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Inhibiting effect of seed extract of *Abrus precatorius* on corrosion of aluminium in sodium hydroxide

R. RAJALAKSHMI, S. SUBHASHINI, M. NANTHINI and M. SRIMATHI

Department of Chemistry, Avinahilingam University for Women, Coimbatore - 641 043 (India).

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ABSTRACT

Economic losses due to corrosion are direct, as well as, indirect and affect the economy of country. Corrosion inhibitors are one of the widely used methods to control corrosion. Particular advantage of corrosion inhibitor is that often can be implemented or changed in situation without disturbing a process. Due to toxic nature and high cost of some inhibitors currently in use it is nearly to develop environmentally acceptable and less expensive inhibitors. Natural product can be considered as a good source for this purpose. An evaluation of effective performance of seed extract of abrusprecatorius on corrosion inhibition of aluminium in sodium hydroxide at ambient temperature has been made. Conventional weight loss and polarization measurements techniques were used for evaluation. Surface coverage values were tested graphically for suitable adsorption isotherms.

Key words: *Abrus precatorius,* Corrosion, Sodium hydroxide.

INTRODUCTION

The rapid industrialization of many countries indicates that the competition for the price of metal resources will increase. It is obvious that metals are extremely important in modern engineering, yet many can be badly affected by corrosion.

All metals are thermodynamically unstable and to react with their environment top produce compounds such as oxides or carbonates. This reaction involves the movement of electrons and is called electrochemical reaction. Its corrosion can cause considerable losses to the user. Thus it is a greatest disaster in modern age of science and technology / industrialization. Hence corrosion control is warranted one of practical methods for corrosion protection is use of inhibitors. The most effective and economic way of reducing losses due to corrosion can be achieved by using plant extract. The extracts of some common plants and byproduct (Peels, seeds , fruit shell etc.,) contain many organic compounds. E.g., Organic and amino acids, alkaloids, pigments, proteins and tannins. Most of these constituents are known to have an inhibitor action. Hence in our present study has been carried out to investigate the effect of seed extract of Abrusprecatorius on corrosion of aluminium in sodium hydroxide.

EXPERIMENTAL

In the present study aluminium was selected. Rectangular samples of area 1 x 0.5cm.sq of 4mm have been cut from a large sheet of Aluminium-19500.A hole was drilled in the specimen, mechanically polished degreased thoroughly dried and kept in a desiccators for weight loss test .The experiments were carried out by using 4N sodium hydroxide.

The inhibitor used for this study was Abrusprecatorius the extract was prepared by 2.5 g of dried seed in 500ml of 4N NaOH for 3 hours kept overnight filtered made up to 500 ml to get 5 % extract of the inhibitor. Literature collection reveals presence of following constituents present in seeds of Abrusprecatorius

Plant profile

Gundumani

Botanical name: Abruprecatorious

Family Name: Fabaceae

Tamil Name: Gundumani

Malayala Name: Kunni kuru

English Name: Roasry Pea, Prayer beads, Wild Liquorice, Jequirity bean

Habit: Tree

Propogation: Seeds

Chemical composition: Proteins named Abrins

Parts used: Seeds

Medicinal uses: Cancer cells

Cultivated area: All over world

Price: 100seeds – Rs.10

Number of distinct activities for species =234

Phytochemical constituents

ABRUS PRECATORIUS L.
"CRAB'S EYE"
"JEQUERITY"
ABRALINE SD CRC
ABRASINE PL JSG
ABRICIN PL JSG
ABRIN SD CRC
(+)-ABRINE PL JSG
ABRISIN PL JSG
ABRUSGENIC-ACID PL JSG
ABRUSGENIC-ACID-METHYL-ESTER PL JSG
ABRUSLACTONE PL JSG
ABRUSSIC-ACID PL CRC
ANTHOCYANINS SD HHB
ASH 17,000-81,000 LF CRC
CALCIUM 1,266-2,660 LF CRC
CAMPESTEROL SD CRC
CARBOHYDRATES 137,000-652,000 LI CRC
CHOLINE SD MPI
P-COUMAROYLGALLOYL-GLUCODELPHINIDIN PL JSG
CYCLOARTENOL SD CRC
DELPHINIDIN PL JSG
N,N-DIMETHYL-TRYPTOPHAN SD CCO
N,N-DIMETHYL-TRYPTOPHAN-METHCATION-METHYL-ESTER SD CCO
FAT 28,000 SD CRC
FIBER 37,000-176,000 LF CRC
GALLIC-ACID SD HHB
GLYCYRRHIZIN 100,000 LF HHB
GLYCYRRHIZIN 12,500 RT CRC
HYPAPHORINE SD HHB
KILOCALORIES 620-2,930 LF CRC
PECTIN SD HHB
PENTOSANS 92,100 SD HHB
PHOSPHORUS 650-3,095 LF CRC
PICATORINE SD MPO
POLYGALACTURONIC-ACIDS 58,600 SD HHB
PRECASINE SD JSG
PRECATORINE SD CCO
PROTEIN 56,000-267,000 LF CRC
PROTEIN 194,000 SD CRC
TRIGONELLINE SD MPI
WATER 790,000 LF CRC

Weight loss methods

The weight loss measurements were carried out with varying concentration of the inhibitor from 2 – 14 %. The experiments were conducted at high temperatures (313 K, 323K, 333K, 343K) and in different time intervals ½ an hour, 1-hour, 3-hour, 6-hour. The percentage inhibition efficiency (% IE), rate of corrosion was calculated.

Polarization studies

Tafel polarization curves were recorded potentiodynamically using computerized solartron model 1284Z.

The conventional three electrode glass cell assembly was used with a Aluminum -19500 rod as a working electrode, Pt foil as the counter electrode and calomel electrode as the reference electrode. The cell assembly was immersed in 4N NaOH in the presence and absence of inhibitors after a specific period of time, potentiodynamic polarization studies were carried out a sweep rate of 2mv/sec potential (E) vs. log current (I) plots were recorded.

RESULTS AND DISCUSSIONS

The results pertaining to the present investigation of seed extract of abrusprecatorius are tabulated and discussed.

Effect of Concentration of inhibitor on the corrosion of A1 in 4N NaOH

Fig.1 Depicts the effect of concentration of the plant extract on A1 corrosion in 4N NaOH medium. From the table1 it is understood that the concentrations of the plant extract Abrusprecatorius increase the inhibition efficiency, for all the periods of immersion. The maximum inhibition efficiency was found to be 75.25% at 0.7% concentration during 3 hrs of immersion.

Table 1: Effect of immersion on the IE of AB extract on aluminium

Concentration	½ hr		1 hr		3 hr		6 hr	
(%)	CR (mpy)	IE (%)	CR (mpy)	IE (%)	CR (mpy)	IE (%)	CR (mpy)	IE (%)
0.1	1117	33.8	99	53.7	21829	55.3	72245	48.7
0.2	1090	35.4	82	59.8	19653	59.7	65181	55.8
0.3	969	42.5	75	62.1	16350	66.5	64727	54.0
0.4	964	42.8	68	66.6	15808	67.6	58903	58.2
0.5	923	45.3	67	66.8	15402	68.4	58758	58.3
0.6	859	49.1	64	68.3	14251	70.8	58352	58.3
0.7	765	54.2	61	70.1	12085	75.2	58552	58.4

Table 2: Variation of IE and corrosion rate of AL at higher temperature

Concentration	313k		323k		333k		343k	
(%)	CR (mpy)	IE (%)	CR (mpy)	IE (%)	CR (mpy)	IE (%)	CR (mpy)	IE (%)
0.1	2027	42.6	5041	32.7	15709	6.0	6844	32.9
0.2	1826	48.3	4724	36.9	15623	6.4	6285	38.4
0.3	1737	50.8	4651	38.0	15184	9.0	5893	42.2
0.4	1628	54.0	4548	39.3	14277	14.0	5532	50.9
0.5	1556	55.9	4027	46.6	13514	19.0	5003	50.9
0.6	1523	56.9	3752	49.9	12824	23.2	4989	51.1
0.7	1480	58.1	3685	50.0	12645	54.1	4678	52.2

This may be attributed to the increase in the surface area of the adsorbed molecules of the plant extract on A1 surface. This is represented in the figure1

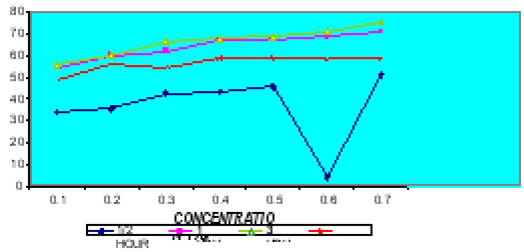

Fig. 1: Effect of concentration of AB on Al corrosion in NaoH

Effect of Time of immersion on A1 in the presence of plant extract (AB)

A1 samples were immersed in 4N NaOH medium and weight loss studies were carried out

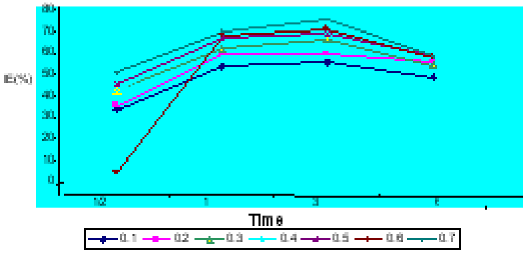

Fig. 2: IE as a function of time of immersion on Al in 4N NaOH

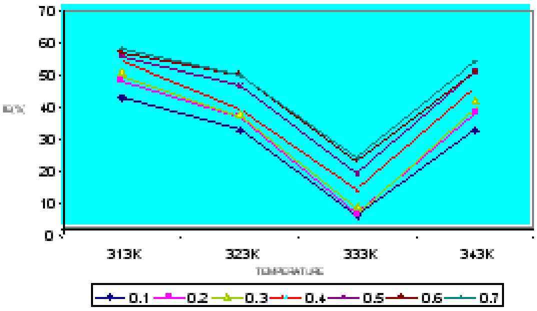

Fig. 3: Influence of temperature on the corrosion behavior of using extract at various concentration

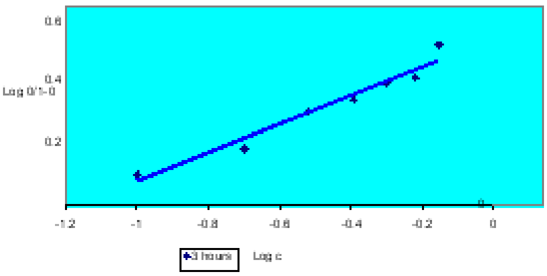

Fig. 4: Langmuir Adsorption isotherm for AB extract in 4N NaOH at room temperature

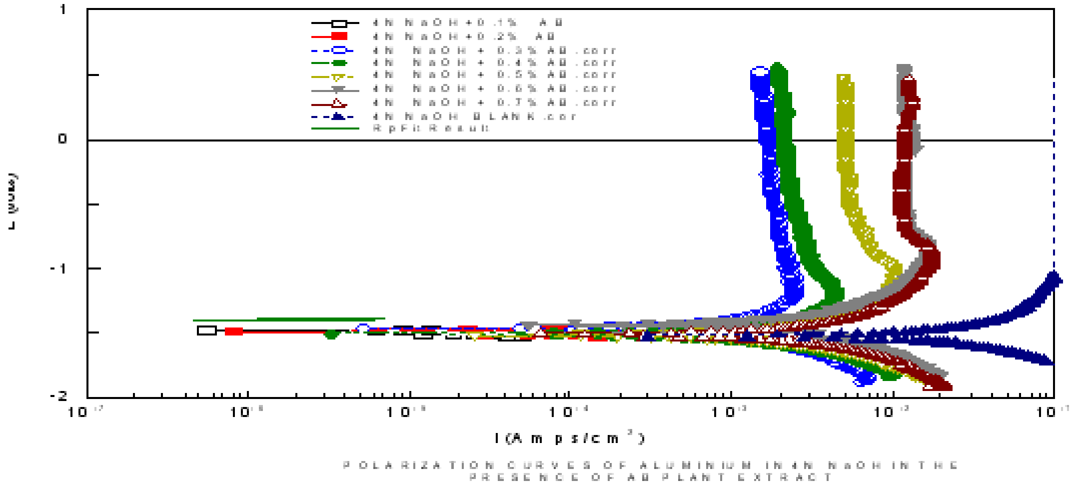

Fig. 5: Polarization curves of Al in the presence of AB extract in NaOH

Table 3: Corrosion parameters of AL in 4N NaOH in the presence of seed extract of AB

S. No	Concentration(%)	I Corr X 10^{-3}	E Corr V	Ba mv/dec	Bc mv/dec	I E (%)
1	Blank	36.77	1.50	537	402	-
2	0.3	17.15	1.46	737	421	53.31
3	0.4	13.47	1.5	577	381	63.36
4	0.5	09.00	1.52	610	445	75.52
5	0.6	4.448	1.43	567	471	87.9
6	0.7	3.188	1.50	388	356	91.5

in the absence and presence of plant extract at various time intervals. Experimental results were shown in the fig. 2. From the figure it is clear that inhibition efficiency was found to be maximum at 3 hours of immersion.

Initially inhibitors efficiency increase from ½ hour to 3 hours and then there is a decline inhibition effect at 6 hours. This behaviour maybe attributed due to the increase in corrosion loss with increase in the time of immersion may be ascribed to changes occurring in the inhibitor and to the built up of metal salts in solution. Many researchers pointed out rather strongly to the fact that the rate increase is carried largely by the increase in active surface area as the metal is attacked. Nevertheless it might have been due to the contamination and weakening of the extract medium by the corrosion product.

Influence of Temperature on A1 corrosion in 4N NaOH

Temperature studies were carried out for A1 corrosion the absence and presence of plant extract by weight loss measurements. Temperature studies are purposeful to learn about thermodynamic parameters and activation energy of the system Table 2, Fig. 3 List the effect of temperature of A1 corrosion in 4N NaOH. From table it can be inferred that as the concentration of the plant extract AB increase the inhibitor efficiency also increase with the temperature increase from 40°- 50°.

The inhibitor efficiency further decline at 60°C.At 700C the efficiency again increase and this can be explained by the following way. With the increase of temperature of equilibrium between adsorption and desorption process is shifted leading to a higher desorption rate than adsorption until equilibrium is again established at a different value of equilibrium constant. It explains the lower inhibition effect at higher temperature especially at higher concentration of the inhibitor.

Initially there may be physical adsorption at 50 and 60 and afterwards there may be chemical adsorption of the plant extracts on A1 surface resulting in the increase in the inhibition effect. In corrosion, generally it is assumed that inhibitor act through a process of adsorption on the metal surface. The adsorption of the inhibitor may determine the structural change of the double layer thus reducing the rate of electrochemical partial reaction. The knowledge of the adsorption behavior of the inhibitor is important for the definition of its active mechanism for this reason various isotherms were studied.

In the present study Langmuir adsorption Isotherm is tried by plotting Log θ / 1- θ Vs log c. the straight line for Langmuir adsorption indicates the inhibitor adsorbs on the A1 surface and there is a formation of monolayer in the A1 surface. This prevents the corrosion of A1 surface in alkaline medium.

Polarization studies

The potentiodynamic polarization studies were performed in a convention three-electrode cell, containing a platinum electrode as the counter electrode, saturated calomel electrode as reference electrode. The Aluminium plate was immersed as work link electrode. The polarization measurements were then started so that a steady open circuit potential was reached. Constant current densities increasing in steps potential were measured at each current density. The measurements were carried out in an stirred test solutions. Corrosion current Icorr were evaluated by the corrosion potential, Ecorr.

Experiment was duplicated and means value was calculated

The results of polarization studies of Al in NaOH with and without the seed extract of AB are furnished in the table.3. From the table the Icorr was found to decrease with increase the concentration of inhibitor. This indicates that the inhibitor inhibits corrosion in aluminium strongly. The inhibitive effect were determined from the value of corrosion current and maximum inhibition effect is to found to be 0.7 concentration

CONCLUSION

It can be concluded from the findings that seed extract of Abrusprecatorius (AB) acts as an effective inhibitor at different concentration at different times of intervals. The efficiency of seed extract of Abrusprecatorius on corrosion of aluminium may be due to presence of phytochemical constituents, which are adsorbed on aluminium surface.

Results are summarized below.

- Maximum inhibition efficiency was found to be at 3 hours of immersion at room temperature.
- Initially there may be physical adsorption at 50°C and 60°C and afterwards there may be chemical adsorption of the plant extracts on Al surface resulting in the increase in the inhibition effect.
- Langmuir adsorption Isotherm was obeyed and it indicates that the seed extract of AB are adsorbed on the Al surface thus forming highly protecting oxide film.
- Thermodynamic parameters ΔG, ΔH and ΔS wer evaluated and the negative value of ΔG inferred that there is a strong interaction between metal surface and the seed extract of AB.
- A value of Activation energy reflects the effectiveness of inhibitor.
- From the polarization studies the values of I_{Corr} decreases with increasing concentration of the inhibitor in for the inhibition are adsorbed on the Al surface.
- Tafel constants ba and bc indicate that the inhibitors are mixed type.
- Inhibition efficiency obtained by weight loss method and polarization method are quite comparable.

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