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Corrosion Site Blocking Effect of Magnesium Alloy in 3% NaCl using Bio-molecule

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ABSTRACT
The boundary impact of bio-particle in the destructive destinations of magnesium combination has been concentrated on utilizing pectin in a 3% NaCl medium. The level of capacity of bio-atom to go about as consumption controlling specialist was researched by weight reduction estimations and potentiodynamic polarization. Inhibition proficiency of inhibitor arrives at most extreme qualities at 93 %. Polarization bends show that the pectin acts as a through blended method of restraint. It was observed that pectin particle adsorbed on the magnesium compound surface and ensured it against consumption, affirmed the defensive film through the filtering scanning electron microscopy and energy dispersive spectroscopy.
KEYWORDS: *Weight loss measurements, Electrochemical Analysis, SEM, EDX, Alkaline medium*

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INTRODUCTION
Corrosion control employing inhibitors have one of the important methods for economic and effective to protect corrosion metals [1–3]. Currently, research focus in corrosion related to development of "Eco-friendly corrosion inhibitors", compounds with high inhibition efficiency however little risk of environmental pollution [4]. Chromate, nitrate dichromate and nitrite are generally utilized as consumption inhibitors in numerous media and for different metals and composites [5]. On the other hand, the bio harmfulness of these items, particularly chromate, is very much reported [6] just as their non-natural agreeable qualities [7], which limit their application. Recently, a few investigations have been done because of natural mixtures containing nitrogen, oxygen or sulphur atoms on the consumption of steel in acidic media [8-14]. Most organic inhibitors act by adsorption on the metal surface [15]. Pectin possess carboxylic and carboxymethyl functional groups on its carbohydrate backbone making it a possible compound for corrosion and scaling reduction in various media [16].

MATERIAL AND METHODS
MATERIALS
Specimens of size 1.0cm×4.0cm×0.1cm were press cut from the magnesium alloy sheet, were machined and abraded with a series of emery papers. This was trailed by washing in acetone and bidistilled water lastly dried in air. Prior to any trial, the substrates were treated as depicted and newly utilized with no further storage. A stock solution of 1000ppm of pectin was ready in bidistilled water and the ideal focus was gotten by proper dilution.
The review was completed at room temperature in outside environment. Every one of the weighing of the magnesium composite specimens, previously, then after the fact inundation, were finished utilizing a Denver balance, TP 214 model, with a meaningfulness of 0.1 mg in 210 g range. This equilibrium has reproducibility (standard deviation) of 0.1 mg in 210 g range.
DETERMINATION OF CORROSION RATES AND INHIBITION EFFICIENCIES
The earlier weighed specimen samples were immersed by means of glass hooks in 150 mL beakers containing 100 mL of the solutions. The test solutions consisted of blank (3% NaCl solution) and inhibitor

solutions in 3% NaCl containing different inhibitor concentrations. After the immersion periods, magnesium alloy specimens were taken out from the test solution, scrubbed with cotton and a mild cleaning solution, washed with distilled water, treated with isopropyl alcohol to remove traces of impurities and grease, and dried with an air drier. Magnesium alloy specimens were then re-weighed. From the change in the weights of the specimens, the corrosion rates (CR) were calculated by using the following formula:

$$\text{Corrosion Rate } (mmy^{-1}) = \frac{87.6 \times W}{ATD}$$

Where w (mg) is the weight loss, A (cm2) is the surface area, D is the density of the metal specimen and T(days) is the immersion period. The corrosion inhibition efficiency (IE) was calculated using the following equation:

$$\%\ IE = \frac{C_{R0} - C_{Ri}}{C_{R0}} \times 100$$

where *CR0*and *CRi*, are the corrosion rates in the absence and the presence of the inhibitor respectively.

ELECTROCHEMICAL STUDIES

The electrochemical studies were carried out using magnesium alloy electrode. The potentiodynamic polarization were carried out using CHI Electrochemical analyzer model 760 D with operating software CHI 760D in the Department of Chemistry, The Gandhigram Rural Institute - Deemed University, Gandhigram. Conventional three-electrode system was used for potentiodynamic polarization. In this setup, polished magnesium alloy with 1cm2 exposed surface areas was used as working electrode, platinum electrode as an auxiliary electrode and saturated calomel electrode (SCE) as reference electrode. The reference electrode was placed close to the working electrode to minimize IR contribution. The three electrode set up was immersed 3% NaCl solution in an electrochemical cell, both in the absence and presence of various inhibitor and allowed to attain a stable open circuit potential (OCP).

The potentiodynamic polarization estimations were begun from cathodic to the anodic bearing (OCP + 200 mV) with an output pace of 1 mV/s and the boundaries like consumption current (Icorr), Corrosion potential (Ecorr), anodic Tafel slant (βa) and cathodic Tafel slant (βc) were figured from the polarization bends. The upsides of hindrance efficiencies (IEp) were determined from Icorr esteems utilizing the condition,

$$(\%)\ IE_p = \frac{I_{corr} - I'_{corr}}{I_{corr}} \times 100$$

where Icorr and I'corr are the corrosion current densities in case of blank and inhibited solutions, respectively.

SCANNING ELECTRON MICROSCOPY (SEM)

The magnesium alloy specimens were immersed in blank and respective test solutions for a period of seven days. Then, they were taken out and dried. The nature of the protective film formed onto the surface of the specimen was analyzed by Scanning electron microscopy (SEM),

Specimens were immersed in blank and in the presence of the inhibitor formulation. After 7 days, the specimens were taken out, washed with triple distilled water and air dried. The SEM images of the surfaces of the specimens were obtained using VEGA3 TESCAN model in the Central Instrument Facility, National College, Tiruchirappalli, Tamil Nadu.

ENERGY DISPERSIVE X-RAY ANALYSIS (EDX)

EDAX (Model: BRUKER Nano Germany) system attached with Scanning Electron Microscope was used for elemental analysis of the film formed on the magnesium alloy surface. As a sort of spectroscopy, it depends on the examination of the example through collaboration between electromagnetic radiation and the matter. So that, an identifier was utilized to change over X-ray energy into voltage signals. This data is shipped off a pulse processor, which estimates the signals and passed them into an analyzer for information show on the investigation.

RESULTS AND DISCUSSION

WEIGHT LOSS MEASUREMENT

Weight reduction estimations gives the most dependable outcomes concerning the effectiveness of a given inhibitor molecule, so the relating corrosion information got from them approach administration conditions more precisely than the information acquired with some other test. Table1. Shows the weight loss (in mg cm-2) of magnesium alloy immersed in 3% NaCl solution in the absence and presence of different concentrations of pectin at room temperature. The gradual increase in the weight loss with absence and presence of pectin molecule indicates that insoluble surface film do not form on the magnesium alloy surface during corrosion in 3% NaCl solution. This means that pectin is first adsorbed on the magnesium alloy surface impeding corrosion either by merely blocking the reaction sites (anodic and cathodic processes), that the weight loss decreased (corrosion rate is suppressed), and therefore the corrosion inhibition strengthened with increase in inhibitor concentration

POLARIZATION ANALYSIS

Tafel plots of magnesium combination inundated in 3% NaCl arrangement in the absence and presence of inhibitor are given in Figure 1. Boundaries of Tafel plots are summed up in Table2.

The result of Table 4.12 show that corrosion potential, (Ecorr) in blank (3% NaCl) is -96.1mV/SCE and the related corrosion current density (Icorr) is 29.826 A/cm2. When 150ppm pectin is added to the blank solution, the corrosion potential is 134.5 mV/SCE shifted to anodic region and its corrosion current density is decreased to 2.892μA/cm2. It is recognizable from Figure 4.9, that Tafel bends are moved extraordinarily to bring down Corrosion current thickness within the presence of inhibitor (150ppm pectin). The consumption current thickness (Icorr) esteem decline from the clear worth (29.826 to 2.892μA), this decrease in Icorr to control the Corrosion the concentrated on inhibitor went about as great enemy of destructive properties. The βa (190.1mV/decade) and βc (123.6mV/decade) slopes esteems predominately moved in anodic locale for the expansion of inhibitor from the clear, which implies the pectin goes about as a blended sort inhibitor. All in all, both anodic and cathodic responses of magnesium composite terminal are definitely ensured by the inhibitor17. Corrosion potential is moved to less anodic areas and the change in anodic Tafel slope (190.1 mV/decade) is more noteworthy than the change in cathodic Tafel slope (123.6 mV/decade). This perception recommends that the inhibitor is a blended kind inhibitor [18-19].

SCANNING ELECTRON MICROSCOPE

Scanning electron microscopy (SEM) was analyzed to study the nature of the surface film on the magnesium alloy immersed in different solutions. Figures 2 (a), 2 (b) and Figure 2 (c)show SEM images of polished magnesium alloy, magnesium surface in the absence and the presence of the inhibitor respectively. It could be seen from Figure 2b (50nm), that the surface is strongly damaged, highly porous corrosion product, fault the metallic properties and there is formation of different forms of corrosion products on the surface in the absence of the inhibitor. It further shows that the corrosion products appear very uneven and the surface layer is too rough. Figure 2a (50nm) reveal the good surface properties and absence of corrosion product. Figure 2c (50nm), reveal that SEM images of polished magnesium alloy immersed in the inhibitor solutions are in good conditions having smooth surfaces.

Important to stress that when the inhibitor is present in the solution, the morphology of the magnesium surface is quite different from the previous one. In the formed protective film, this has uniformly distributed onto magnesium surface. This might be deciphered as because of the adsorption of the inhibitor on the metal surface fusing into the inactive film to obstruct the dynamic site present on the magnesium surface. Along these lines, the defensive film covers the whole metal surface.This perception additionally represents the high hindrance productivity esteems acquired during the weight reduction studies and electrochemical investigations of the inhibitor framework. This demonstrated that the inhibitor particles impeded the disintegration of magnesium by shaping a protective film on the magnesium surface and subsequently decreased the corrosion rate. Thus, SEM investigation shows the idea of the protective film [20].

ENERGY DISPERSIVE X-RAY ANALYSIS

Creations of thin film estimated to the magnesium combination surface were examined utilizing EDX. In Fig. 3a shows fortitude of surface properties and presence of the multitude of tops in the magnesium amalgam composition. The cleaned magnesium amalgam example submerged in 3% NaCl arrangement was fizzled in light of the fact that it is seriously debilitated the surface because of the Corrosion as displayed in Fig. 3b.

On adding 150ppm pectin in 3% NaCl arrangement, the abatement of magnesium peak and presence of carbon, sodium and oxygen peak was observed because of the development of a protective film on a superficial level21 as shows in Fig. 3c. The activity of inhibitor is identified with adsorption and arrangement of a boundary film on the anode surface.

CONCLUSION

High blocked impact of pectin in 3% NaCl solution on the magnesium composite dynamic locales which shields from corrosion. Potentiodynamics polarization study showed the concentrated on inhibitor molecule went about as a blended kind inhibitor. SEM examination uncovered the magnesium amalgam surface covered with a defensive film, in this manner, shaping a hindrance against assault by forceful particles from the destructive environment and EDX investigation supported the defensive film arrangement on the metal surface of magnesium compound.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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