most of the synthetic organic compounds showed good anticorrosive activity, which are highly toxic to cause severe hazards to both human being and the environment during its application [12]. Hence, the use of natural products, which are eco-friendly and used as corrosion inhibitors, has become need of the time. Now the development of corrosion inhibitor of natural source and nontoxic type has been, considered more important and desirable [13-15]. Plant extracts contain mixtures of proteins, polysaccharides, polycarboxylic acids, tannin, alkaloids, and terepinoids and so forth[16]. Some investigators studied the plant extract and the derived organic species become more important as an environmentally benign, easily available and acceptable source for a wide range of inhibitor. A large number of research studies have been devoted to the inhibitive performance of natural corrosion inhibitors on the corrosion of metals in various aggressive solutions showing that these extracts could act as potential corrosion inhibitors [17-19]. The world becomes much aware of the environmental problems and the toxic effects of the used chemicals in different industries. Nowadays there is growing attention towards eco-friendly corrosion inhibitions “green corrosion inhibitors”. There are several advantages of these naturally obtained inhibitors. They are readily available, environmentally friendly, biodegradable, efficient, and renewable[20-24].The present study designed to investigate the adsorption and inhibiting properties of plant extract of leaves of Bahunia Varigata (Aapta), Azadirachta Indica (Neem), Pongamia Pinnata (Karanj), Santalum Album (Sandal Wood) and Astonia Scholaris (Saptparni) *for* the corrosion of mild steel in 0.1, 0.01 and 0.001 N HCl solutions.

II. EXPERIMENTAL SECTION

The plant leaves was collected and cut into small pieces and they dried in sunlight for 2 days after this process this dried plant leaves crushed in mortar to form plant leaves powder. About 25g of dried powdered leaves of each plant was refluxed with alcohol for about 1hrs and was kept overnight to completely extract the basic components as these are soluble in the alcohol .The solution was filtered off and the filtrate was diluted to 50ml with alcohol. To analysis, the inhibition efficiency of Natural plants leaves extract. In the experiment, beakers were clean first by regmal paper and wash with water and it was dried. After drying it was, cuted in small 5cm pieces and its weight were determined on labeled from 1-18 and in beakers having labeled 1-6 20ml 0.1N HCl, 7-12 20ml 0.01N HCl, 13-18 20ml 0.001N HCl were added, and this experimental system for five natural plants. After the preparation of the Natural plants extract solution was, added (0.25ml, 0.50ml, 0.75ml, 1.0ml, and 1.25ml) in different labeled beaker and all binding wire weighed pieces dipped in each beakers for 48 hours. After 48 hours, the wire pieces taken out from the beaker. Then, it washed with water and dried at room temperature. Its weight was determined on analytical balance as final weight. Weight of metal wire pieces before and after dipping in corrosion solution, loss in weight, % loss weight was calculated by usual method. The % inhibition efficiency was calculated by using following formula.

Where,

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

I.E. = Inhibition efficiency.

W_i= Weight loss of metal in inhibitor solution

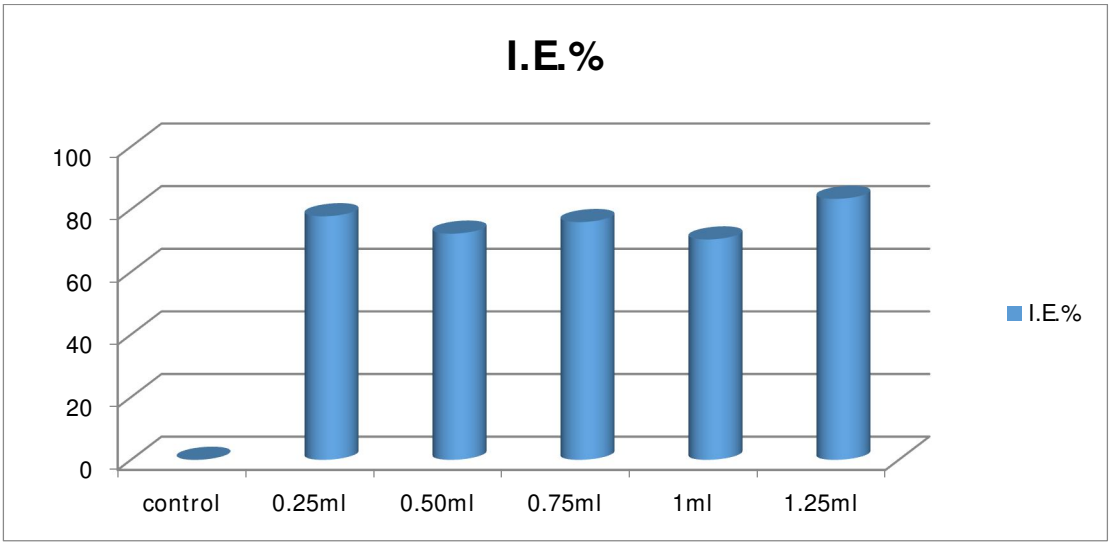
W_u = weight loss of metal in control solution

III. RESULT AND DISCUSSION

Effect of Bahunia Varigata on corrosion in 0.1N HCl (Table no. 1)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E. (%)
Control	0.300	0.246	0.054	0.054	-
0.25ml	0.316	0.304	0.012	3.79	77.77
0.50ml	0.330	0.315	0.015	4.54	72.22
0.75ml	0.308	0.295	0.013	4.22	75.92
1ml	0.300	0.284	0.016	5.33	70.37
1.25ml	0.302	0.293	0.009	2.98	83.33

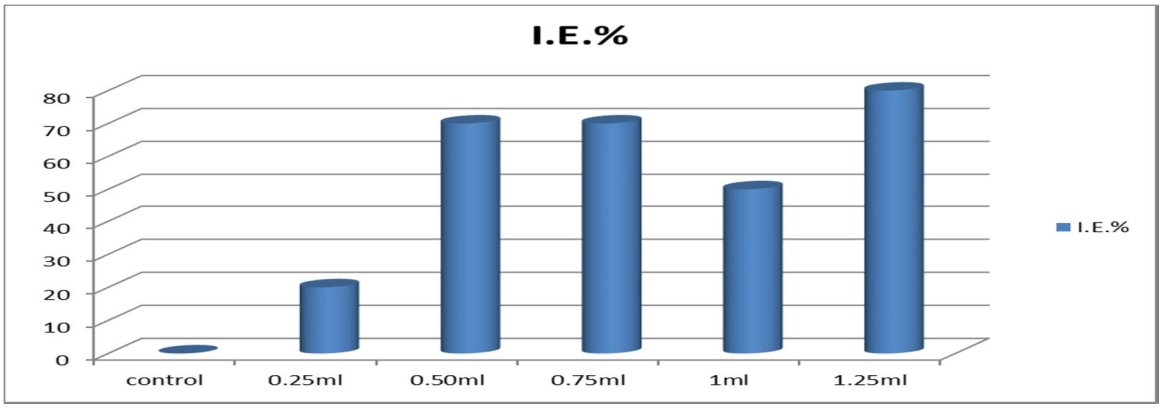
Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing Bahunia Varigata (Graph no.1)



Effect of Bahunia Varigata on corrosion in 0.01N HCl (Table no. 2)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.298	0.288	0.010	3.35	-
0.25ml	0.314	0.306	0.008	2.54	20
0.50ml	0.311	0.306	0.003	0.96	70
0.75ml	0.296	0.293	0.003	1.01	70
1ml	0.304	0.299	0.005	1.64	50
1.25ml	0.298	0.296	0.002	0.67	80

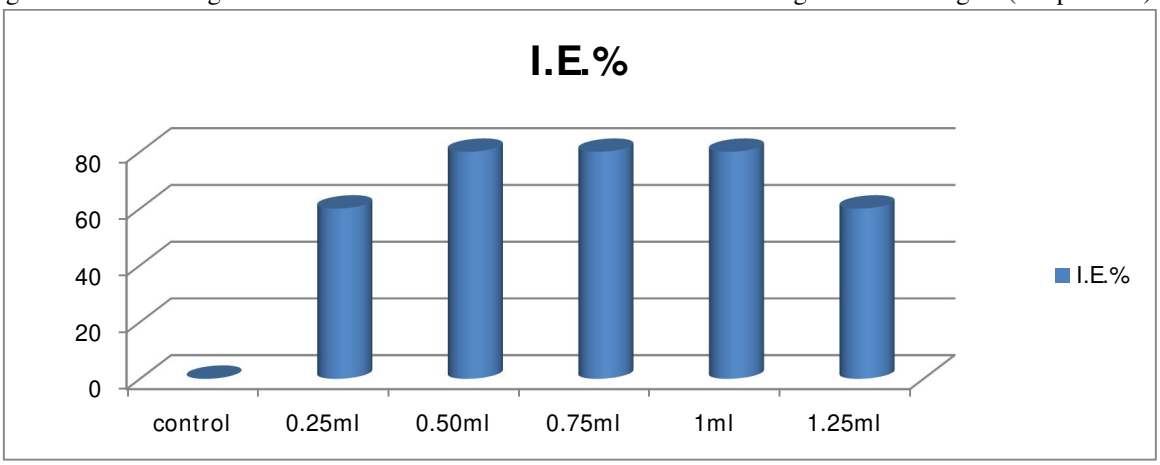
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing Bahunia Varigata (Graph no. 2)



Effect of Bahunia Varigata on corrosion in 0.001N HCl (Table no. 3)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.326	0.321	0.005	1.53	-
0.25ml	0.324	0.322	0.002	0.61	60
0.50ml	0.291	0.290	0.001	0.34	80
0.75ml	0.296	0.295	0.001	0.33	80
1ml	0.300	0.299	0.001	0.33	80
1.25ml	0.312	0.310	0.002	0.64	60

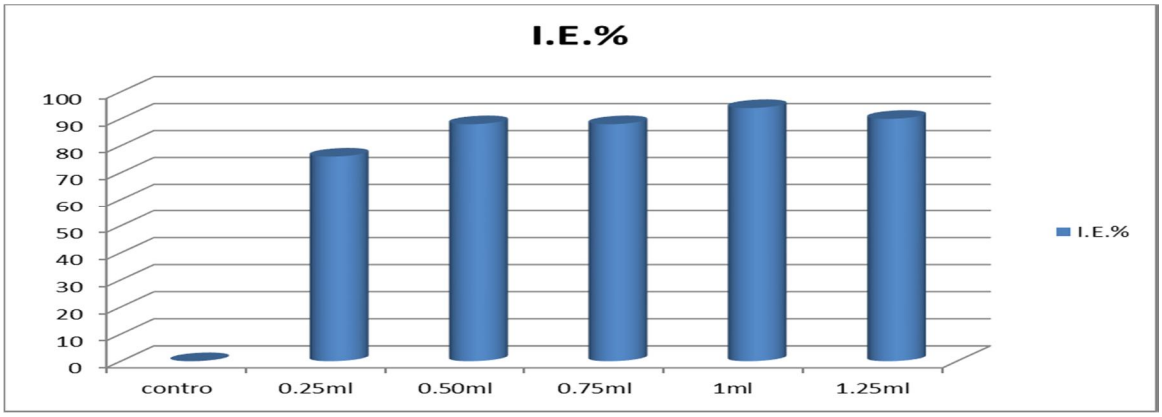
Fig: Variation of weight loss of mild steel in 0.001N HCl solution containing Bahunia Varigata (Graph no. 3)



Effect of Azadirachta Indica on corrosion in 0.1N HCl (Table no. 4)

Sample	Initial weight(W_1)	Final Weight (W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.312	0.262	16.02	0.050	-
0.25ml	0.317	0.305	3.78	0.012	76
0.50ml	0.310	0.304	1.93	0.006	88
0.75ml	0.316	0.310	1.89	0.006	88
1ml	0.305	0.303	0.98	0.003	94
1.25ml	0.297	0.292	1.68	0.005	90

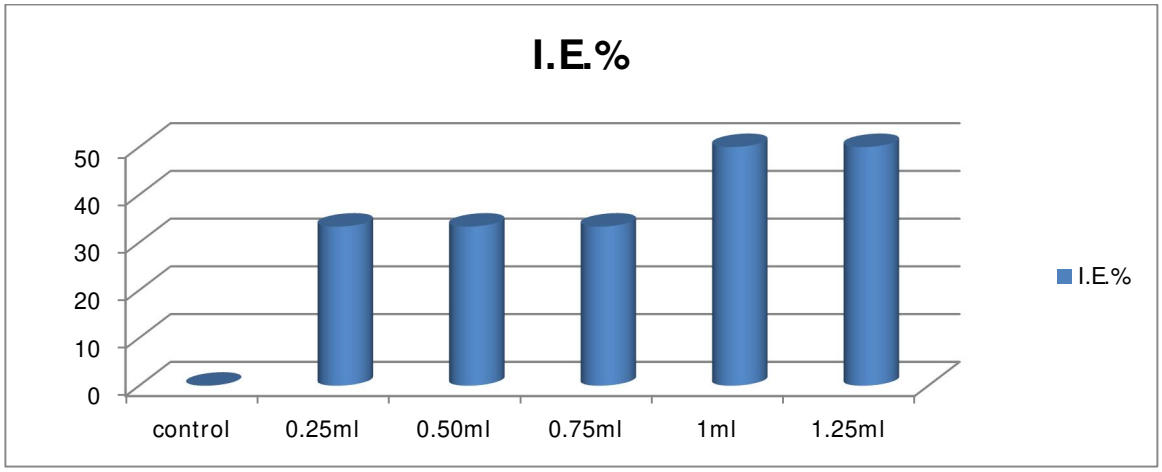
Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing Azadirachta Indica (Graph no.4)



Effect of Azadirachta Indica on corrosion in 0.01N HCl (Table no. 5)

Sample	Initial weight(W_1)	Final Weight (W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.306	0.300	0.006	1.96	-
0.25ml	0.288	0.284	0.004	1.38	33.33
0.50ml	0.309	0.305	0.004	1.29	33.33
0.75ml	0.320	0.316	0.004	1.25	33.33
1ml	0.288	0.285	0.003	1.04	50
1.25ml	0.290	0.287	0.003	1.03	50

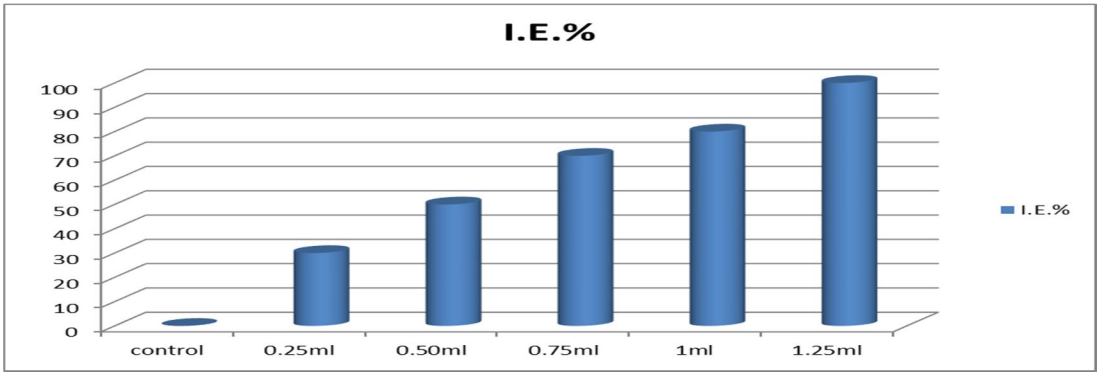
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing Azadirachta Indica (Graph no.5)



Effect of Azadirachta Indica on corrosion in 0.001N HCl (Table no. 6)

Sample	Initial weight(W_1)	Final Weight (W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.279	0.269	0.010	3.58	-
0.25ml	0.294	0.287	0.007	2.38	30
0.50 ml	0.290	0.285	0.005	1.72	50
0.75ml	0.306	0.303	0.003	0.98	70
1ml	0.297	0.295	0.002	0.29	80
1.25ml	0.293	0.293	0.00	0.0	100

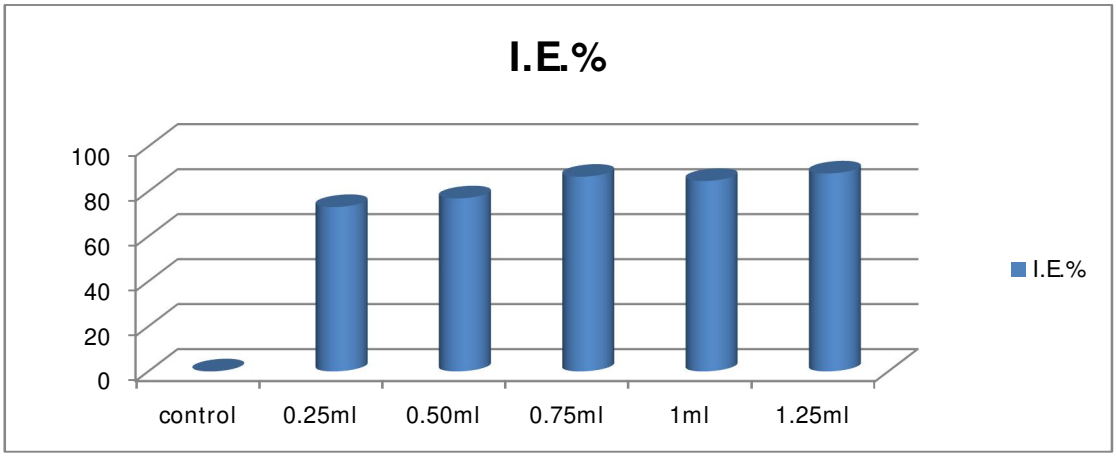
Fig: Variation of weight loss of mild steel in 0.001N HCl solution containing Azadirachta Indica (Graph no. 6)



Effect of Pongamia Pinnata on corrosion in 0.1N HCl (Table no. 7)

Compound	Initial weight(W_1)	Final Weight (W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.300	0.248	0.052	17.33	-
0.25ml	0.296	0.282	0.014	4.72	73.07
0.50ml	0.297	0.281	0.012	4.05	76.92
0.75ml	0.279	0.290	0.007	2.35	86.53
1ml	0.302	0.294	0.008	2.64	84.67
1.25ml	0.294	0.288	0.006	2.04	88.46

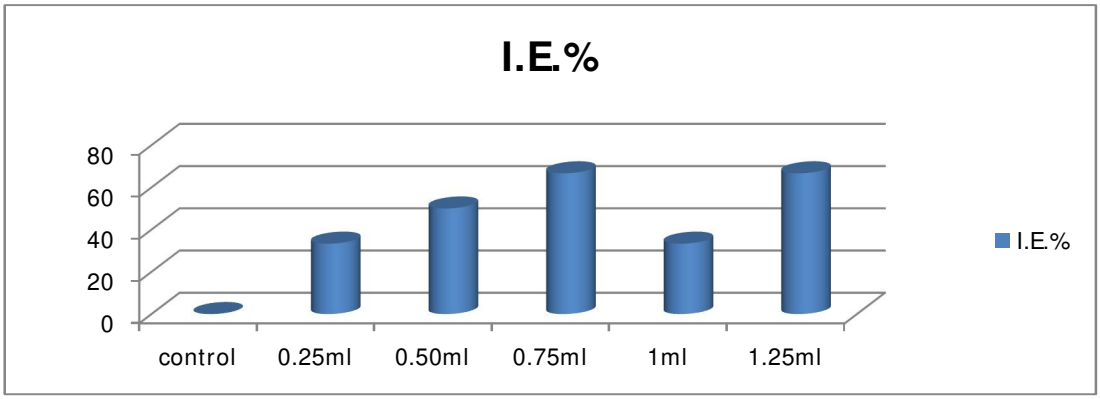
Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing Pongamia Pinnata (Graph no.7)



Effect of Pongamia Pinnata on corrosion in 0.01N HCl (Table no. 8)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.304	0.298	0.006	1.97	-
0.25ml	0.308	0.304	0.004	1.29	33.33
0.50ml	0.299	0.295	0.003	1.003	50
0.75ml	0.303	0.301	0.002	0.66	66.66
1ml	0.312	0.308	0.004	1.28	33.33
1.25ml	0.308	0.306	0.002	0.0006	66.66

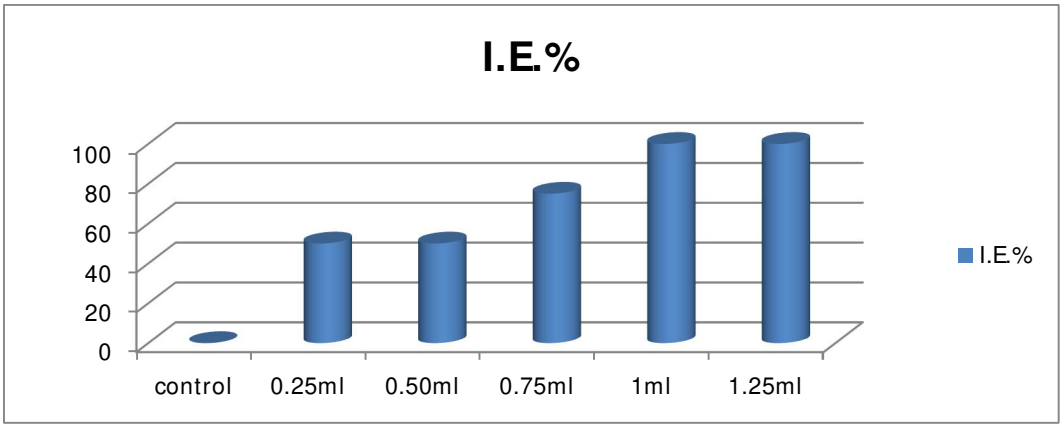
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing Pongamia Pinnata (Graph no.8)



Effect of Pongamia Pinnata on corrosion in 0.001N HCl (Table no. 9)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.302	0.299	0.004	1.32	-
0.25ml	0.312	0.310	0.002	0.64	50
0.50ml	0.300	0.298	0.002	0.66	50
0.75ml	0.306	0.305	0.001	0.32	75
1ml	0.292	0.292	0.00	0.0	100
1.25ml	0.288	0.288	0.00	0.0	100

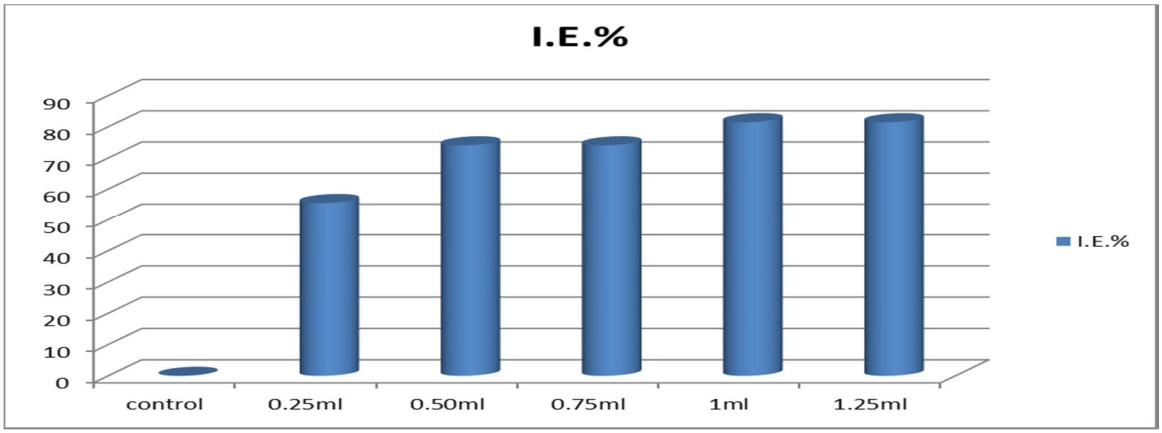
Fig: Variation of weight loss of mild steel in 0.001N HCl solution containing Pongamia Pinnata (Graph no. 9)



Effect of Santalum Album on corrosion in 0.1N HCl (Table no.10)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.297	0.243	0.054	18.18	-
0.25ml	0.309	0.285	0.024	7.76	55.55
0.50ml	0.296	0.282	0.014	4.72	74.07
0.75ml	0.313	0.289	0.014	4.42	74.07
1ml	0.301	0.291	0.010	3.32	81.48
1.25ml	0.305	0.295	0.010	3.27	81.48

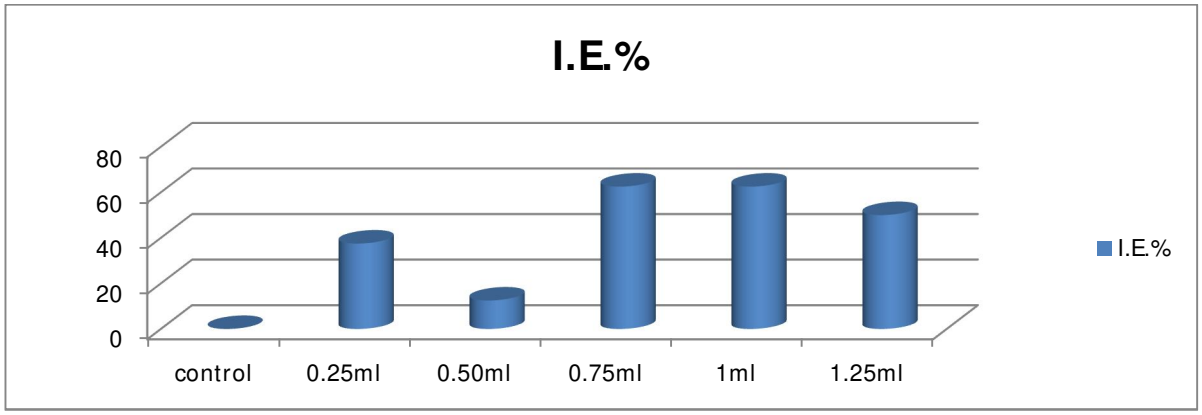
Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing Santalum Album (Graph no. 10)



Effect of Santalum Album on corrosion in 0.01N HCl (Table no.11)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.298	0. 290	0.008	2.68	-
0.25 ml	0.297	0.292	0.005	1.68	37.5
0.50 ml	0.299	0.292	0.007	2.34	12.5
0.75 ml	0.297	0.294	0.003	1.01	62.5
1 ml	0.306	0.303	0.003	0.98	62.5
1.25 ml	0.303	0.297	0.004	1.32	50

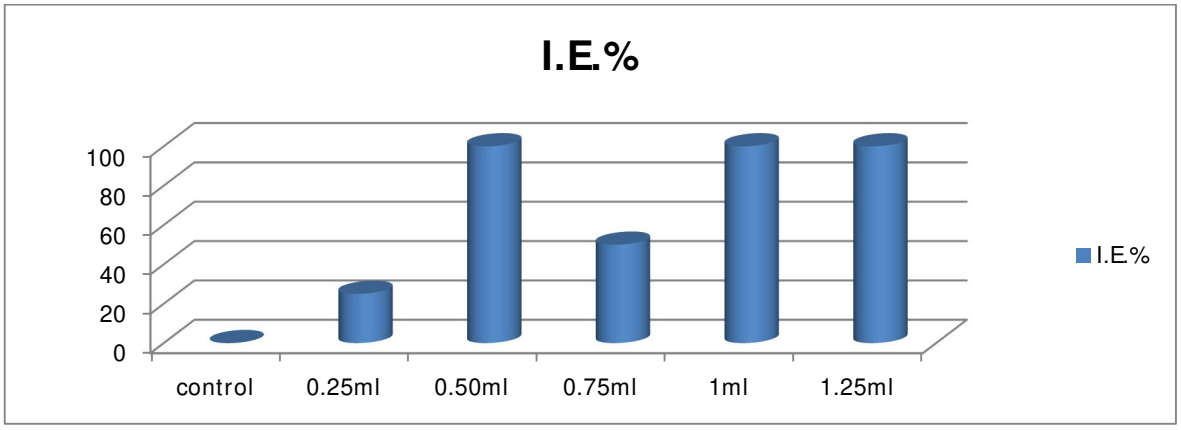
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing Santalum Album (Graph no. 11)



Effect of Santalum Album on corrosion in 0.001N HCl (Table no. 12)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.311	0.307	0.004	1.28	-
0.25 ml	0.308	0.305	0.003	0.97	25
0.50 ml	0.320	0.320	0.0	0.0	100
0.75 ml	0.301	0.299	0.002	0.66	50
1 ml	0.310	0.310	0.0	0.0	100
1.25 ml	0.301	0.301	0.0	0.0	100

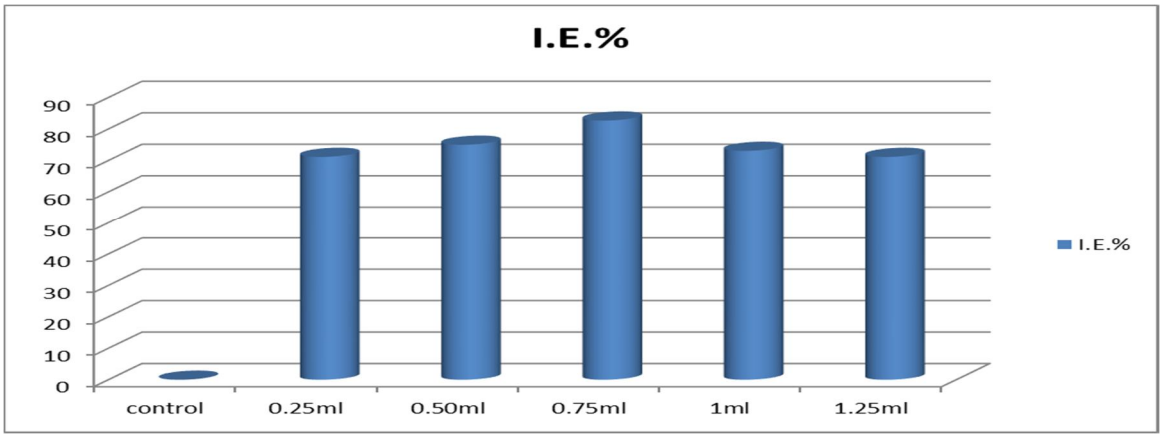
Fig: Variation of weight loss of mild steel in 0.001N HCl solution containing Santalum Album (Graph no. 12)



Effect of Astonia Scholaris on corrosion in 0.1N HCl (Table no.13)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.296	0.244	0.052	17.56	-
0.25 ml	0.302	0. 287	0.015	4.96	71.15
0.50 ml	0.304	0.291	0.013	4.27	75
0.75 ml	0.296	0.287	0.009	3.04	82.69
1 ml	0.300	0.288	0.012	4	73.07
1.25 ml	0.306	0.291	0.015	4.90	71.15

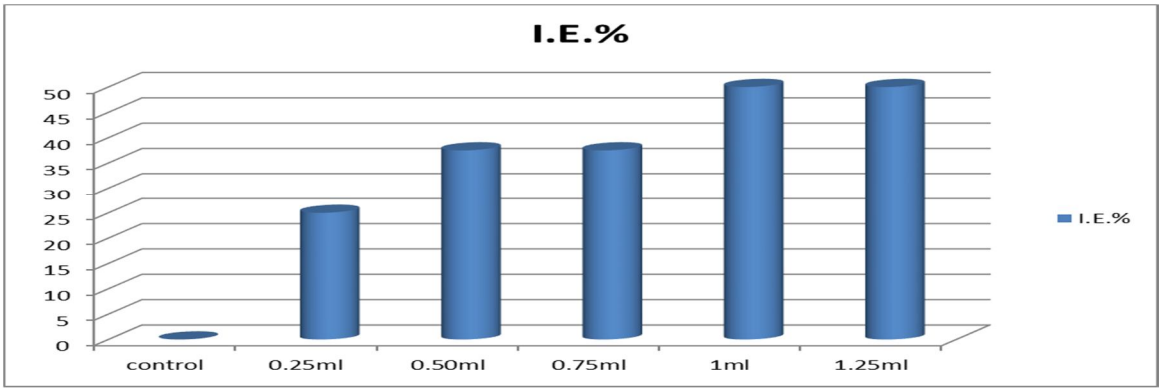
Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing Astonia Scholaris (Graph no.13)



Effect of Astonia Scholaris on corrosion in 0.01N HCl (Table no. 14)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.300	0.292	0.008	2.66	-
0.25 ml	0.297	0.291	0.006	2.02	25
0.50 ml	0.297	0.292	0.005	1.68	37.5
0.75 ml	0.290	0.285	0.005	1.72	37.5
1 ml	0.291	0.287	0.004	1.37	50
1.25 ml	0.300	0.296	0.004	1.33	50

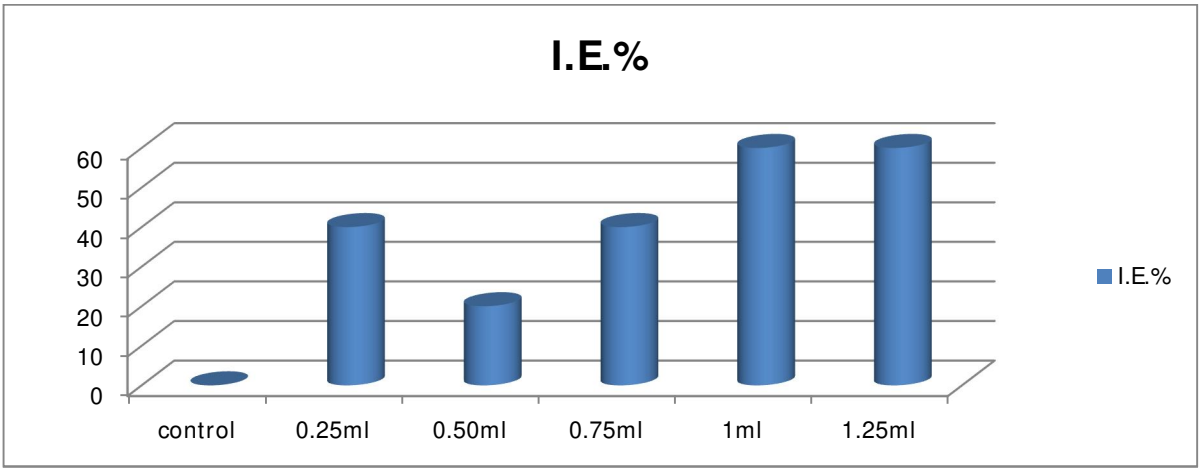
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing Astonia Scholaris (Graph no. 14)



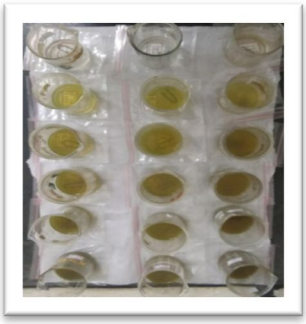
Effect of Astonia Scholaris on corrosion in 0.001N HCl (Table no. 15)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E.(%)
Control	0.296	0.291	0.005	1.63	-
0.25 ml	0.315	0.312	0.003	0.95	40
0.50 ml	0.296	0.292	0.004	1.35	20
0.75 ml	0.297	0.294	0.003	1.01	40
1 ml	0.296	0.294	0.002	0.67	60
1.25 ml	0.310	0.309	0.001	0.32	60

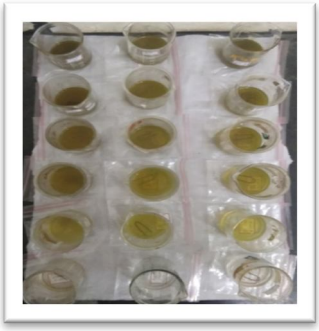
Fig: Variation of weight loss of mild steel in 0.001N HCl solution containing Astonia Scholaris (Graph no. 15)



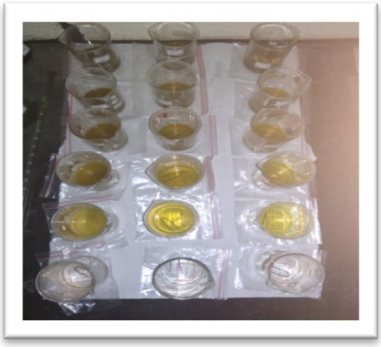
Experimental results regarding inhibition efficiency of Natural plants were Bahunia Varigata (Aapta), Azadirachta Indica (Neem), Pongamia Pinnata (Karanj), Santalum Album (Sandal Wood) and Astonia Scholaris (Saptparni). Under reveals that the natural plant leaves extract have inhibition property. They inhibit oxidation of mild steel in hydrochloric acid medium. We conclude that the inhibition efficiency is also depending on the oxidizing medium. In experimental process, we have to use hydrochloric acid medium namely 0.1, 0.01, and 0.001 N HCl concentration. Effect of natural plant leaves extract on corrosion of mild steel in hydrochloric acid medium recorded in table and represented in a graph. From the observation table we conclude that in 0.1N HCl Bahunia Varigata plant leaves extract shows inhibition efficiency 83.33 % for 1.25 ml and in 0.01 N HCl for 0.25 ml is exhibit 20.00 %. In addition, 80.00 % inhibition efficiency for addition of 1.25 ml plant leaves extract. In 0.001 N HCl acid medium at 0.50, 0.75, 1.00 ml plants leaves extract shows similarly 80.00% inhibition efficiency. In 0.1N HCl solution shows Azadirachta Indica plant leaves extract maximum inhibition efficiency 94.00 % and for 0.25, 0.50, 0.75 ml shows 80.00 % inhibition efficiency. Simultaneously in 0.01 N HCl acid medium exhibits less than 50.00 %. Interesting result in 0.001 N HCl solutions for 1.25 ml plant leaves extract is 100 % inhibition efficiency. In 0.1N HCl the inhibition efficiency of Pongamia Pinnata plant leaves, extract shows 88.46 for 1.25 ml. In 0.01 N HCl exhibits, the minimum inhibition efficiency is 33.33 % and shows 66.66 % for 0.75 ml Pongamia Pinnata leaves extract. The inhibition efficiency of Pongamia Pinnata plant leaves extract shows inhibition efficiency in the range 50% for 0.25 and 0.50 ml and inhibition efficiency in 0.001 N HCl shows 100 % for 1.00 and 1.25 ml. By graphical representation in Hydrochloric acid medium, in 0.001N HCl, inhibition efficiency of Pongamia Pinnata plant leaves extract is 100%.From the observation table the inhibition efficiency of Santalum Album plant leaves extract shows maximum inhibition efficiency in 0.001 N HCl is 100% for 1.00,1.25 ml and 0.50 ml. The Santalum Album shows less inhibition efficiency in 0.01 N HCl. In 0.1 N HCl Santalum Album shows inhibition efficiency in the range of nearly74.07 to 81.48 %. From all above study of result it has to be, found Santalum Album good inhibitors for mild steel in HCl acid medium. The Astonia Scholaris plant leaves extract exhibit less inhibition efficiency it can be, shown by graphical interpretation data. In 0.1N HCl at 025, 0.50, 1.00, 1.25ml solutions it exhibit more than 71.15 %. Inhibition efficiency result of 0.01N HCl less than 50.00 % similarly 40 to 60 % in 0.001 N HCl. The inhibitor property of natural plant leaves more useful for it is medicinal, Chemical and biological activities. The leaf of the plant is biodegradable and a renewable material. Plant extracts constitute several organic compounds, which have corrosion inhibiting abilities. Green corrosion inhibitors are biodegradable and do not contain heavy metals or other toxic compounds.



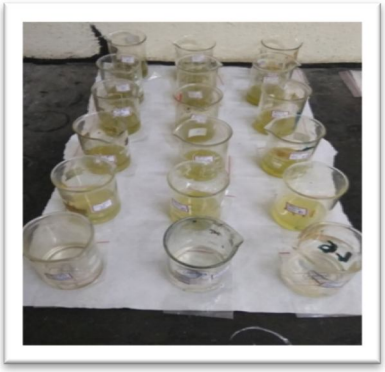
System for Bahunia Varigata (Aapta)-A



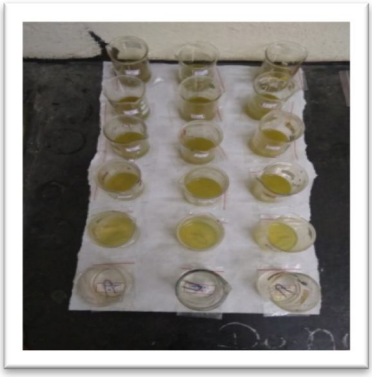
System for Azadirachta Indica (Neem)-B



System for Pongamia Pinnata (Karanji)-C



System for Santalum Album (Sandal Wood)-D



System for Astonia Scholaris (Saptparni)-E

IV. CONCLUSION

From the experimental data and graphical representation results regarding inhibition efficiency of natural plant Bahunia Varigata (Aapta), Azadirachta Indica (Neem), Pongamia Pinnata (Karanj), Santalum Album (Sandal Wood) and Astonia Scholaris (Saptparni) exhibit good inhibition property. The present work devotes to investigate the effect of plant leaves extracts as a corrosion inhibitor for carbon steel in 0.1, 0.01 and 0.001 N HCl by weight loss in different volume of extract solutions, Present review substantiates and proves the performance of plant extracts as effective green inhibitors for mild steel in hydrochloric acid medium**.** The known hazardous effect of most synthetic corrosion inhibitors have motivated scientists to use naturally occurring products as corrosion inhibitors as they are inexpensive, readily available and renewable sources of materials, environmentally friendly, and ecologically acceptable. The inhibitor action which is generally, attributed to the process such as identifying the active constituent in the plant extract for inhibition remains an opportunity for further research.

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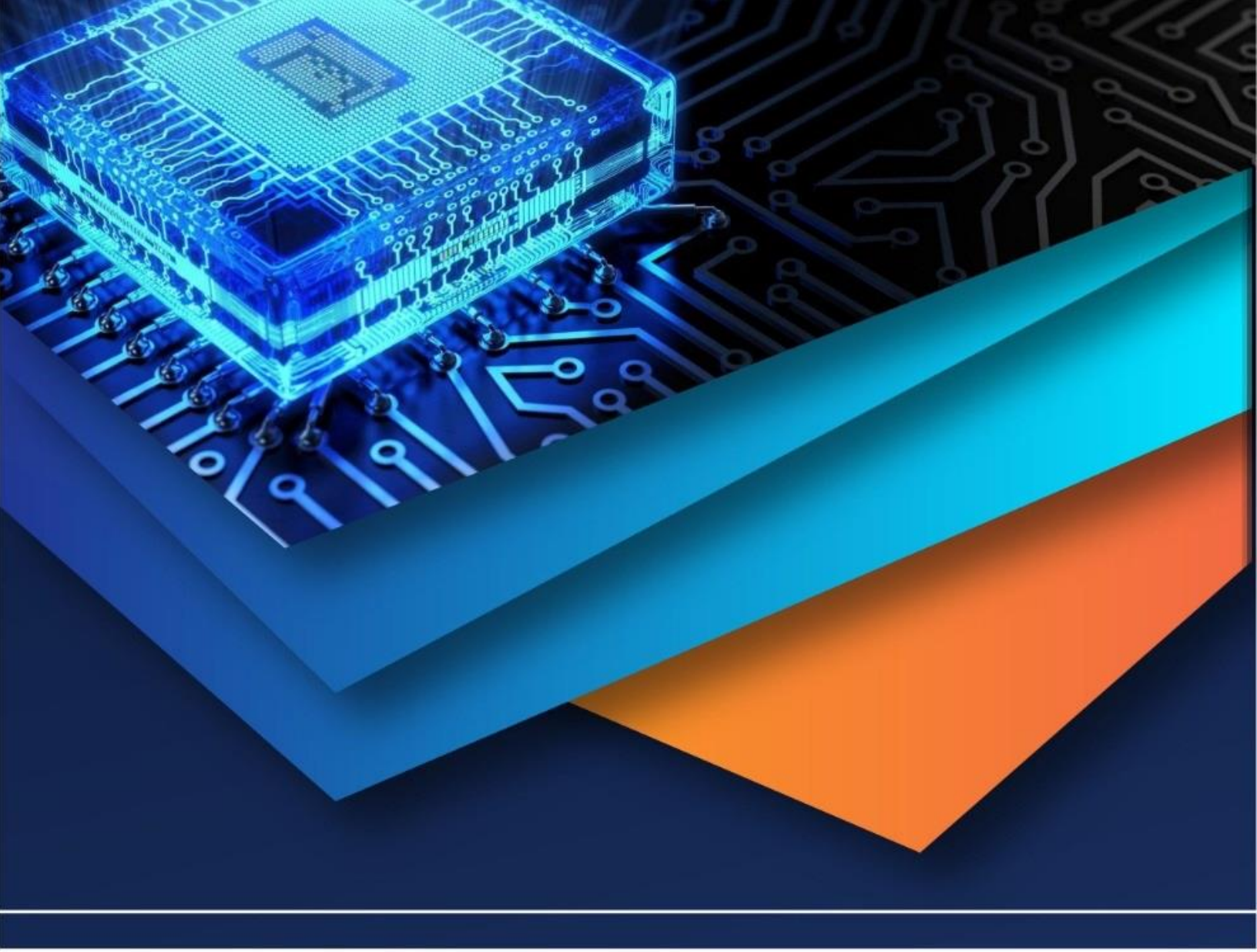

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