International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 7 ǁ July 2022 ǁ PP. 163-167

Corrosion Inhibition of Mild Steel in River Water by Aqueous Extracts of Rhaphidophora Pertusa

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ABSTRACT
The Rhaphidophora pertusa extract is controlling the corrosion of mild steel in river water has been studied by weight loss method and electrochemical impedance spectroscopy in the absence and presence of Rhaphidophora Pertusa extract at different time interval and temperature. The inhibition efficiency increases with increases the concentration of Rhaphidophora pertusa extract and immersion period. The inhibition efficiency increased with increasing tempreature. Surface analysis (SEM, FT-IR) was also carried out to establish the corrosion inhibitive property of this plantextract in river water. The plant extract is able to reduce the corrosion of carbon steel more effectively in 50 ppm than 500 ppm river water media.
Keywords: *corrosion inhibitor, Mild steel, plant extract, weight loss method ,FT-IR, SEM*

Date of Submission: 25-06-2022 Date of acceptance: 06-07-2022

I. INTRODUCTION

CORROSION

Corrosion is the deterioration of materials due to chemical reaction with the environment resulting in the new and less desirable material from the original. The word "corrodere", which means"to gnaw to pieces". Although most of the times corrosion refers to metals, other materials such as glass and polymers also undergo corrosion. Corrosion destroys the beauty and luster of the metal andshortens its life. Metals undergo oxidation ($M \rightarrow M^{+}+e^{-}$) and this is facilitated by suitable electron acceptor in the environment. As the free energy of pure metal is higher than low energy metal oxide, metals have strong tendency to return to its native low energy oxide state. This process of coming backto the native oxide state is called as corrosion. Corrosion not only leads to repair or replacement of thestructures but also becomes a threat to natural resources and even causes potential hazards. Accidents resulted from corroded structures can lead to safety concerns, loss of life, destruction of resources, andmore. Failed pipelines cause pollution of drinking water. Corroded engines affect automobiles, ships and aircrafts. Damaged machineries affect petrochemical production food processing, mining,agricultural production and defense. Inefficient bridges cause collapse leading to death and other crisisoften leads to huge indirect costs like traffic delays, public outcry etc. When medical prosthetic implants such as pacemakers, hip joints and plates corrode, serious health problems occur. Consequences of corrosion in industrial plants lead to many economic issues such as overdesign, maintenance, contamination of product, loss of efficiency, inability to use desirable materials, damageof the adjacent equipment, etc. Corrosion is one of the growing issues which have high impact on economy of the country. Many countries made attempts to determine national cost of corrosion. According to an estimation, corrosion both in direct and indirect ways accounts for the lossof about thousand billion rupees in India alone. A study carried out on United States in 1976 revealed that annual cost of metallic corrosion to the U.S. economy was $70 billion, or 4.2% of the gross nationalproduct. Corrosion of metals not only influences economy but also affects technology. Because, implementation of new technology requires materials which withstand high temperature, pressure andcorrosive environments.

Pickling is the removal of any high temperature scale on the surface of metals. Pickle liquor is used to remove impurities like inorganic contaminants and any adjacent low chromium layer of metal from the surface of stainless steel. Pickle liquor is a solution containing strong acids like hydrochloric acid, sulphuric acid and nitric acid. Pickling is commonly used in cleaning and descalingof steel in various steel manufacturing processes (Fig 1.3.). In industries, when steel is exposed to hot working processes and other processes at high temperatures, a discolouring oxide layer scale will be developed on the surface. So, the work piece is dipped into a vat of pickle liquor to remove the unwanted scale. In processing industries, the steel is subjected to welding or other heating processes till colored oxide layer is seen. This results in the depletion of chromium on

the surface if the steel underneath the oxide layer. Lower chromium content reduces corrosion resisting capacity. To restorethe high anti-corrosion performance, the damaged metal layer must be removed. Chemical means of removal (application of inhibitor) is better than mechanical removal because mechanical removal may leave abrasive or other particles embedded.

II. SCOPE AND OBJECTIVE OF THE STUDY

The present study is to Eco- friendly inhibitors system using readily available extract of plantsand Zinc as synergist for corrosion inhibition of carbon steel in river water and evaluate its immersion on the Corrosion Rate and Inhibition efficiencies of the Inhibitor system. The objectives of the present study is to investigate the role of various Ph on the formation of protective film on the surface and its conformed by synergism parameter and F- test and potentiodynamic polarization and impedance studies. Further I will conformed by FTIR spectroscopy and scanning electron measurements.

III. MATERIALS AND METHODS

The mild steel specimens were chosen from the same sheet to the following composition

Types of Element	**Carbon**	**Sulphur**	**Phosphorus**	**Manganese**	**Iron**
Percentage of composition	0.1%	0.0267%	0.06%	0.4%	99.287%

The analysis of the specimen was carried out by the optical emission spectroscopy technique at the National Metallurgical laboratory unit at the CSIR complex, Taramani, Chennai, India. Mild steel specimens of the dimensions 1.5 cm × 3.5 cm × 0.2 cm polished tomirror finish with 1/0, 2/0, 3/0, 4/0, 5/0, and 6/0 emery polishing papers and degreased with acetone and were used in the weight loss studies and surface examinations studies by FTIR. Forpotentiodynamic polarization studies and impedance studies, 1 cm × 1 cm × 0.2 cm piece of same material was welded on to a mild steel rod. That piece was polished to mirror finish with1/0, 2/0, 3/0, 4/0, 5/0 and 6/0 emery polishing papers and degreased with acetone. Barring the1 cm^2 surface to be exposed for electrochemical studies, the rest of the piece and rod were covered with araldite paste.

Rhaphidophora pertusa

The plant extract was prepared by refluxing 20 g of dried leaves of Rhaphidophora pertusa with 200 ml of well water for 3h. pure analytical grade reagents and double distilled water were used for the preparations of solutions. The extracts were then filtered off and made up to 100 ml. From this solution, different concentrations of the plant extract were made.

IV. RESULT AND DISCUSSIONS

Analysis of weight loss study: (RP-Zn^{2+} system)

RP (ppm)	**IE%**			**CR (mmpy)**		
	Zn^{2+} (ppm)			**Zn^{2+} (ppm)**		
	0	**25**	**50**	**0**	**25**	**50**
0	-	14	22	0.8192	0.7041	0.6387
100	45	49	61	0.4502	0.4174	0.31666
200	52	56	67	0.3929	0.3600	0.2702
300	58	63	73	0.3440	0.3027	0.2209
400	64	70	81	0.2618	0.2453	0.1555
500	68	77	94	0.2867	0.1880	0.0898

Corrosion rate (CR) and Inhibition Efficiency of RP-Zn^{2+} system(Period of immersion: 1 day)

SYNERGISM PARAMETER (SI):

RP(ppm)	**Zn^{2+}(50ppm)**	**Θ1**	**Θ2**	**Θ'1+2**	**SI**	**IE%**
100	50	0.45	0.22	0.61	1.1000	61
200	50	0.52	0.22	0.67	1.1345	67
300	50	0.58	0.22	0.73	1.2133	73

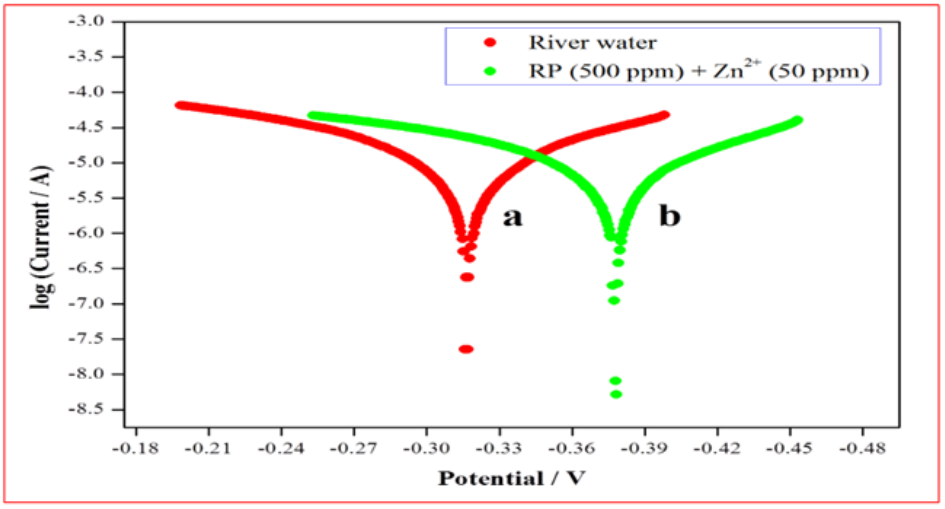
400	50	0.64	0.22	0.81	1.4778	81
500	50	0.68	0.22	0.94	2.2690	94

RP-Zn^{2+} at 500:50 ppm, S_I = 2.2690 indicates the existence of synergism between RP and Zn^{2+}

POTENTIODYNAMIC POLARIZATION STUDY

System	E_{corr}(mV vSCE)	b_a(mV/dec)	b_c(mV/dec)	LPR(Ω cm^2)	i_{corr}(A/cm^2)
Blank (RW)	-316.65	136.49	132.89	2334	12.533 × 10-4
RP-Zn^{2+} (500:50ppm)	-378.27	151.95	158.44	4072	8.270 × 10-4

Corrosion Parameters of carbon steel in RW by polarization method with and withoutRP-Zn^{2+} system

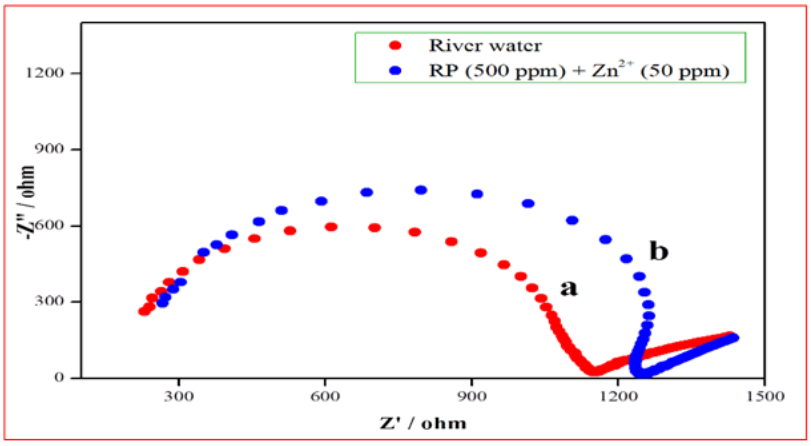


Polarization curves correlation of carbon steel in RW and RP-Zn^{2+} system

4.3. AC IMPEDANCE SPECTRA

System	Rct (Ω cm^2)	Cdl (µF/cm^2)
Blank (RW)	858	3.0931 × 10^{-7}
RP-Zn^{2+} (500:50 ppm)	981	2.9531 × 10^{-7}

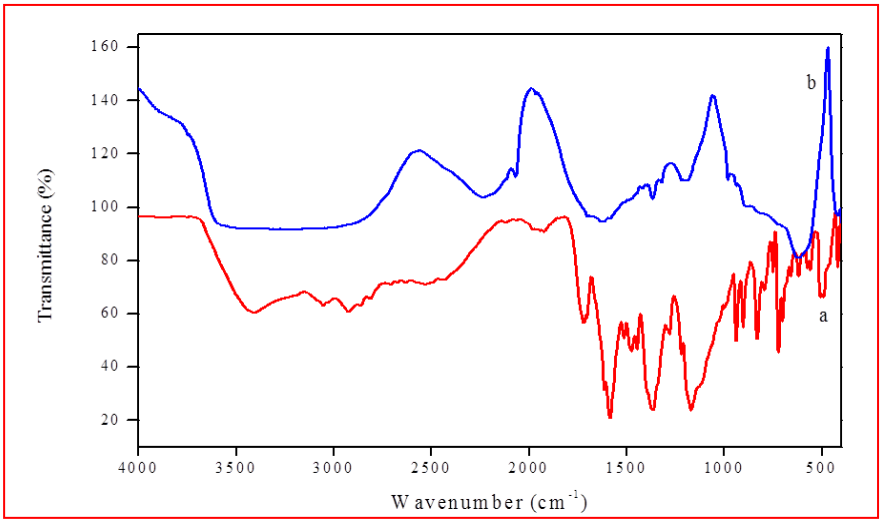
AC impedance parameters of RW and RP-Zn^{2+} system



AC impedance spectra (a) Blank-RW (b) RP-Zn^{2+} system

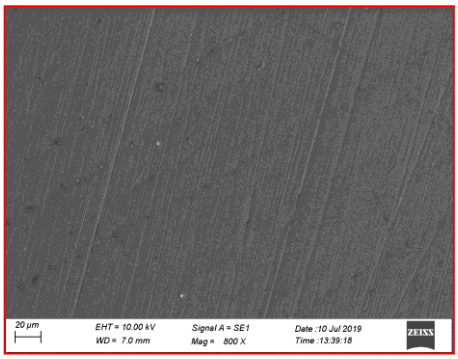
ANALYSIS OF FT-IR SPECTRA:

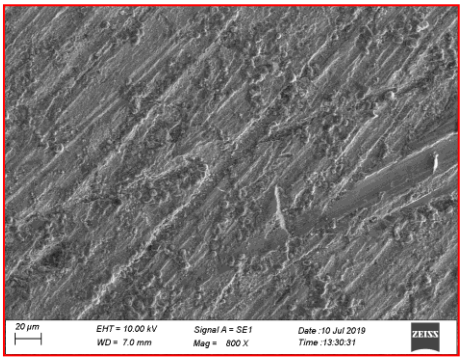
The FT-IR spectrum of the film formed on the surface of metal immersed in RP-Zn^{2+} system is depicted in Figure 4.5.5.b. The –OH stretching frequency appears at 3215 cm^{-1}. A band at 1699 cm^{-1} indicates C=O stretching frequency. The band observed at 1585 cm^{-1} is due to C=C stretching frequency. A band at 1419 cm^{-1} can be attributed to the –CH bending vibration. These shiftsconfirms that the electron cloud density of -OH, C=C and –CH functional groups in RP has coordinated with Fe^{2+} ions presents on the metal surface **Error! Reference source not found.**. The Zn-Ostretching frequency appears at 615 cm^{-1}. Thus it is concluded that Fe^{2+}-RP protects the anodic regionand Zn(OH)2 protects the cathodic region **Error! Reference source not found.** of the metal surface. Thus,process of corrosion is inhibited.



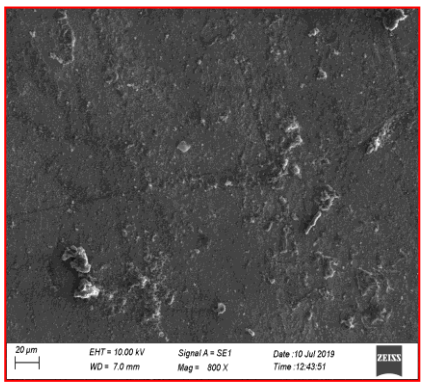
FT-IR spectra (a) dried RP extract (b) RP-Zn^{2+} (500:50 ppm)

ANALYSIS OF SCANNING ELECTRON MICROSCOPY





Carbon steel – Polished Blank (RW)



RP-Zn^{2+} system (500:50 ppm)SEM images

V. CONCLUSION:

Plant products are organic in nature, and some of the phyto consitiuents including tannins, amino acids, alkaloids, and pigments are known to exhibit inhibiting action. The mechanistic aspects of corrosion inhibition are discussed based on the results obtained from the classical weight-loss method, potentiodynamic polarization study, AC impedance measurements, FT-IR spectroscopy, surface analysis techniques like scanning electron microscopy SEM.

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