International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.9, No.05 pp 558-562, 2016

Corrosion Inhibition Using Water Hyacinth

B.Subramanyam and R.Prasanna Kumar*

School of Civil Engineering.SASTRA University, Thanjavur -613401, India.

Abstract : Corrosion can also occur in materials other than metals, such as ceramics or polymers, and it degrades the useful properties of meterials and structures including strength, appearance and permeability to liquids and gases. Corrosion from civil engineering point of view is wearing of metals due to chemical changes. Due to the gradual wearing away of material, the resistance capacity of materials decreases. In many structures the effects of corrosion are seen clearly. In case of offshore structures this effect is predominant. The adverse effects of corrosion increase with the increase in number of days of exposure of materials to the environment. Generally these effects of corrosion are controlled by painting, plating, galvanization, anodization, bio-film coatings, etc. In the present work an attempt was made to study the corrosion inhibition property by using a material called water hyacinth.
Key words: Water Hyacinth, Multimeter**,** Weight loss method, Inhibition efficiency, resistance.

Introduction

Corrosion of steel is a predominant phenomenon in many structures and more specifically in offshore structures. Due to this there is a rapid deterioration of materials and development of cracks in the structures, ultimately affecting the stability of the structures. The popular cases are bridges, buildings etc. which have been affected by corrosion due to the sea water environment. This sea water environment may be either a direct contact with the surface of the structures or with the medium of air and water to corrode the structures. The main reason for corrosion[7-20] is that the steel bars which we use as reinforcement is made of iron or steel. These easily react with the sea water and form iron oxides that cause a gradual deterioration of materials and eventually leading to loss of strength. In the present study it is proposed to use water hyacinth plant powder mixed with water as an alternative to various conventional anti corrosion coatings.

Objectives of the Study

To study the effect of water hyacinth plant powder in resisting corrosion.

To compare the changes taking place in steel bars by using this material as an alternative to conventional anti corrosion coatings.

Review of Literature

A study was conducted to understand the inhibitive effect of an aqueous extract of naval leaves [1] on the corrosion of carbon steel in dam water using weight loss method. It was found from the results obtained from this method that there is an increase in inhibition efficiency with increasing inhibitor concentration to a particular extent and then it decreases. Another study was conducted[2] by making use of natural products as corrosion inhibitors for metals and found that these compounds come out as effective inhibitors of corrosion in the years to come because of their biodegradability, easy availability and non-toxic nature. The corrosion inhibition characteristics of water hyacinth extract of varying concentrations was studied[3] on 1014 steel in a chloride environment and found that there was considerable reduction in the metallic ions in the elemental composition of water hyacinth after thirty days. The effect of naturally occurring Emilia Sonchifolia was investigated[4] as a corrosion inhibitor for mild steel by using gravimetric measurements at different temperatures and observed that corrosion rate was retarding.

Experimental Study

Materials used in this study are Water hyacinth plant, Steel bars of 12 mm diameter and sea water. The characteristics of sea water were presented in Table 1 below. After collecting these materials the plant was dried for seven days and crushed into powder and then mixed with water in different concentrations. The mixture was then coated over the steel bar of 8 mm diameter uniformly and a standard electrode and testing bar was placed inside the sea water sample. The resistance is measured using the multimeter instrument and weight loss using a digital balance.

Table 1: Characteristics of Sea Water (Nagapattinam, Tamil Nadu, India)

Parameters	Result
pH	7.91
Total dissolved salts(mg/l)	41881
Total Hardness (CaCO3 equivalent)(mg/l)	6099
Chloride as Cl (mg/L)	19353
Potassium as K (mg/L)	1323
Sulphate as SO4 (mg/L)	1542
Electrical conductivity (micro mhos/cm)	60998

Measuring Resistance Using Multimeter

In this method resistance of the metals was found with standard electrode. It was found that the resistance of uncoated metals keeps on decreasing but in case of coated metals; the resistances first keep increasing to some extent, till the coated material sticks with the bar. But after it loses its sticking property with the metal then the material/ metal loses its resistance and keep decreasing. This was shown in a graph, where in the graph is plotted with time in x- axis and resistance in y-axis. For uncoated bar, the graph decreases and moves downwards but in coated bar, the graph keeps increasing to some extent and forms a heap like shape. From this the corrosion rate happening in the steel bars under different corrosive environment can be understood. Resolution is also related with sensitivity of multimeter. Greater is the sensitivity higher is the resolution. It has one more advantage: it has very high input resistance. The main part of most of the Digital Multi Meter (DMMs) is the analog to digital converter (A/D) which converts an analog input signal into a digital output. While specifications may vary, virtually such multimeters were developed around the same block diagram.

Visual Observation

From the name implies, through visual observation the happenings are judged. In this method, the two metals are placed in sea water having same concentration, one with coating and other with plain surface. It was found that the coated bar dint have any bubbles sticking around the surface of the bars. But in the uncoated bar, reddish brown bubbles were sticking to the surface and also the ribs were turned into red color even after the bar has been taken out from the sea water environment, which reveals that uncoated bar cannot withstand if sea water concentration is more.

The readings obtained from weight loss method were presented in the following Table 2 below.

Table 2 Data for mild Steel bar immersed in sea water with hyacinth extracts

Exposure Time (Days)	Weight (g)	Weight Loss (g)	Cumulative Weight loss(g)	Corrosion rate (mm/yr)	Inhibitor Efficiency (%)
0	189.675	-			
7	188.922	0.753	0.753	0.039	27.10
13	188.592	0.330	1.083	0.009	84.69
21	188.364	0.226	1.311	0.003	92.20
30	188.233	0.131	1.442	0.001	96.05

These readings were taken on the 13^{th} day of the observation. Both the coated and uncoated bar were having the same dimensions including the weight. But on 13^{th} day the increase in the decrease of the weight of the uncoated bar is more, while the coated bar is just slowly starting to lose its weight. These were the observations made on the bars while working out the process

Inhibition Efficiency (IE)

The corrosion IE was then calculated using the equation.

IE [5] = 100 [1-(W_2/W_1)] %, --------------------------------- (1)

Where W_1 is the weight loss value in the absence of inhibitor, W_2 is the weight loss value in the presence of inhibitor, Corrosion rate was calculated using the formula ,

Corrosion rate [6] (mm/year) = 87.6 W/ DAT ------------- (2)

Where W = weight loss in milligram, D = density of specimen g/cm^3, A = area of specimen in square cm, T =exposure time in hours.

Since the rate of corrosion is more for uncoated which means that uncoated bar will easily fail due corrosion. The resistance values coated and uncoated bars were presented in Table 3 below.

Table 3: Resistance Values of Coated and Uncoated Steel bars

Day	Resistance in 20 K	Resistance in 20 K
1	3.1	3.1
2	3.1	3.4
3	3.1	3.5
4	3	3.7
5	3	3.8
6	3	4
7	3	4.2
8	2.9	4.3
9	2.9	4.6
10	2.8	4.8
11	2.8	5
12	2.7	5.1
13	2.7	5.3
14	2.6	5.5
15	2.5	5.6
16	2.4	5.9
17	2.3	6.1
18	2.1	6.3
19	1.8	6.5
20	1.5	6.6
21	1.1	6.7

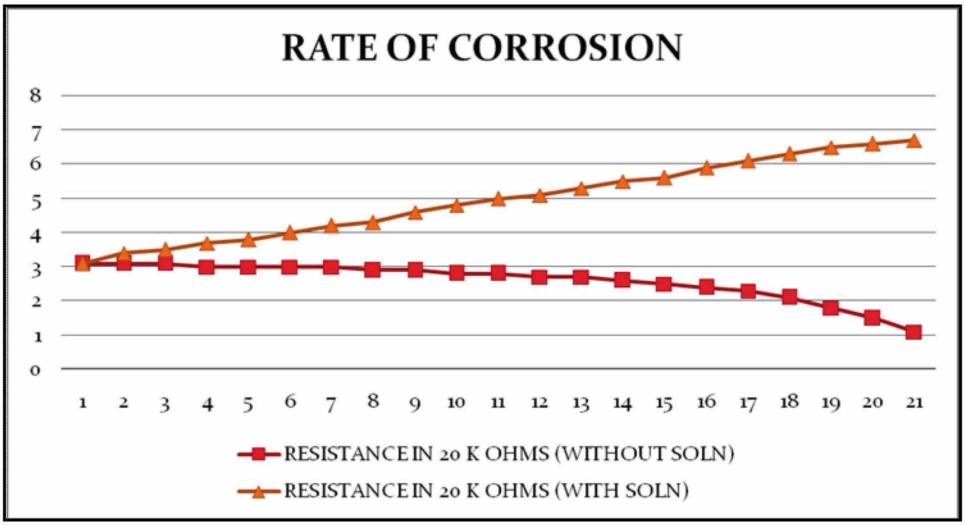

Fig 1 Resistance vs Rate of corrosion

Discussion of Test Results

From the results obtained from digital balance, it can be said that the uncoated bar has been exposed to a larger amount of the concentration of the sea water in any medium. So the weight initially decreases lightly and after that it starts decreasing more and more until the bar got completely corroded. The bar which was coated and also exposed to the larger amount of the concentration of the sea water doesn't lose its weight like the uncoated bar. Its weight decreased slightly throughout the observation period.

From the multi meter readings it can be observed that the uncoated bar's resistance is decreasing more and more due to which it may completely fail. This failure may cause the whole structure to fail. But in the coated bar, the resistance is increasing drastically initially and after some days its incremental increase in resistance is decreasing. So from the Fig 1 also, it can be understood that the coated bar keep on increasing or increases up to a point and can decrease afterwards. This may happen. There may be this critical point. So this can be of more help in the increasing the life of the structure. From the Visual method it was observed that the bubbles were coming from the uncoated bar. This means that the uncoated bar is getting corroded and is forming cracks in between. This causes the formation of bubbles as the sea water enters the bar. While in the coated bar, the water hyacinth solution is protecting the bar as a layer and is preventing the bar from corrosion. There is no/less anode mud formed when compared to the uncoated bar.

Conclusion

From the results of the experiments conducted and from visual observations it can be concluded that the material water hyacinth is a cheap, highly efficient, eco-friendly and anti corrosive. Since the resistance values of coated bars were increasing, this material will be very much useful in reducing corrosion of reinforcement.

References

1. Abdulrahman, A.S. and Mohammad, I. (2011). Eco-friendly green inhibitor to improve the strength of concrete contaminated by chloride and sulphate, IJRRAS, 9(3), 355 – 360.
2. Raja, P. B. and Sethuraman, M. G. (2008). Natural products as corrosion inhibitor for metals in corrosive media – A review' Materials letters, 62(1), 113-116.
3. Oloruntoba, D.T. (2013). Corrosion Inhibition of Water Hyacinth on 1014 Steel in a Chloride Environment, CJASR, 2(2), 6-16. Available online at http://www.cjasr.com.
4. Shanab, S. M. M. and Shalaby, E. A. (2012). Biological activities and anticorrosion efficiency of water hyacinth (Eichhornia crassipes). Journal of Medicinal Plants Research, 6(23), 3950-3962.
5. Wranglen G., Synergistic effect of 2-chloroethyl phosphonic acid and Zn2+ Introduction to Corrosion and protection of Metals (Chapman & Hall, London) 236 (1985).

6. Fontana Mars G., Corrosion Engineering, TATA McGrawHill publishing company Limited, New Delhi, Third edition, 171 (2006).
7. Mary Anbarasi C and Jerli Auxilia A, Surface Modification of Carbon Steel by Hexanesulphonic Acid-Ni^{2+} System and its Corrosion Study, International Journal of ChemTech Research,2016, Vol.9, No.01 pp 218-225.
8. P.R.Thyla, N. Tiruvenkadam, M. Senthil Kumar; Investigation of Corrosion Behavior of Light Weight NanoHybrid Al 6061-ZrO2 –SiC- Gr Composites; International Journal of ChemTech Research;
9. Sravani Pappu, Vamsi Kamal, M. K. Mohan; Effect of Heat Treatment on the Electrochemical Corrosion Behavior of Ti- 15 V- 3 Al- 3 Cr- 3 Sn Alloy in HCl and NaCl Media; International Journal of ChemTech Research;2015, Vol.8, No.1, pp 155-163.
10. G. Kavitha, S. Jegannathan, and C. Vedhi; Inhibition of corrosion of mild steel in sulphuric acid by 2-Picoline N-Oxide and 4-Picoline N-Oxide; 2015, Vol.7, No.4, pp 1693-1701.
11. S.Karthikeyan, P.A.Jeeva; Hydrogen permeation analysis of corrosion of stainless steel in pickling solution; International Journal of ChemTech Research;2015, Vol.8, No.7, pp 335-339.
12. Ashish Kumar, Sumayah Bashir; Review on Corrosion inhibition of Steel in Acidic media; International Journal of ChemTech Research;2015, Vol.8, No.7, pp 391-396.
13. Charitha B.P., and Padmalatha Rao; Ecofriendly biopolymer as green inhibitor for corrosion
14. control of 6061-aluminium alloy in hydrochloric acid medium; International Journal of ChemTech Research;2015, Vol.8, No.11 pp 330-342.
15. V.Saravanan, P.R. Thyla, N. Nirmal, S.R. Balakrishnan; Corrosion Behavior of Cenosphere - Aluminium Metal Matrix Composite in Seawater Condition; International Journal of ChemTech Research;2015, Vol.8, No.2, pp 726-731.
16. J. Yamuna, Noreen Anthony; Corrosion Protection of Carbon Steel in Neutral Medium using Citrus medica [CM] leaf as an Inhibitor; International Journal of ChemTech Research;2015, Vol.8, No.7, pp 318-325.
17. S.Karthikeyan, M.Anthony Xavior, P.A.Jeeva, K.Raja; A green approach on the corrosion studiesof Al-SiCcomposites in Sea water; International Journal of ChemTech Research;2015, Vol.8, No.3, pp 1109-1113.
18. A.V.Balan, T.Kannan; Effect Of Heat Input On Pitting Corrosion Resistance Of Super Duplex Stainless Steel Weld Claddings; International Journal of ChemTech Research;2016, Vol.9, No.03 pp 358-362.
19. M. Gnanasekaran, A. Kumaravel, S. Jerome; Effect of oxide layer and activating flux on corrosion behavior of TIG welding of 304 austenitic stainless steel weldments; International Journal of ChemTech Research;2016, Vol.9, No.04 pp 350-356.
20. R. Ganapathi Sundaram, and M. Sundaravadivelu; Electrochemical and Surface Investigation of Quinoline-8-sulphonyl chloride as Corrosion Inhibitor for Mild Steel in Acidic Medium; International Journal of ChemTech Research;2016, Vol.9, No.03 pp 527-539.
21. Mary Anbarasi C and Jerli Auxilia A; Surface Modification of Carbon Steel by Hexanesulphonic Acid-Ni2+ System and its Corrosion Study; International Journal of ChemTech Research;2016, Vol.9, No.01 pp 218-225.

*****