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CORROSION PROTECTION:-A STRONG STRATEGY USING GREEN CHEMISTRY

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Abstract: - This review summarizes the research work published by researchers by using natural compounds as corrosion inhibitors for different metals alloys in different mediums. Herein, plant extracts has been considered as green corrosion inhibitors. In this review the advantages and disadvantages of the various methods used to obtain green corrosion inhibitors are presented. The inhibition effectiveness of these corrosion inhibitors, including the techniques used to evaluate them and the respective inhibition mechanisms, are also discussed. Finally, a critical evaluation is presented together with the outlook as regards possible future improvements.

Keywords: - Corrosion, Techniques, Active Constituents, Medium, Green inhibitors,

I. INTRODUCTION

Corrosion, a global problem is a natural process in which deterioration of metal takes place due to surrounding medium. It has been proved that Corrosion was the main cause for Bhopal gas tragedy (India), The Prudhoe Bay oil spill (Alaska), Flixborough disaster, Guadalajara explosions (Analco), Carlsbad pipeline explosion (Mexico)[1]. It is estimated that economical loss due to corrosion is 3.4% of the global GDP (2013)[2]. In India every year a huge amount of about Rs. 100 billion dollar[3] is lost due to corrosion and this loss of money can be checked by applying protection against corrosion. To check corrosion, efforts are continuously done but due to toxicity and environmental hazards the use of some chemical corrosion inhibitors like chromate are banned. It is demand of time to protect the environment from chemical corrosion inhibitors, some green inhibitors are required that may be used as eco friendly corrosion inhibitors.

Green inhibitors as a plant extracts are easily available, environmentally acceptable, and renewable source. They contain hetero atoms like oxygen, nitrogen and sulphur. These hetero atoms contain lone pair of electrons having tendency to donate its lone pair of electron to metal atom and form coordinate bond. Due to this a protective layer is formed on the surface of metal and consequently metal is protected from corrosion. In this article informations of natural products are shared which are used as corrosion inhibitors for various metal and alloys in aggressive media.

Types of corrosion:-

There are many types of corrosion but right now there is no universally accepted terminology. In broad sense corrosion can be classified into following types

S.No.	Types of corrosion
1	Galvanic cell corrosion (due to interaction of two dissimilar metal) Erosion corrosion Selective Leaching/corrosion In joints

	In welding In rivets
2	Concentration cell formation (Due to difference in amount of oxygen penetration on metal surface) Waterline corrosion Crevice corrosion Pitting corrosion Stress corrosion Inter granular corrosion Hydrogen damage Soil corrosion Microbial corrosion

II. FACTORS AFFECTING CORROSION

Corrosion may be defined as natural processes in which metal is degraded due interaction between metal and its surrounding medium. The rate of corrosion is affected by chemical reactivity, purity, physical state, metal surface, fabrication of metal, nature of metal oxide and environmental factors like temperature, humidity, presence of impurity in atmosphere, pH of surrounding medium.

III. METHODOLOGY

The rectangular shaped coupons of metals are mechanically polished with emery sheet, washed with double distilled water, degreased with alcohol and finally dried at room temperature before being immersed in the test. The initial weight of the specimen was recorded using an analytical balance

A stock solution of plant extracts (inhibitor) is prepared and taken as the stock solution. From this different concentration of inhibitor solutions ranging from 0.1% to 1.5% were diluted. After the corrosion test in acidic or basic solution of standard solution with and without the inhibitor in different concentration (0.1% to 1.5%). The weight loss is determined after different immersion periods (1 hr, 3 hr, 5 hr, 7 hr, 12 hr and 24 hr) at 303 K. The weight loss experiments were conducted at different temperatures (308, 318, 328, 338 and 348 K). The surface morphology of the metal specimen is evaluated by SEM analysis.

IV. CORROSION INHIBITION

S. No.	Plant Inhibitor	Plant parts	Material	Medium	Active costituents	Technique	Reference
1	Ambrosia maritime	leaves	Aluminium	NaCl	damsin and ambrosin	Chemisorption	4
2	Lupinus sp.	leaves	Aluminium	NaCl	Lupinane,Multiflorine, Sparteine	Chemisorption	4
3	Cymbopogon proximus	-	Aluminium	NaCl	Proximadiol, 5α-hydroxy-β-	Chemisorption	4

					eudesmol, 5α-hydroperoxy-β-eudesmol		
4	Ambrosia maritime	Leaves	Aluminium	NaCl	ambrosin and damsin		4
5	Lupinus sp	Leaves	Aluminium	NaCl	papaverine, strychnine, quinine and nicotine		4
6	Garcinia indica	seed	Aluminium	H_3PO_3	Hydroxyl citric acid, Functional food, Anthocyanins, Kokum Butter, Garcinol	Chemisorption	5
7	Cucumis melo	pulp	Cast iron	HCl	carotenoids	Langmuir	6
8	Cucumis melo	pulp	Aluminium	NaCl			7
9	Cucumis melo	seed	Aluminium	HCl			7
10	Neolamarckia cadamba	bark	Mild steel	NaOH	3b-isodihydrocadambine		8
11	Senna auriculata	leaves	Aluminium	NaOH,	Luteolin, Quercetin and Kaempferol		8,9
12	Saffron	leaves	Aluminium	HCl	Safranal, Crocin, Zeaxanthin, Crocetin, Picrocrocin	Temkin	10
13	Phoenix dactylifera	fruit	Aluminium	NaCl		Langmuir	11
14	Baccopa monieri	-	Aluminium	NaOH	Bacoside A, Bacoside B		12
15	Solanum trilobatum	leaves	Aluminium	NaOH	thymol		13
16	Olive	seed	Aluminium	HCl	olive biophenols		14
17	Vitex negunda	leaves	Aluminium	NaOH	flavonoids, steroids, tannins and phenolic compounds		15
18	Vitex negunda	husk	Aluminium	NaOH			16
19	Vitex negunda	leaves	Aluminium	H_2SO_4	flavonoids, steroids, tannins		16

20	Aloe vera	leaves	Aluminium	HCl	Mannose- 6-phosphate	Langmuir	16,17
21	Trachyspermum capticum	seed	Aluminium	NaOH	saponins, phenolic compounds, nicotinic acid		18
22	Damisissa extract	-	Aluminium	Na_2CO_3	ambrosin, damsin, and coumarin		19
23	Corchours itorius extract		Aluminium	Na_2CO_3			19
24	Lupine	seed	Aluminium	NaOH			20
25	Hibiscus rosa senensis	flowers	Aluminium	NaOH	quercetin-3-O-glucoside		21
26	Date palm extract	-	Aluminium	HCl			22
27	Adathoda vasica	leaves	Aluminium	NaOH			23
28	Phyllanthus amarus leaf extract	leaves	Aluminium alloy	HCl	hypophyllanthin, nirurin, niranthin, phyltetralin, nirtetralin	Langmuir	24
29	Ginseng	root	Aluminium alloy	HCl		Freundlich	25
30	Gongronema latifolium	leaves	Mild steel	HCl	saponins, flavonoids, resins, terpenoids, steroids, glycosides carbohydrates, proteins, fats	Langmuir	26
31	Rutin	-	Aluminium alloy	NaCl			27
32	Red onion skin	-	Mild steel	HCl	Quercetin		28
33	Solanum melongena	leaves	Mild steel	HCl	carotene, nicotinic acid, ascorbic acid and riboflavin	Langmuir	29
34	Euphorbia hirta	leaves	Aluminium alloy	NaOH	n tannin, saponin, alkaloids, ketonic terpenoids and glycosides	Temkin	30,31
35	Dialum guineense	leaves	Low carbon steel	CH_3COOH	Vitamin C, histidine and the amino acid	Langmuir	**32**

36	Newbouldia leavis	leaves	Aluminium alloy	H_2SO_4			33
37	Palisota hirsute	leaves	Aluminium alloy	KOH	tannins, alkaloids, saponins, essential oils, flavones, organic and amino acids	Langmuir and Temkin	34
38	Ziziphus jujuba	leaves	Aluminium alloy	NaOH		Langmuir	35
39	Pisum sativum	peel	Carbon steel	HCl	cysteine sulphoxides		36
40	Solanum tuberosum	peel	Mild steel	HCl and H_2SO_4	thymol		37
41	Citrus reticulate	peel ,	Aluminium alloy,copper	NaOH			38
42	Plumbago eupaea	leaves	Aluminium alloy	NaOH		langmuir, temkin	39
43	Lupinus varius	leaves	Aluminium alloy	NaOH			40
44	Moringa olifera	leaves	Aluminium alloy				41
45	Mentha pulegium oil	leaves and seed	Carbon steel	HCl	p-Menthan-3-one (51.57%), Pulegone (21.3%) and Neomenthol (13.45%)		42
46	Chromolaena odorata	leaves	Aluminium alloy	HCl	essential oils, steroids	Langmuir	43
47	Euphorba hirta	leaves	Aluminium alloy	HCl	Triterpenoids,saponins,essential oils	Langmuir	44
48	Euphorba hirta	leaves	Aluminium alloy	NaOH			45
49	Ipomoea invulcrata	-	Aluminium alloy	HCl			46
50	Aspilia africana		Aluminium alloy	HCl	Niacin,Riboflavin,Thiamine		47
51	Hibiscus sabdariffa	petal	Pure Aluminium	H_2SO_4 and HCl		Langmuir	48,49
52	Sinapis alba	dry powder	Stainless steel	HCl		Langmuir	50
53	Moringa	stem	Aluminiu	NaOH	Arginine		51

	olifera	and bark	m				
54	Terminalia arjuna	stem and bark	Aluminium	NaOH	b-Sitosterol		51
55	Mangifera indica	stem and bark	zinc	hydrogentetraoxosulphate	alkaloids, flavonoids and tannins	Langmuir	52
56	Citrus aurantofolia		Mild steel	H_2SO_4		Langmuir and Freundlich	53
57	Terminalia Chebula		Mild steel	HCl		Langmuir	54
58	Piper nigrum		Mild steel	H_2SO_4	Piperine, Piplartine, Rutin	Langmuir	55,
59	Water melon rind		Mild steel	H_2SO_4 and HCl	citurlline	Temkin	56
60	Musa paradisiana		Mild steel	HCl	Gallocatechin and dopamine	Langmuir	57
61	Nicotiana tabacum		Mild steel	H_2SO_4		Langmuir	58
62	Pectin		Mild steel	HCl		Langmuir	59
63	Hunteria umbellata		Mild steel	H_2SO_4 and HCl		Langmuir	60
64	Vernonia amygdalina		Mild steel	H_2SO_4		Langmuir	61
65	Azadiracta indica		Mild steel	NaCl , H_2SO_4	azadirachtin, azadirone, gedunin, nimbin, nimbandiol, nimbinene, nimbolide, nimonol, nimbolin, salannin,margolone , melianol, vilasanin, and flavanoids	Freundlich	62,63
66	African breadfruit		Mild steel	H_2SO_4	Proteins and carbohydrates	Freundlich	64
67	Ligularia fischeri		Mild steel	HCl		Langmuir	65
68	Elaeis guineensis		Mild steel	HCl		Langmuir	66
69	Thymus algeriensis	leaves and seed	Aluminium alloy	HCl			67
70	Eriobotrya	Leave	Carbon	HCl		Langmuir	68

	Japonika	extract	steel				
71	Cassia Auriculata	flowers	Mild steel	HCl	Sennosides	Tamkins	69
72	Combretum bracteosum	leaves	Mild steel	H_2SO_4	Tannic acid		70
73	Pongamia pinnata				Karanjin, Pongapine, Kanjone		71
74	Andrographis paniculata	leaves	Carbon steel	HCl	Andrographolide		72

V. CONCLUSION

From detailed literature survey it is found that Green corrosion inhibitors (natural products, extracts from plants material, and synthetic low-toxicity compounds) are not only economically feasible to mitigate the problems caused by corrosion but also they are renewable. Environmental regulations in industrialized countries are increasing the pressure to eliminate corrosion, in the short term; a number of compounds are used to protect corrosion in industries. Currently numbers of ecofriendly alternatives as green inhibitors are functioning to minimize environmental impact and providing effective corrosion inhibition. We hope that these green inhibitors will be able to replace the currently used toxic commercial compounds worldwide to reduce corrosion.

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