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EXPERIMENTAL AND INVESTIGATION ON CORROSION BEHAVIOUR NAN COATED STEEL USING CONDUCTING POLYMER

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ABSTRACT

Polyaniline is a conductive polymer due to its simple synthesis, controllable electrical conductivity and good environmental stability, good corrosion resistant. Polyaniline has an emeraldine base polymer, it is synthesized by chemical polymerization method(Addition polymerization). To improve the effectiveness of solution casting method it is essential that a high degree of confidence be achieved in predicting the corrosion rate. The coating was carried out by using solution casting method and tested using pitting corrosion tester. To predict the pitting corrosion rate before coating and after coating on carbon steel (HCS and LCS).The corrosion rate of both high carbon steel and low carbon steel was found to be less than the uncoated steel plates. However, the corrosion rate of lower carbon steel is much lower than the high carbon steel in the coated and uncoated condition

1. INTRODUCTION

Carbon steel, the most widely used engineering material, accounts for approximately 85%, of the annual steel production worldwide. Despite its relatively limited corrosion resistance, carbon steel is used in large tonnages in marine applications, nuclear power and fossil fuel power plants, transportation, chemical processing, petroleum production and refining, pipelines, mining, construction and metal-processing equipment. The cost of metallic corrosion to the total economy must be measured in hundreds of millions of dollars per year. Because carbon steels represent the largest single class of alloys in use, both in terms of tonnage and total cost, it is easy to understand that the corrosion of carbon steels is a problem of enormous practical importance. This is the reason for the existence of entire industries devoted to providing protective systems for irons and steel. Carbon steels are by their nature of limited alloy content, usually less than 2% by weight for total of additions. Unfortunately, these levels of addition do not generally produce any remarkable changes in general corrosion behavior.

2. EXPERIMENTAL DETAILS

Recently conducting polymer mainly for nanocomposite most used on corrosion protection application particularly polyaniline nano composite greater importance in corrosion application and electrical, thermal application. A quantity of coated carbon steel give the better corrosion rate after coating at different medium. In synthesis of conducting polymer chemical polymerization method.synthesised conducting polymer coated on high carbon steel plate and low carbon steel plate using solution casting method. From that specimen determine corrosion rate After completion of previous work conducting polymer chemical composition and hardness of coated metal also analyzed. From the experimental investigation on the corrosion behavior of nano coated steel by using a conducting polymer polyaniline

3. EXPERIMENTAL WORK

a) Synthesis of Polyaniline (PANI) Nanocomposite

Polyaniline Nanocomposite synthesized using by chemical polymerization method,

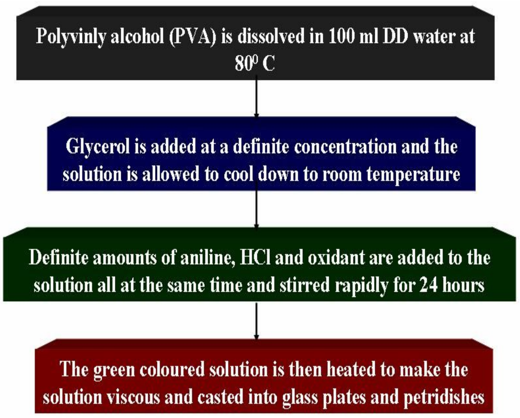


Fig .1 Block Polyaniline synthesis

b) Solution Casting Method

Nanocomposite syster involves the melting or nanocomposite in solvent. Th simple procedure to coating (polyaniline nanocomposite dis: methyl pyrolidine.The dis nanocomposite with NMP soluti drop on High carbon high chr carbon steel plate after droplе nano coated carbon plate using heating 200˚C at 1hour.The time been vapourized and nanocomp plate.

Fig 2 Nano coated carbon steel plates using solution casting method

c) Potentiodynamic polarization experiment

High Carbon High Chromium Steel (HCHC) and Low Carbon Steel (LCS) specimens of dimensions 10 mm x 10 mm and 10mm x 7.5mm were prepared. The specimens were coated with polyaniline nanocomposite. While mounting, proper care was taken to avoid gaps between specimen and resin to prevent crevice attack during polarization experiments. These specimens were immersed in the electrolyte for 30 min at open circuit potential and subsequently subjected to potentiodynamic anodic polarization at room temperature from a potential of 0.25 V below OCP. The potential was measured with respect to saturated calomel electrode (SCE) and a potential scan rate of 0.01 V min-1 was maintained. Polarization experiments were stopped around 0.5 9 10-3 A, after the current monotonically increased beyond 0. 25 9 10-4 A in the passive region. The experimental details are presented in our earlier work.

Table.1 Corrision medium rate

Corrosion Medium	P_H level
Acid	1 to 3
Neutral	7

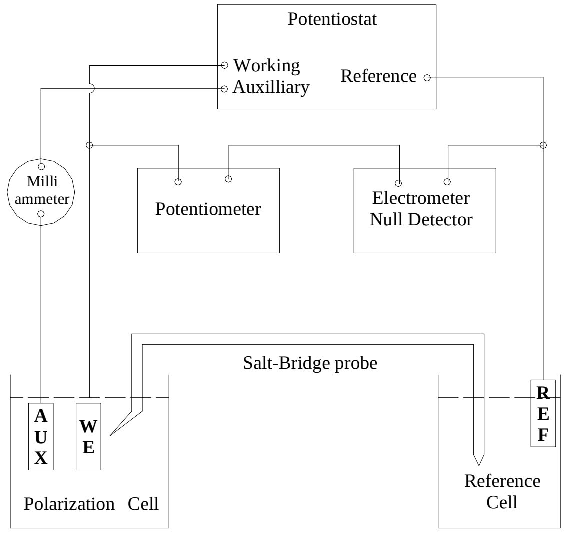


Fig. 3 Schematic representation of the polarization

Corrosion rate formula:

Corrosion rate = I_{corr} x Metal factor / 1000 in miles/yr I_{corr} = Corrosion current

Fig 4 Potentio dynamic polarization Experiment set up

In corrosion test we have prepared eight specimen at Neutral solution (NaCl) and four specimen at acid (HCL) and alkaline (NaOH) solution. High Carbon Steel (HCS) four specimen in neutral medium (NaCl),Low Carbon Steel (LCS) four specimen in neutral medium (NaCl),High Carbon Steel (HCS) two specimen in acid (HCL) and alkaline medium (NaOH),Low Carbon Steel (LCS) two specimen in acid (HCL) and alkaline medium (NaOH)

Fig.5 corrosion tested specimen

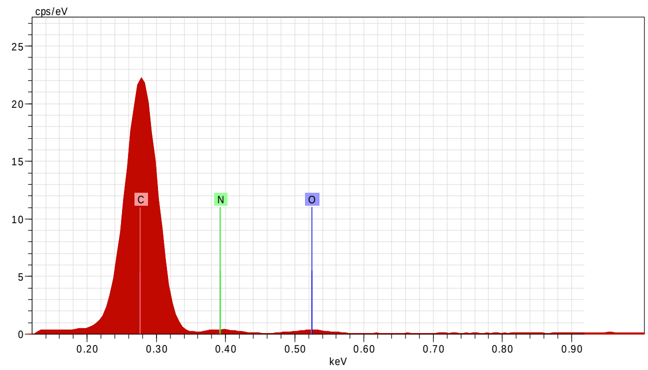
d) Micro Structure Analysis

Optical Metallography

Microstructural examinations have been carried out using a light optical microscope (VERSAMET-3) incorporated with an image analyzing software (Clemex-Vision). The specimens for metallographic examination were sectioned to the required sizes from the coated metal regions and were polished using different grades of emery papers. Final polishing was done using the diamond compound (1µm particle size) in the disc polishing machine. The ASS specimens were etched with 5% Oxalic acid and the DSS specimens were etched with 40% NaOH, by using Electrolytic etching method with a voltage of 2-3 V and 6-10 V respectively, whereas the FSS specimens were etched with 5ml HCl,1g Picric acid and100ml Methanol applied for 10-15 seconds.

4. RESULT

i) Energy Dispersive X-Ray Spectroscopy (EDAX) Analysis



Spectrum: sample 55

El AN Series unn. C norm. C Atom. C Error (1 Sigma)

[wt.%] [wt.%] [at.%] [wt.%]

C 6 K-series 79.73 79.73 82.65 8.85

N 7 K-series 14.25 14.25 12.67 2.52

O 8 K-series 6.01 6.01 4.68 1.10

Total: 100.00 100.00 100.00

From the above result synthesized polyaniline nanocomposite chemical composition is identified. There have three elements only determined Carbon (C),Nitrogen (N),Oxygen (O).These are all available at different percentage.

The below diagram also EDAX but this is each element have different colour to identified. it is also a mapping diagram blue colour image is carbon element, green and violet colour having nitrogen and oxygen elements.

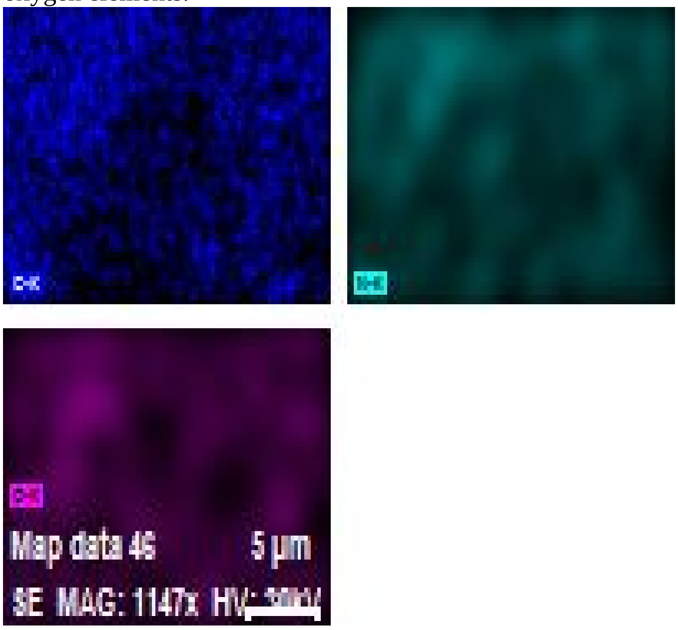


Fig. 6 Images of C,N,O Element from EDAX

iii) Corrosion Rate for Different Medium

Table.2 **Corrosion Rate for Different Medium**

Corrosion Medium	**HCS Corrosion rate (Miles/yr) 10^{-5}**	**LCS Corrosion rate (Miles/yr) 10^{-5}**	**Base Metal Corrosion rate (Miles/yr) 10^{-5}**
Neutral (Nacl) 1	**0.000091**	**0.00006688**	**0.9718**
Neutral (Nacl) 2	**0.00173**	**0.156524**	
Neutral (Nacl) 3	**0.00165**	**0.00586**	
Neutral (Nacl) 4	**0.00108**	**0.00598**	
Acid (HCL)	**0.0006688**	**0.003479**	**0.01602**
Alkaline (NaOH)	**0.000172**	**0.00001307**	**0.000743**

ii) MICROSTRUCTURE Analysis

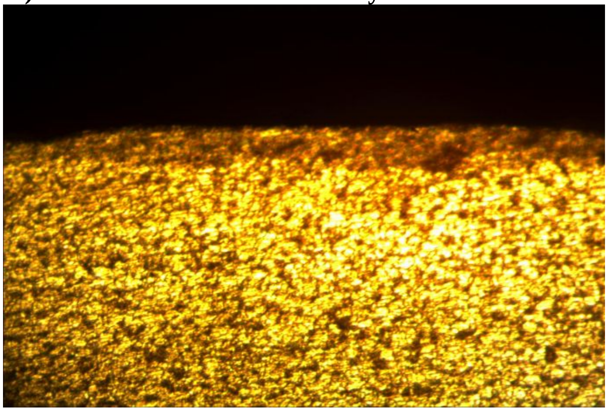


Fig.7 Microstructure of nanocomposite coated LCS(200X)

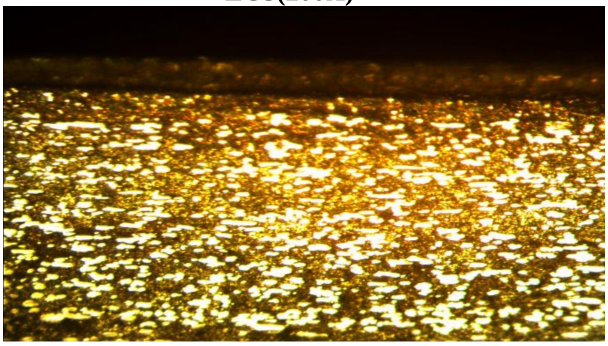


Fig.8 Microstructure of nanocomposite coated HCS (200X)

The microstructure analysis after polyaniline coating high carbon steel is found to be pearlite structure and low carbon steel is ferrite structure. These microstructure images nano coated region has been indicated. Above two images magnification range was 200X. From the above chart using low carbon steel after coating corrosion rate was 45.4% at neutral medium.In acid medium corrosion rate have 27.9%.Final level alkaline medium corrosion rate was 60.7%.

5. DISCUSSION

Conducting polymer synthesized by chemical polymerization method and synthesized conducting polymer was coated on high carbon steel and low carbon steel specimen using solution casting method at low and high level quantity. The specimen was prepared as per ASTM recommended size. After conducting polymer coating specimen was used to test Potentio dynamic polarization method at different medium were neutral, acid and alkaline on coated region and base metal of specimen. The synthesized conducting polymer chemical composition was measured by using EDAX analysis. There have carbon, nitrogen and oxygen element. These three elements available at different level but carbon rate is high and other element of nitrogen, oxygen also compare to carbon medium level available. These three element coating process on high carbon steel ,low carbon steel conducting polymer bonding of grain structure have been changed. Because corrosion rate became to more positive. The corrosion rate of high carbon steel and low carbon steel on coated region at different medium measured and hcs vs. base metal corrosion rate was 67.9%,39% and 43%.Then low carbon steel vs. base metal at neutral medium of corrosion rate 47.2%,acid medium of corrosion rate 46.09% and alkaline medium 57.15 Microstructure of the high carbon and low carbon steel specimen measured at various magnification form previous images of microstructure after coating high carbon steel have occurred pearlite structure and low carbon steel changed as a ferrite structure. These microstructure images nano coated region has been indicated. Above two images magnification range was 200X from low carbon steel specimen.

6. CONCLUSION

Experimental Investigation

From the experimental investigation on the corrosion behavior of nano coated steel by using a conducting polymer polyaniline, it is found that :

1. The corrosion rate of both high carbon steel and low carbon steel was found to bee less than the uncoated steel plates. However, the corrosion rate of lower carbon steel is much lower than the high carbon steel in the coated and uncoated condition.

2. The corrosion rate for nano coated low carbon steel was found to be 47.2 %, 46.06% and 57.15% lower than the uncoated low carbon steel in the neutral, acid and alkaline meduium respectively.

3. The corrosion rate for nano coated high carbon steel was found to be 67.9 %, 39.00% and 43.00 % lower than the uncoated high carbon steel in the neutral, acid and alkaline medium respectively.

In this process a parameters obtained from any combination of within the ranges of variable studied. It also helps further to choose the influential process parameters or ranges of parameters so that a minimum value of corrosion rate can be obtained. Moreover the factorial experimentation technique is more convenient to predict the effects of main and interaction variables.

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