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Corrosion Inhibition of Mild Steel Alloy by the Influence of Natural Extracts in the Presence of Dye Effluent

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ABSTRACT: The inhibition potentials of two natural extracts (Prawn shell extract, Muntingia fruit extract) was investigated by evaluating the corrosion behavior of the mild steel and copper alloy immersed in dye effluent solution containing natural extract. Linear polarization resistance, corrosion current charge transfer resistance, double layer capacitance and impedance were utilized to evaluate the corrosion inhibition and adsorption properties of the natural extract. Scanning Electron Microscopy studies (SEM) provided the confirmatory evidence of improved surface condition, due to adsorption, for the corrosion protection. Impedance measurement has shown that the change in the impedance parameter like charge transferred resistance with the addition of extract is due to the adsorption active molecules leading to the formation of a protective layer on the surface of the MS Alloy.

KEYWORDS: Corrosion, Inhibition, Polarization, Impedance, Natural Extracts, MS alloy.

I. INTRODUCTION

Metals are widely used in human activities due to excellent mechanical and electrical properties^[1-4]. In order to preserve the desired state of these metals, their prevention maintenance is a priority. Corrosion is probably the most desired phenomenon that leads the metals to become weaker^[5,6]. This natural process originates from the electrochemical interaction of metals with the corrosive environment. Sulfides, oxides and others are generated through reactions between the metal surface and corrosive medium^[6-9]. Mild steel is most widely used in oil, food, energy, chemical, construction industries due to its different application, most of which based on its excellent mechanical properties. This metal shows high mechanical resistance, durability and toughness, among others, which makes it a highly available material and at a relatively low cost. However the versatility of mild steel and its performance is continually being threatened as it is subjected to corrosive environmental degradation. To the lesser extent, copper alloy are studied as well. The high cost associated with corrosion, due to the replacement of rusted metals, can be reduced by using corrosion inhibitors^[10]. The use of many inorganic and synthetic inhibitors to resist the corrosion, but their use is now marred by their toxicity and high cost of manufacturing. This has prompted researchers to explore other areas to produce eco friendly, cheap and biodegradable green corrosion inhibitors to replace the inorganic and synthetic inhibitors. The use of plant extract, fruits extract, biomass waste as green corrosion inhibitors to reduce the corrosion rate of metals and receiving strong performance^[11]. This present work is undertaken to evaluate the corrosion resistance of mild steel and copper alloy by using two natural extract like prawn shell extracts, muntingia fruit extract in methylene blue dye effluent. To investigate the corrosion behaviour of mild steel and copper alloy in dye effluent by polarisation study and AC impedance spectra.

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II. METHODOLOGY

2.1 Sample preparation

Alloy specimens namely MS Alloy were put to use as Test material for this study .The Chemical Composition of the alloys is presented in Table.

Table 1: Types of wires used and their composition

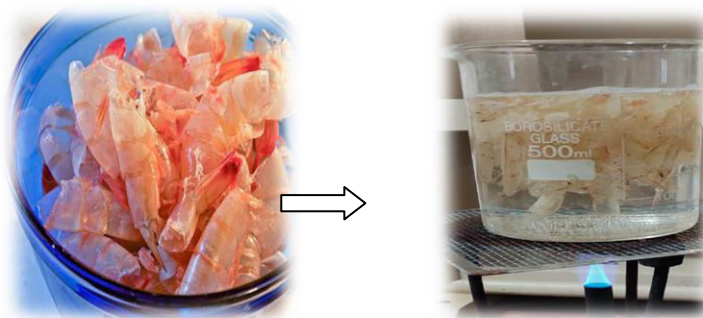
S.NO	Types of work	Composition (%)
1	MS Alloy	C – 0.16 to 0.18 %, Mg – 0.70 to 0.90 %, Si – 0.40 %, S – 0.04 %, P – 0.04 %

2.2 Methylene Blue Dye

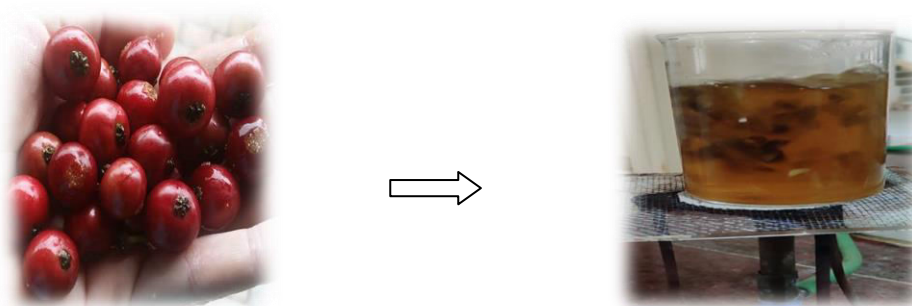
Methylene blue used as blank solution as well as inhibitor.

2.3. Preparation of test solution

The Dye effluent was used as corrosion medium to discover the inhibition potential of two natural extracts such as Prawn shell extract, Muntingia fruit extract.



Boiled the dried shrimp shell and filtered that extract



Boiled the dried muntingia calabura fruit and filtered that extract

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2.4. Inhibitor System

- ❖ 100ml of natural extract of Prawn shell, Muntingia fruit and tobacco in a standard measuring flask.
- ❖ 40 ml of natural extracts were mixed with 60 ml of Dye effluent (blank) in a standard measuring flask. This solution mixture was used to assess the corrosion resistance of metal alloy by way of various electrochemical and surface characterization studies.

2.5. Various Environment

Table 2:

S.No	Natural Extract	Environment
1	Prawn shell	a) Blank b) Prawn shell extract c) Blank + Prawn shell extract
2	Muntingia calabura fruit	a) Blank b) Muntingia calabura fruit extract c) Blank + Muntingia calabura fruit extract

Table 3: Environment for surface examination study

S.No	Specimen	Natural Extract	Environment
1	MS Alloy	Prawn shell	a) Blank b) prawn shell extract c) Blank + Prawn shell extract
		Muntingia calabura fruit	a) Blank b) muntingia calabura fruit extract c) Blank + muntingia calabura fruit extract

III. RESULT AND DISCUSSION

3.1. Analysis of polarization curves

Potentiodynamic polarization study is used to explore the corrosion inhibition (CI) of metals and alloys. When CR decreases, there is increase in linear polarization resistance (LPR) and decrease of corrosion current (I_{corr}). Fig 4.1 to 4.3, illustrates the polarization curves (Tafel plots) of MS alloy evaluated in various test solutions at a room temperature.

3.1.1. MS Alloy – Prawn Extract

The polarization curves of MS alloy is immersed in various test solution are shown in figure 4.1.corrosion parameters namely corrosion potential (E_{corr}), Tafel slopes (bc;ba), corrosion current(I_{corr}), Linear Polarization Resistant(LPR) are given in table 4.

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Table 4: Corrosion parameters of MS Alloy immersed in various test solution for Polarization study.

Alloy	System	E _{corr} mV/SCE	B _c V/decade	B _a V/decade	LPR ohm cm ²	I _{corr} A/cm ²
MS	Blank	-897	0.1860	0.2585	114135	4.131×10 ⁻⁷
	Prawn	-991	0.1488	0.3266	113095	3.929×10 ⁻⁷
	Blank + Prawn	-860	0.1409	0.1760	298523	1.140×10⁻⁷
	Blank	-897	0.1860	0.2585	114135	4.131×10 ⁻⁷
	Muntingia	-934	0.1661	0.2678	67237	6.630×10 ⁻⁷
	Blank + Muntingia	-962	0.1517	0.2175	92582	4.196×10 ⁻⁷

When MS Alloy immersed in Blank, LPR value is 114135 ohm cm². The corrosion current (I_{corr}) value is 4.131 x 10⁻⁷ A/cm². The corrosion potential (E_{corr}) value is -897 mV vs SCE. When MS alloy immersed in Prawn extract system, the LPR value is increases to 298523 ohm cm² and the corrosion current value increases to 1.140x10⁻¹⁰ A/cm² further decreases. This indicates that corrosion resistance of MS alloy increases in Blank + Prawn System, Thus the polarization study leads to the conclusion that MS Alloy is immersed in various test solution, the decreasing order of corrosion resistance of MS Alloy is as follows:

Blank + Prawn extract > Blank + Muntingia extract

In this medium of the MS Alloy in Blank + Prawn increases.

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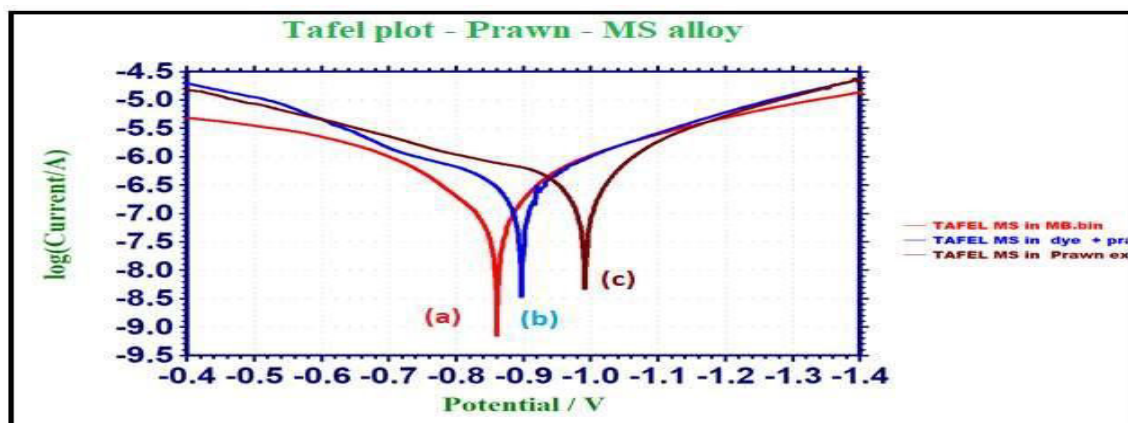


Fig:1.1 Polarization curve of MS alloy immersed in various test solution (a) Dye effluent; (b) Dye effluent + Prawn Shell extract

3.1.2. MS Alloy – Muntingia Extract

The polarization curves of MS Alloy immersed in various test solution are shown in fig 4.2. The corrosion parameters namely corrosion potential (E_{corr}), Tafel slopes (b_c/b_a), corrosion current (I_{corr}), Linear Polarization Resistant(LPR) are given in table 4. When MS Alloy immersed in Blank (Dye Effluent), LPR Value is 114135 ohm cm^2 . The corrosion current (I_{corr}) value is 4.121×10^{-7} A/ cm^2 . The corrosion potential (E_{corr}) is -897 mV vs SCE. When compared to the one in Blank system and Muntingia extract, LPR Value further increases to 92582 ohm cm^2 and the corrosion current (I_{corr}) value is 4.196×10^{-7} A/ cm^2 . This indicates that corrosion resistance of MS Alloy increases in Blank + Muntingia extract system. Thus the polarization study leads to the conclusion that when MS alloy immersed in various test solution, the decreasing order of corrosion resistance of MS alloy is as follows:

Blank + Muntingia extract < Blank + prawn extract

This study suggest that MS alloy having lower corrosion resistance for Muntingia extract.

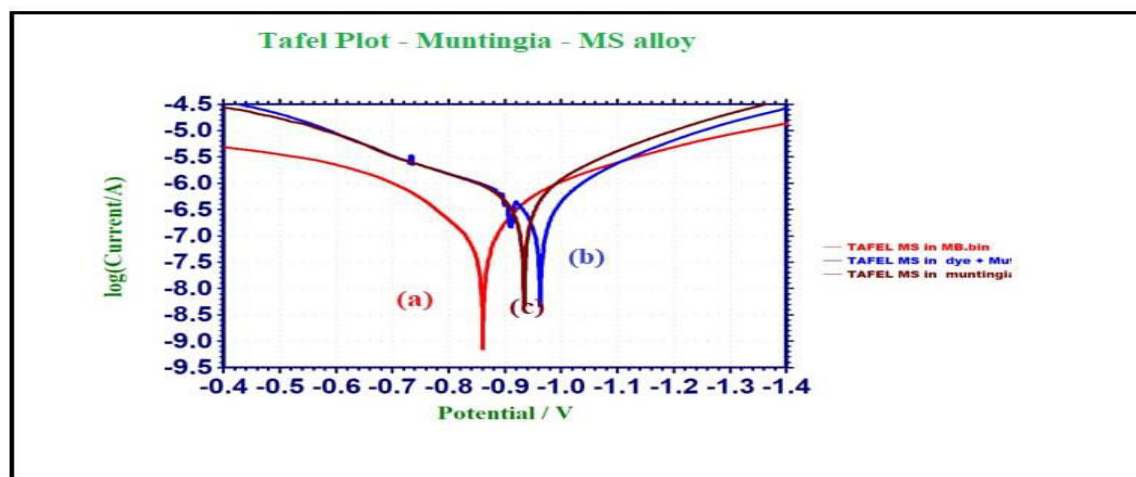


Fig:1.2 Polarization curve of MS alloy immersed in various test solution (a) Dye effluent; (b) Dye effluent + Muntingia extract

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3.2. AC Impedance spectral study

The AC impedance spectra of MS alloy immersed in various test solution are shown in figure 1.3 and 1.5 (Nyquist plot) and figure 1.4 and 1.6 (Bode plot). The corrosion parameters are given table 5.

Table 5: Corrosion parameters of MS alloy immersed for AC impedance spectra

Alloy	System	Nyquist Plot		Bode Plot	
		R_t Ohm cm ²	C_{dl} F/cm ²	IMP value log (Z/Ohm)	Phase Angle
MS	Blank	3723	2.8849×10^{-10}	3.359	60.53
	Prawn	9190	5.5495×10^{-10}	1.072	55.49
	Blank + Prawn	17678	1.3669×10^{-9}	1.077	59.36
	Blank	3723	2.8849×10^{-10}	3.359	60.53
	Muntingia	4001	1.275×10^{-9}	1.077	60.26
	Blank + muntingia	2962	1.7218×10^{-9}	1.087	57.78

3.2.1. MS Alloy – Prawn extract

When MS alloy is immersed in Dye effluent the Charge Transfer Resistance (R_t) value is 3723 ohm cm². The Double layer capacitance (C_{dl}) value is 2.8849×10^{-10} F/cm². The Impedance log(Z/ohm) value is 3.359. When MS alloy is immersed in Blank + Prawn extract system the Charge Transfer Resistanc (R_t) increases to 17678 ohm cm². Double Layer capacitance (C_{dl}) value increases to 1.3699×10^{-9} F/cm². The impedance log (Z/ohm)) value is 1.077. This indicates that the corrosion resistance of MS alloy in Blank + Prawn extract system further increases. Thus AC impedance spectra lead to the conclusion that the corrosion resistance of MS alloy immersed in various test solution decreases in the following order.

Blank + prawn extract > Blank + Muntingia extract

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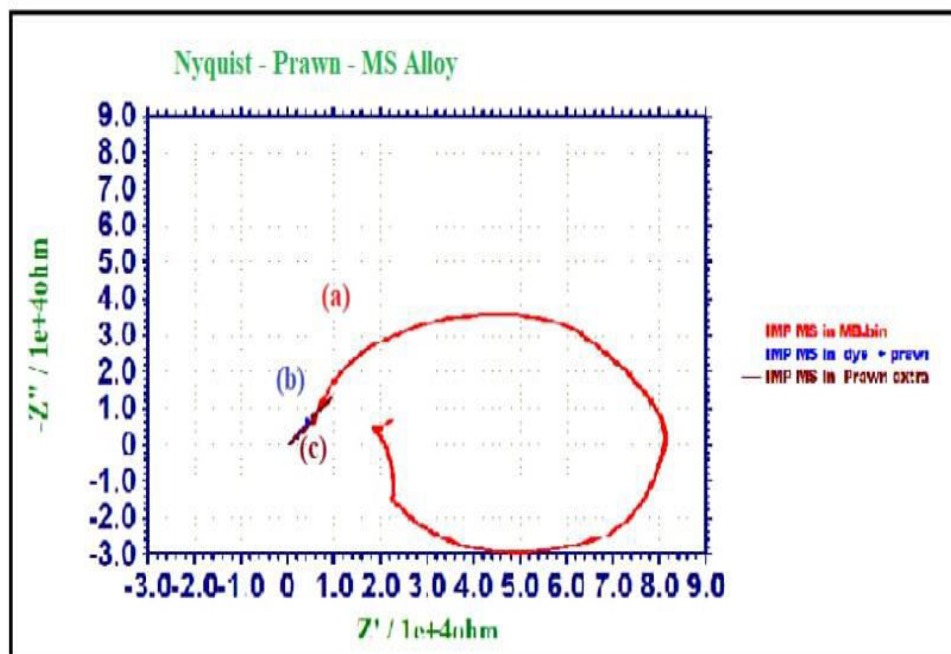
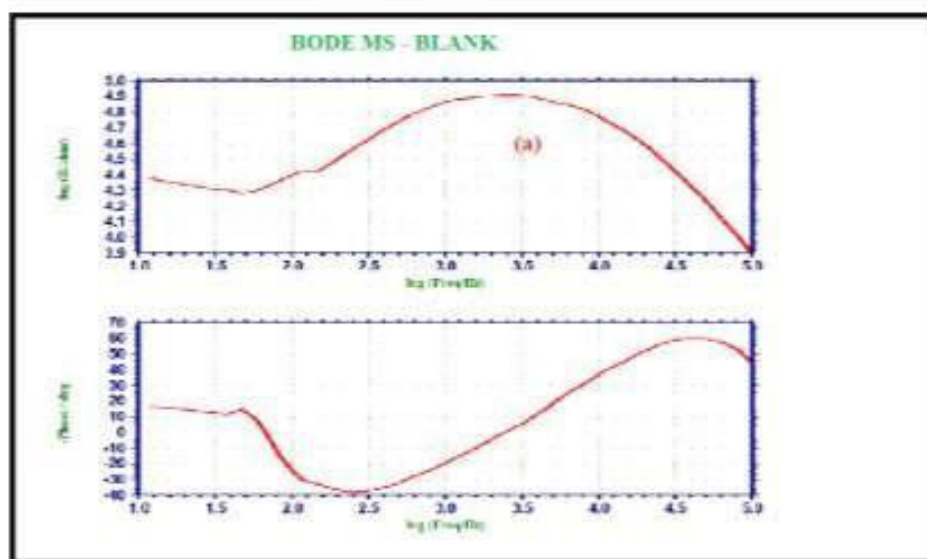


Fig: 1.3 AC impedance spectra for MS alloy immersed in (a) Dye effluent;
(b) Dye effluent + Prawn extract (Nyquist plot)



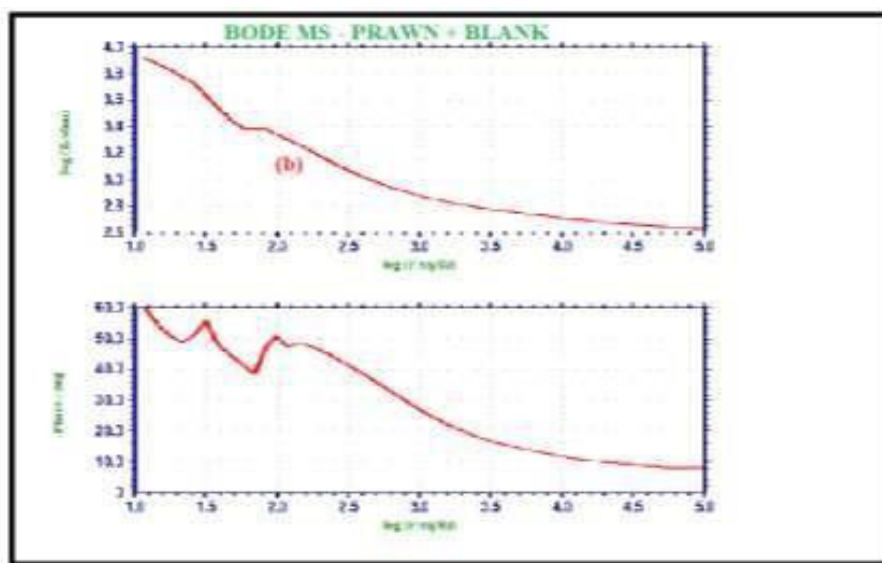


Fig:1.4 AC impedance spectra for MS alloy immersed in (a) Dye effluent;
(b) dye effluent + prawn extract (Bode plot)

3.2.2. MS Alloy – Muntingia extract

When MS alloy is immersed in Dye effluent the Charge Transfer Resistance (R_t) value is 3723 ohm cm^2 . The Double layer capacitance (C_{dl}) value is $2.8849 \times 10^{-10} \text{ F/cm}^2$. The Impedance log (Z/ohm) value is 3.359. When MS alloy is immersed in Blank + Muntingia Extract system the Charge Transfer Resistance (R_t) increases to 2962 ohm cm^2 . The Double Layer capacitance (C_{dl}) value decreases to $1.7218 \times 10^{-9} \text{ F/cm}^2$. The impedance log (Z/ohm) value is 1.087. This indicates that the corrosion resistance of MS alloy in Blank + Prawn extract system further increases. Thus AC impedance spectra lead to the conclusion that the corrosion resistance of MS alloy immersed in various test solution decreases in the following order.

Blank + Muntingia extract < Blank + prawn extract

Thus AC impedance spectra leads to the conclusion that MS alloy having higher corrosion resistance for Muntingia extract.

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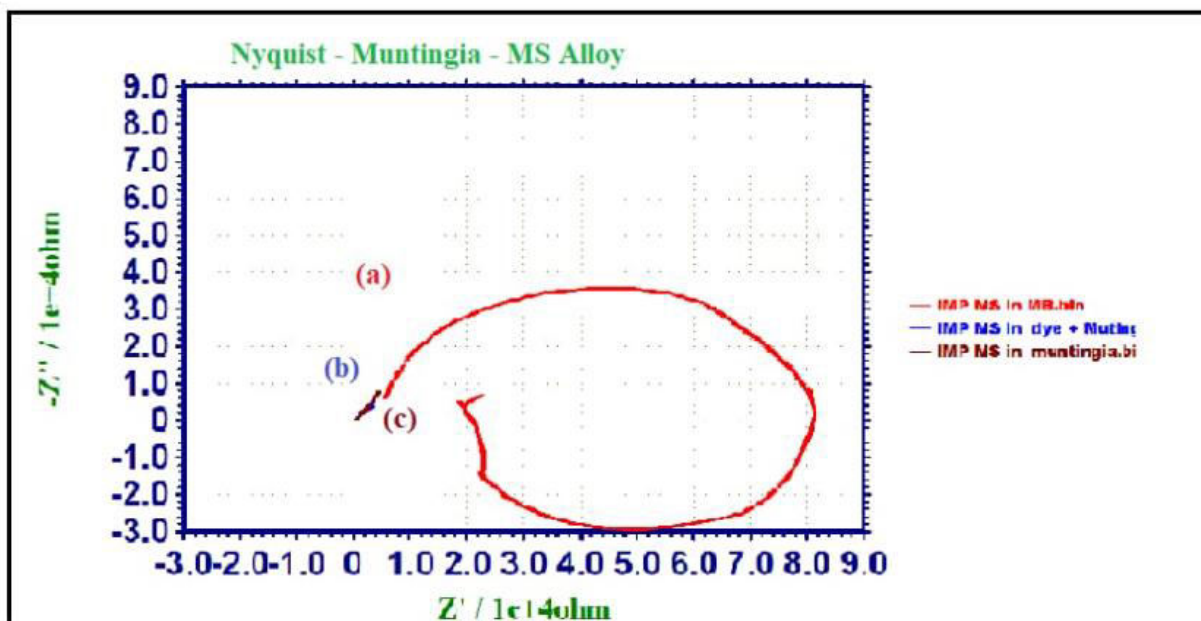
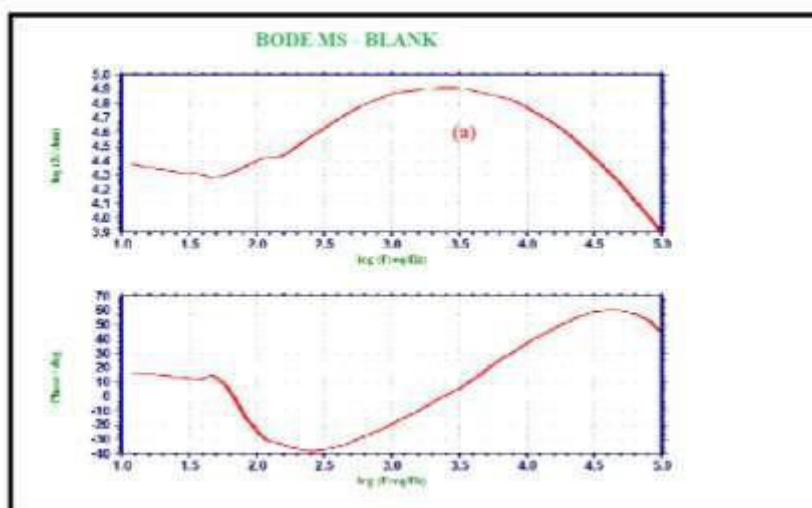


FIG:1.5 AC impedance spectra for MS alloy immersed in (a) Dye effluent; (b) Dye effluent + Muntingia extract (Nyquist plot)



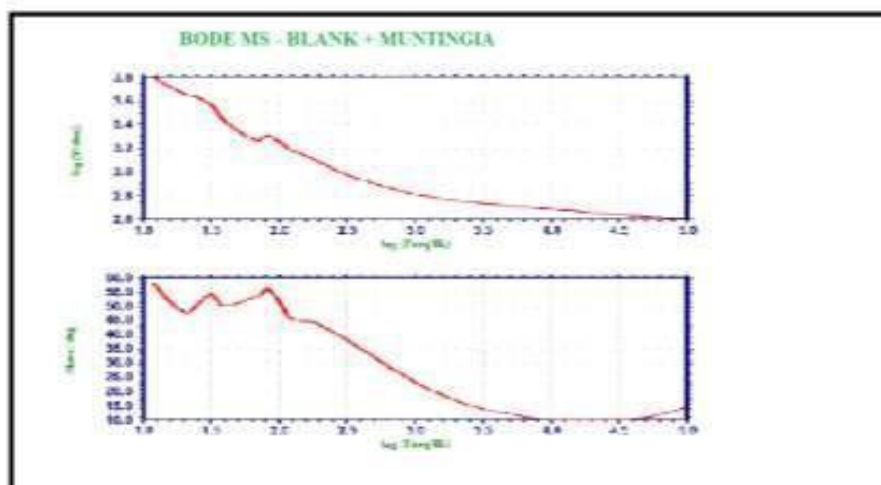


Fig:1.6 AC impedance spectra for MS alloy immersed in (a)Dye effluent; (b) Dye effluent + Muntingia extract (Bode plot)

3.3. Scanning Morphology study

Scanning Electron Microscopic (SEM) studies

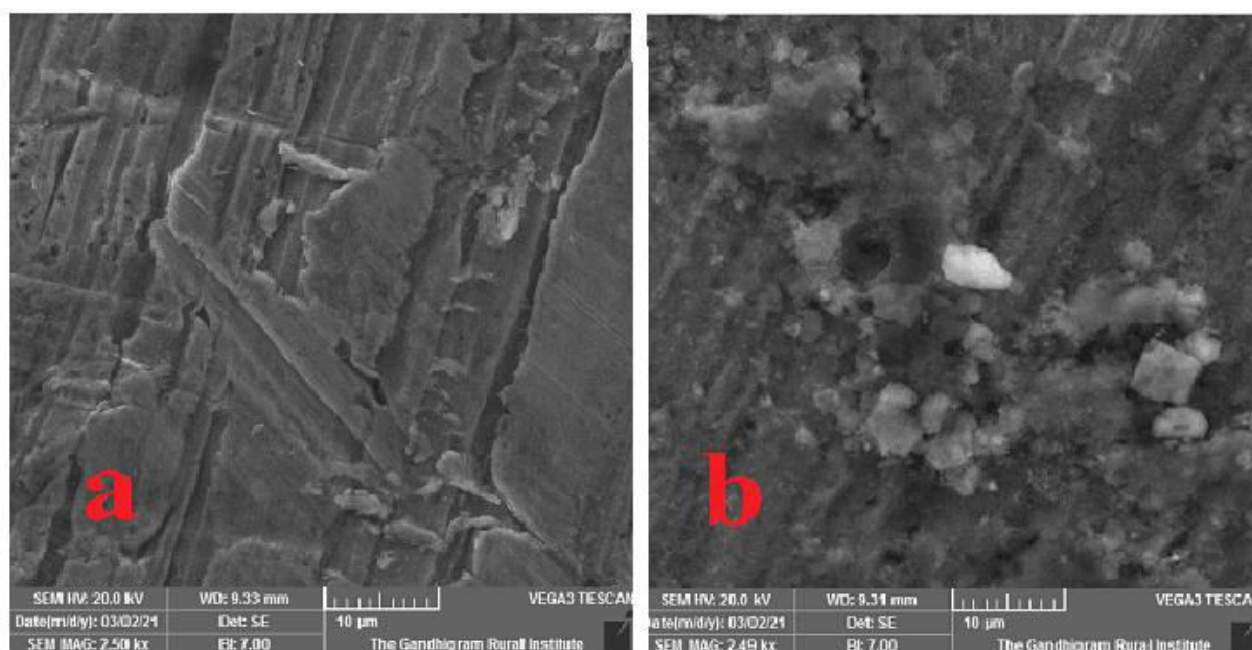


Fig:1.7 SEM Image (a) Polished MS (b) MS + Prawn extract

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The two dimensional representation of the surface gives the nature of the protective film formed on Metal surface. Gives the SEM images of polished surface of MS alloys exposed for one day in dye solution for the uninhibited and inhibited. In comparing SEM microgram of MS alloy, there was rough surface for uninhibited solution and smooth surface for inhibited solution with extract of dye effluent in forming an insoluble complex of MS Prawn extract on the surface. Thus, it had become free from corrosion. The inhibitor effectively controls the dissolution of MS alloy.

In figure 1.7(b), the manufacturing defects on surface were noticeable as well as the scratches imprint that could be attributed to mechanical polishing by MS course polishing paper.

IV. CONCLUSION

The natural products are used as inhibitor MS alloy affected by dye effluent. The electrochemical reaction occurring on the alloy's surface lead to the formation of chemical compound .the chemical reaction lead to the materials with the under degradation . The corrosion is the deterioration of a material due to interact with its environment. It is the process in which metallic atoms leave the metal or form compounds in the presence of water and gases. Alloy can be corroded by the direct reaction of metal to a chemical. Corrosion is a global problem that has played building, monuments, equipment and infrastructure for centuries. The systematic analysis of natural extracts as corrosion inhibitors and also use of various electrochemical techniques, examination techniques besides. The polarization studies a AC impedance studies SEM. so as to bring out some useful conclusion regarding the mechanistic aspects of corrosion inhibition by MS alloy. The surface analytical studies like SEM, also provide better understand about the reaction takes place on the metal surface. The order of corrosion inhibition of metal alloys using natural extracts system as experiment by polarization study. The both studies used MS alloy happened to show high corrosion resistance. It is considered to be (MS + Dye effluent + prawn shell extract) a weak system among alloy used. The highest resistance to corrosion of the MS Alloy was shown by Prawn shell extract. The practitioner can use the outcomes of our experiment to decide or recommend to their corrosion inhibition of natural products to maintain the corrosion is MS alloy.

REFERENCES

- [1] Parthipan, P. Elumalai, P. Narenkumar, J. Machuca, L.L. Murugan, K. Karthikeyan, O.P. Rajasekar, A. Allium sativum (garlic extract) as a green corrosion inhibitor with biocidal properties for the control of MIC in carbon steel and stainless steel in oilfield environments. *Int. Biodeterior. Biodegrad.* **2018**, 132, 66–73.
- [2] Loto, R.T. Olowoyo, O. Synergistic effect of sage and jojoba oil extracts on the corrosion inhibition of mild steel in dilute acid solution. *Procedia Manuf.* **2019**, 35, 310–314.
- [3] Anupama, K.K. Ramya, K. Joseph, A. Electrochemical measurements and theoretical calculations on the inhibitive interaction of *Plectranthus amboinicus* leaf extract with mild steel in hydrochloric acid. *Measurement* **2017**, 95, 297–305.
- [4] Verma, C. Ebenso, E.E. Bahadur, I; Quraishi, M.A. An overview on plant extracts as environmental sustainable and green corrosion inhibitors for metals and alloys in aggressive corrosive media. *J. Mol. Liq.* **2018**, 266, 577–590.
- [5] Zhu, Y. Wang, L. Behnamian, Y. Song, S. Wang, R. Gao, Z. Hu, W. Xia, D.H. Metal pitting corrosion characterized by scanning acoustic microscopy and binary image processing. *Corros. Sci.* **2020**, 170, 108685.
- [6] Mai, W. Soghrati, S. Buchheit, R.G. A phase field model for simulating the pitting corrosion. *Corros. Sci.* **2016**, 110, 157–166.
- [7] Kıcı, N. Tansuğ, G. Erbil, M. Tüken, T. Investigation of ammonium (2,4-dimethylphenyl)-dithiocarbamate as a new, effective corrosion inhibitor for mild steel. *Corros. Sci.* **2016**, 105, 88–99.
- [8] Singh, P. Srivastava, V. Quraishi, M.A. Novel quinoline derivatives as green corrosion inhibitors for mild steel in acidic medium: Electrochemical, SEM, AFM, and XPS studies. *J. Mol. Liq.* **2016**, 216, 164–173.
- [9] El Ibrahim, B. Jmiai, A. Bazzi, L. El Issami, S. Amino acids and their derivatives as corrosion inhibitors for metals and alloys. *Arab. J. Chem.* **2020**, 13, 740–771.
- [10] Ladan, M. Basirun, W.J. Kazi, S.N. Rahman, F.A. Corrosion protection of AISI 1018 steel using Co-doped TiO₂/polypyrrole nanocomposites in 3.5% NaCl solution. *Mater. Chem. Phys.* **2017**, 192, 361–373.
- [11] Rekha N Nair, green corrosion inhibitor for mild steel in acidic medium, *International journal of modern trends in engineering and research*, **2017**, 4(12), 2393-8161.



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