MANTECH Publications

Journal of Research in Physics and Applied Sciences
Volume 4, Issue 2, July-December 2021

Anticorrosion Potential of Cardiospermum Halicacabum on Mild Steel in Sulphuric Acid Medium

Anbarasi.K[1], Malathi.D[2]

Assistant Professor[1], Student[2]

Department of Chemistry

Nirmala College for Women, Coimbatore-18

Corresponding Author's E-mail: *anbuaradhana12@gmail.com[1]*

Abstract

The inhibitive action of leaf extract of Cardiospermum halicacabum (LCH) on mild steel corrosion 1N H_2SO_4 solutions was studied using weight loss measurement, Scanning Electron Microscopy (SEM), Fourier Transform Infrared (FTIR) analysis. The inhibition efficiency was found to increase with increase of the inhibitor concentrations due to the adsorption of the inhibitor molecules on the metal surface. The inhibition efficiency of LCH was found to be 94%. SEM, FT-IR analysis confirms the interaction of plant constituents on metal surface. Organic compounds present in the inhibitor can absorb on the metal surface, block the active sites and reduce the corrosion rate.The results indicated that the potential of Cardiospermum halicacabum leaf extract acts as good green inhibitor on metal corrosion inhibition.

Keywords: *Inhibitive action, Green inhibitor, Mild steel, Inhibition efficiency, Corrosion rate*

INTRODUCTION

Sulfuric acid is used in many industrial applications, for example pickling and chemical cleaning of steel. Unluckily, the acidic solution caused the corrosion damage. The addition of the inhibitors is one of the effective methods used to protect the steel from the corrosive acid attack. Inorganic inhibitors such as chromates, phosphates, and nitrates and organic inhibitors having heteroatoms or π-bonds compounds are the most commonly used metal corrosion inhibitors. Inorganic inhibitors are very expensive

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

and not degradable. The organic inhibitors inhibit through the mechanism of adsorption onto metal surface using their heteroatoms and/or π-electrons as adsorption centres. Most of the organic inhibitors containing nitrogen, oxygen, sulphur atoms and multiple bonds in their molecules facilitate adsorption onto the metal surfaces. The plant extracts are not only cost effective but environment friendly, bio-degradable, non-toxic easily available, potentially with low cost and can be easily extracted by simple procedures [1-3]. The objectives of this research work investigates the anti corrosion behaviour of *Cardiospermum halicacabum* an ecofriendly inhibitor on metal corrosion inhibition in sulphuric acid medium. The corrosion rate of metal and inhibition efficiency of the tested inhibitor evaluated from weight loss method at different immersion periods. Surface morphology of the metal in presence and absence of inhibitor studied by SEM analysis and possible functional groups in the plant extract carried out using FTIR studies.

EXPERIMENTAL

Material

Selection of metal specimen and medium

Mild steel is also known as low carbon steel. The specimen of mild steel was cut into 2mm thickness and 5cm length. The meal specimen with tiny holes are polished with different grades (400, 600) of emery papers and stored in desiccator. The medium used for present work is 1N H_2SO_4. It was prepared by dissolving 50ml of H_2SO_4 in 1950 ml of distilled water.

Preparation of plant extract:

The leaves of *Cardiospermum halicacabum* are collected, cleaned and washed with distilled water, shade dried and ground into powder using an electronic blender. The fine powder was stored in air tight container. 75 g of dried LCH was boiled in 1500 ml of 1N H_2SO_4 with reflux condenser for about 3 hours, kept overnight to extract its phytonutrients.

The extract was filtered, taken in stock solution. From the stock solution the various inhibitor test solution of 0.01%, 0.05%, 0.1%, 0.5%, 1%, 1.5%, 2%, 2.5%, 3% concentration were prepared.

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved



Cardiospermum halicacabum

Methods

Phytochemical screening

The leaf extract of *Cardiospermum halicacabum* was subjected to preliminary qualitative phytochemical screening according to standard procedures to identify the secondary plant constituents [4-5].

Weight loss measurement

The experiment is accomplished with and without the presence of inhibitor at various time intervals (1hr. 3hr, 5hr, 7hr, 24hr) at room temperature. The mild steel is polished and weighed in electronic balance and completely immersed in 100 ml of 1N H_2SO_4 solution(blank) and different concentration of LCH extract. At the end of run, the top surface of the sample was gently washed with water to remove corrosion products and dried, reweighed.

The surface coverage, corrosion rate (CR), inhibition efficiency (IE) of tested plants extract were calculated by following equation, Corrosion rate of mild steel,

$$CR = 534W/DAT \text{ (mpy)}$$

Where, D is density of metal. W is weight loss. A is surface area of metal (cm^2) T is time of exposure.

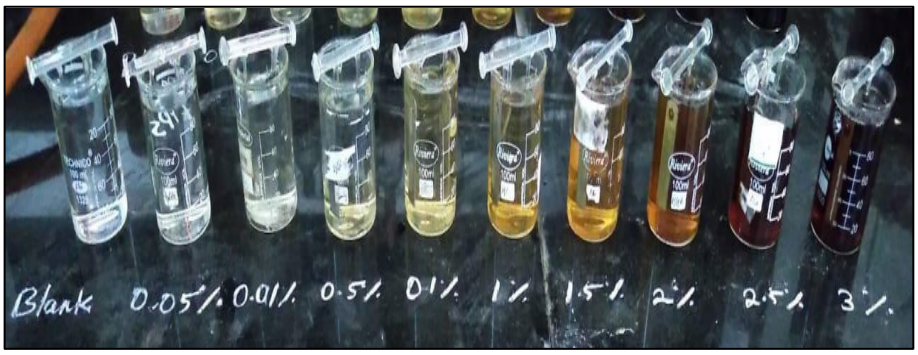
Inhibition efficiency,

$$IE\ (\%) = [CR_{blank} - CR_{inhibitor}/CR_{blank}] \times 100$$

$$\text{Surface coverage } (\theta) = [CR_{blank} - CR_{inhibitor}/CR_{blank}]$$

CR_{blank} is corrosion rate in absence of inhibitor. $CR_{inhibitor}$ is corrosion rate in presence of inhibitor.

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved



Weight loss method of LCH in 1N H_2SO_4

SEM and FTIR studies

The surface study (SEM) was done in order to study the film formation on mild steel surface in presence and absence of inhibitor in acid medium. FTIR analysis gives an idea of the film formation between metal and solution interfaces. The mild steel of specimen was immersed for 3 hours in 1N H_2SO_4 solution contains 0.05%, 3% v/v concentration of Cardiospermum halicacabum leaves extract for about 3 hours. After that specimen are taken out and dried. The nature of the metal surface was analyzed by Shimadzu make Scanning Electron Microscopy (SEM) and FTIR spectroscopy at Karunya University, Coimbatore.

RESULTS AND DISCUSSION

Phytochemical screening

The main phytochemical constituents of LCH shown in Table 1 and Figure 1.The presence of secondary metabolites like flavonoid, glycoside, saponin and coumarin studied using phytochemical screening.

Table 1: Phytochemical screening of LCH

S.No	Phytoconstituents	Observation
1	Coumarins	+
2	Steroids	-
3	Flavanoid	+
4	Phenol	-
5	Protein	-
6	Saponin	+
7	Tannins	-
8	Glycosides	+
9	Anthocyanin	-
10	Quinone	-

Presence + - Absence

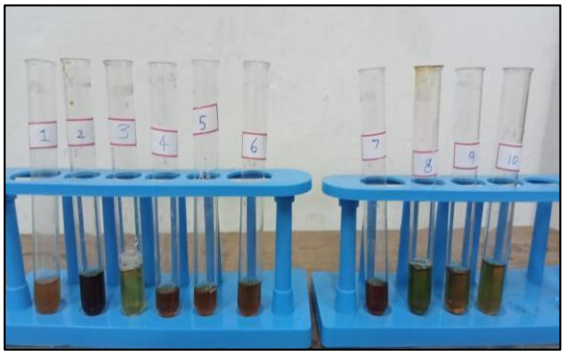


Figure 1: Phytochemical screening of LCH extract

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

Weight loss measurement

Weight loss method explains the dissolution behaviour of mild steel in 0.1N H_2SO_4 environment containing in the absence and presence of LCH extract with various exposure times (1,3,5,7 and 24 hours). The calculated corrosion rate (CR) and inhibition efficiency (IE) values are shown in Table 2. The effect of immersion time and concentration of LCH on CR and IE shown in Figure 2 to Figure 5.The results of weight loss measurements for different immersion periods at room temperature shows the gradual decrease in the corrosion rate of the mild steel with increase in the concentration of LCH extract.

At 1 hour of immersion, the corrosion rate decreased from 315mpy to 112mpy and for 5 hours the immersion, the corrosion rate decreased from 806 mpy to 44mpy, similarly for, 24 hours the corrosion rate decreased from 125mpy to 29mpy in LCH extract.The inhibition efficiency of the LCH extract increases with increase in inhibitor concentration. At 1 hour of immersion the inhibition efficiency increases from 17% to 64% and for 5 hours the inhibition efficiency increases from 66% to 94%, for 24 hours the inhibition efficiency increases from 10% to 77%. LCH considerably protects mild steel surface from corrosion.

Table 2: CR of mild steel and inhibition efficiency of LCH extract in 1N H_2SO_4 at different immersion period

Concentration of LCH (%v/v)	1 hour		3 hours		5 hours		7 hours		24 hours	
	CR mpy	IE %	CR mpy	IE %	CR mpy	IE %	CR mpy	IE %	CR mpy	IE %
BLANK	315	-	779	-	806	-	201	-	125	-
0.01	260	17	654	16	276	66	153	24	138	10
0.05	255	19	663	15	238	70	142	29	149	19
0.1	256	19	419	46	167	79	133	34	109	13
0.5	259	18	260	50	105	87	89	56	79	37
1	265	38	135	83	78	90	65	68	55	56
1.5	195	38	87	89	75	90	58	71	56	55
2	142	55	75	90	58	93	40	80	37	70
2.5	133	58	65	92	46	94	38	81	32	74
3	112	64	55	93	44	94	33	83	29	77

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

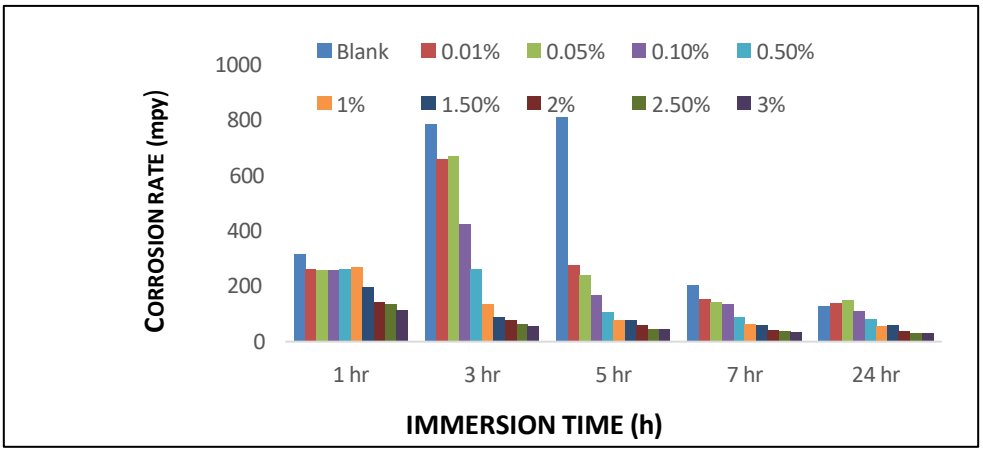


Fig 2.Effect of Immersion time on CR of mild steel in 1N H_2SO_4

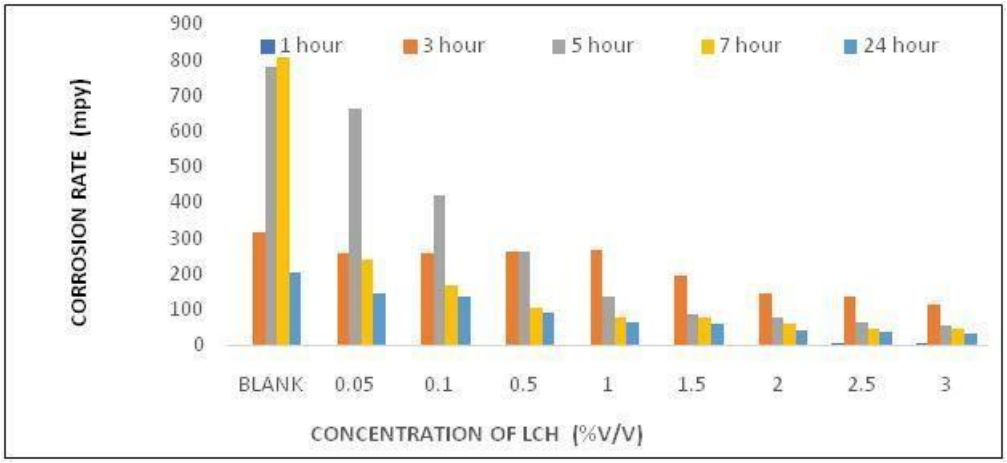


Fig 3.Influence of concentration of LCH on CR of mild steel in 1N H_2SO_4

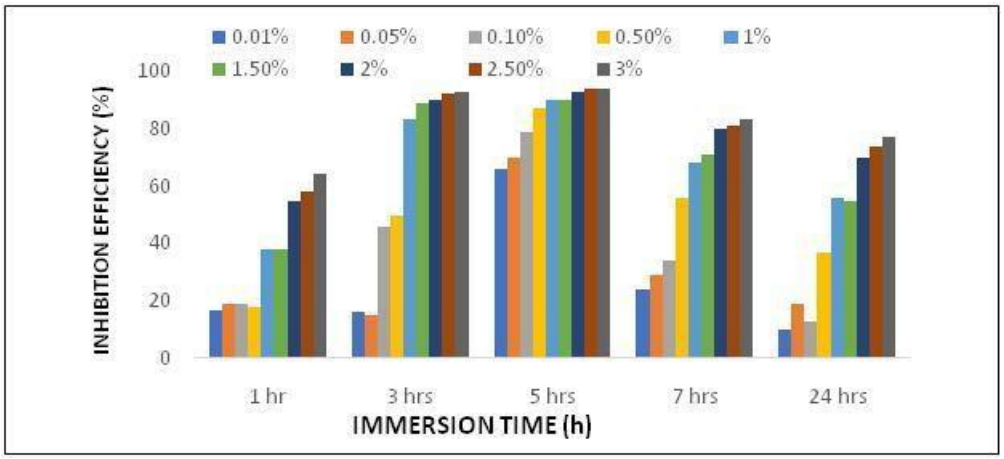


Fig 4.Influence of immersion time on IE% of LCH extract in 1N H_2SO_4

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

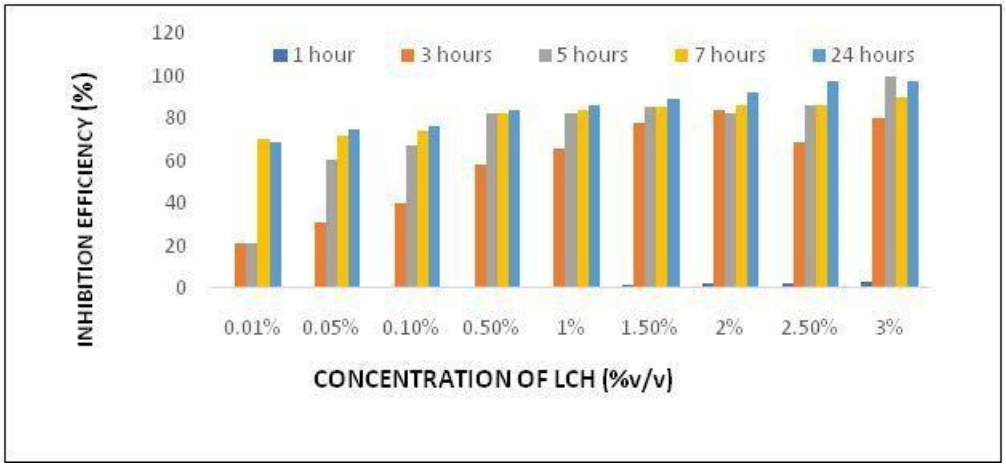


Fig 5 Influence of concentration of extract on IE of LCH in 1N H_2SO_4

SEM analysis

The surface morphology of mild steel (MS) surface was studied by scanning electron microscopy (SEM).The immersion for 3 hours in both presence and absence of Cardiospermum halicacabum leaf extract in magnification range of 100 are shown in Figure 6- 9. In the presence of LCH extracts the surface of the metal specimen highly protected. This is because of the adsorption of plant chemicals on metal surface, which protects them from further corrosion.

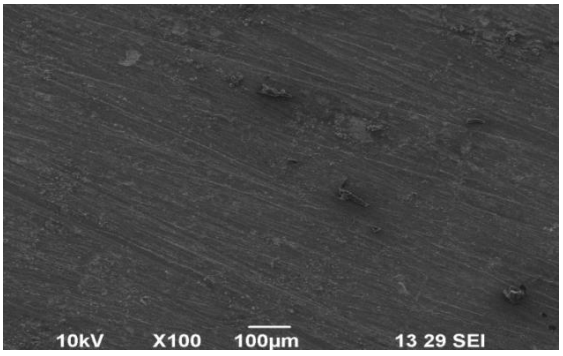


Fig 6: Polished mild steel

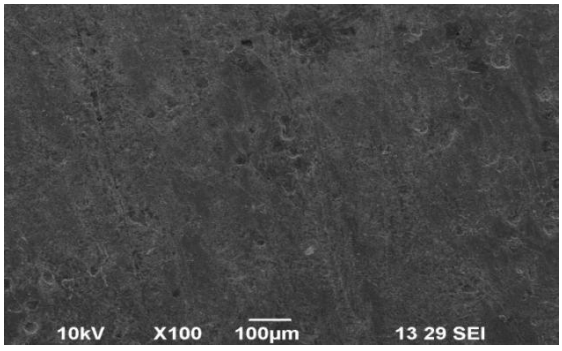


Fig 7: MS in blank

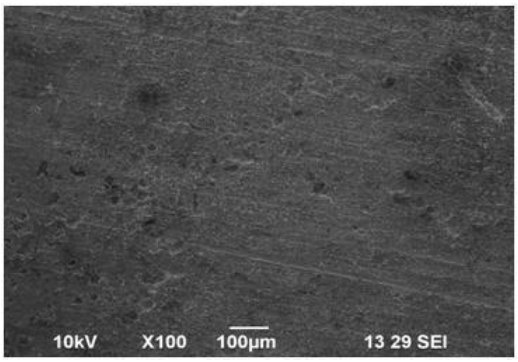


Fig 8: MS in 0.05% LCH

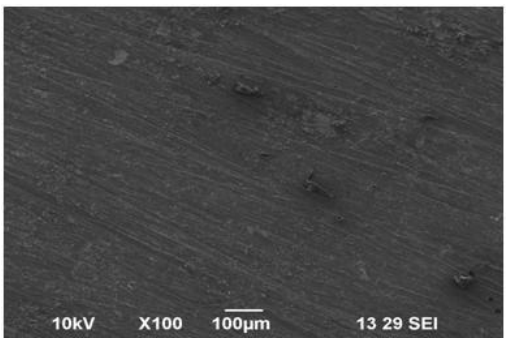


Fig 9: MS in 3% LCH

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

FT-IR analysis

FTIR identifies chemical bonds in a molecule by producing an infrared absorption spectrum and provides information on basis of chemical composition and physical state of the sample. The FTIR peak values of LCH and mild steel immersed in presence and absence of LCH is shown in Table 3 and Figure 10 to Figure 12. The peak value indicates the existence of various functional groups in the plant extract. The interaction of these functional groups protects the metal surface from corrosion in aggressive medium. The formation of iron oxide and hydroxides are eliminated through the adsorption of plant constituents and protects surface of mild steel.

Table 3: FTIR analysis of MS in 1N H_2SO_4, 0.05% and 3% LCH

Peak values cm^{-1}			Possible groups
MS in BLANK 1N H_2SO_4	**MS in 0.05% LCH**	**MS in 3% LCH**	
3356	-	-	N-H
2970	-	-	FeOOH
2360	-	-	α-FeOOH
1381	-	-	Fe_2O_3
-	1381	-	NO_3
-	1126	-	C-O-C
-	-	617	C-H
470	-	-	FeO
-	463	432	C-X

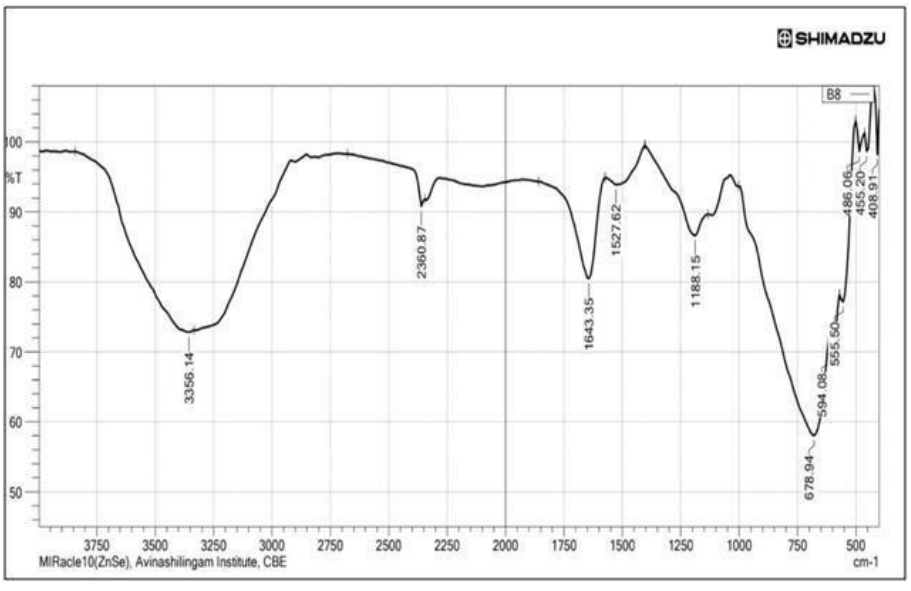


Fig 10 FTIR spectrum of LCH 1N H_2SO_4

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

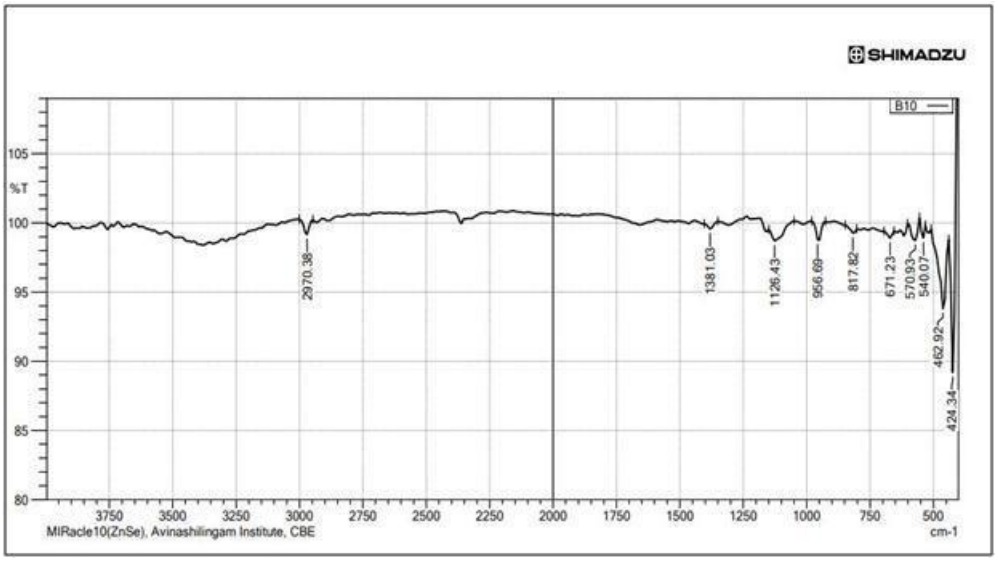


Fig 11 FTIR spectrum of mild steel immersed in 0.05% LCH

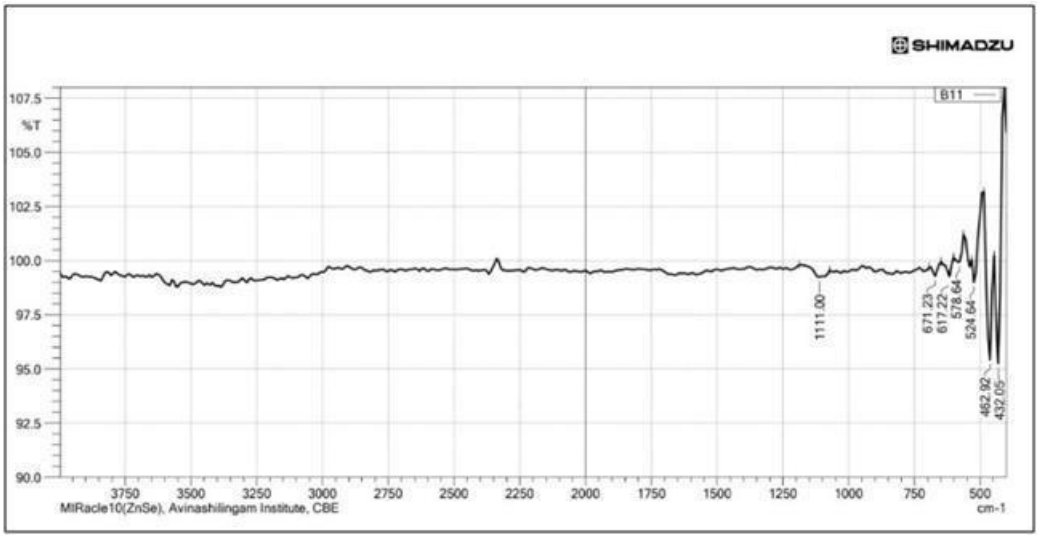


Fig 12 FTIR spectrum of mild steel immersed in 3% LCH

CONCLUSION

- The inhibitor leaves of Cardiospermum halicacabum (LCH) is an efficient corrosion inhibitor for mild steel corrosion in 1N sulphuric acid.
- The maximum inhibition efficiency of 94% is obtained at the concentration of 3% LCH extract at 5 hours of immersion period.
- The corrosion rate decreases with increasing the inhibitor concentration.
- SEM analysis confirms the effectiveness of inhibition of mild steel in acid medium.

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

- FTIR study confirms that the complex film formed between the inhibitor and the metal ions.
- The organic compounds present in the inhibitor can adsorb on the metal surface, block the active sites and reduce the corrosion rate.
- The research work proves the efficiency of the environmental friendly, non toxic and cost effective LCH inhibitor on metal corrosion inhibition.

REFERENCES

1. Camila. G, Dariva, Alexandre. F, Galio, Corrosion Inhibitors-Principles, Mechanisms and Applications, The university of Tennessee, 2014, 10, 365- 379
2. H.H.Uhlig, Importance of corrosion research, The Journal of Science and Technology, 2013, 18, 311-315
3. Abdel-Gaber AM, Abd-El-Nabey BA, Sidahmed IM, El-Zayady AM, Saadawy M 2006 Inhibitive action of some plant extracts on the corrosion of steel in acidic media, Corros. Sci. 48(9) 2765-2779.
4. Davis GD, Anthony von Fraunhofer J,Krebs LA and Dacres CM 2001 The use of Tobacco extracts as corrosion inhibitors. Corrosion, 2001 Paper 1558.
5. Ebenso EE and Ekpe UJ 1996 Kinetic study of corrosion and corrosion inhibition of mild steel in H2SO4 using Carica papaya leaves extract, W. Afri. J. Biol. Appl. Chem. 41: 21-27.
6. Bouklah M and Hammouti B 2006.Thermodynamic characterisation of steel corrosion for the corrosion inhibition of steel in sulphuric acid solutions by Artemisia. Port. Electrochim. Acta , 24: 457 – 468.
7. Bouyanzer A and Hommouti B 2004. A study of anti-corrosion effects of Artemisia oil on steel. Pigm. Resin Technol., 33: 287-292.
8. El-Etre AY and El-Tantawy Z 2006, Inhibition of metallic corrosion using Ficus extract, Portugaliae, Electrochimica Acta, 24: 347-356.
9. Oguzie EE 2008. Corrosion inhibitive effect and adsorption behaviour of Hibiscus sabdariffa extract on mild steel in acidic media. Portugaliae Electrochimica Acta, 26, 303 – 314.
10. Subhashini S 2004 Corrosion inhibition study of mild steel in

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved

acid media by extracts of some Leguminous seeds as eco-friendly inhibitors. J. Camel Pract. Res. 11(1):27-34.

11. Saratha R and Vasudha VG 2009. Inhibition of Mild steel corrosion in 1N H2SO4 medium by acid extract of Nyctanthes arbortristis leaves, E-J. Chem. 6(4): 1003-1008.

Page 108-118 © MANTECH PUBLICATIONS 2021. All Rights Reserved