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Eco-Green Corrosion Inhibitor From Paddy Waste For Carbon Steel

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ABSTRACT

Investigation of inorganic (silica) and organic (lignocellulose) compounds extract from paddy (*Oryza Sativa* sp.) waste as corrosion inhibitor for carbon steel was studied in acidic medium. Silica was obtained by the burning process of rice husk using muffle furnace at high temperature meanwhile, lignocelluloses compound was yield via chemical process of the rice straw. Optical Microscopy, XRD, FTIR, SEM and TEM were used to characterize of both samples. Corrosion test via weight loss method was performed at room temperature in different time interval and varied concentration in ppm of silicate and lignocellulose solutions. Results show that the corrosion inhibition efficiency was found to be increased with increasing concentrations of both corrosion inhibitors.

Key word: silica, lignocelluloses, XRD, FTIR, weight loss method

INTRODUCTION

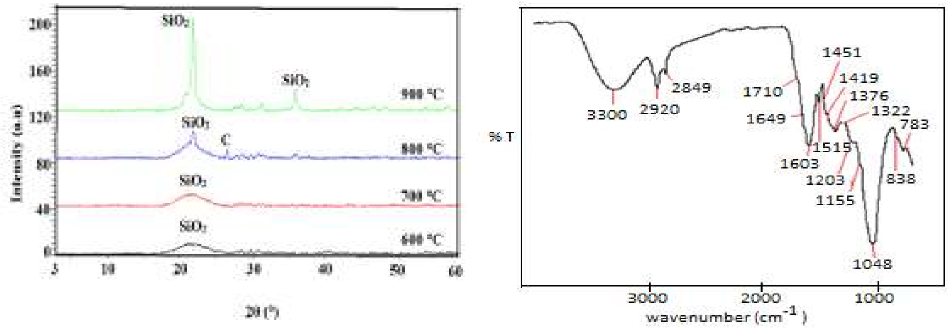
Corrosion is the deterioration of metal and alloys by chemical attack or reaction with its environment. It is a natural phenomenon and difficult to eliminate completely.A couple of eco-green corrosion inhibitors are one of the most practical methods for protecting against corrosion. Inorganic and organic corrosion inhibitors from various plant sources have been reported to be able to reduce metal corrosion attack. In Southeast Asia,silica (inorganic compound) abundantly can be found in rice husk of paddy plant. Lignin (organic compound) can be also found in rice straw. Previous studies have shown that the standard lignin and sodium silicate can offer a good corrosion inhibition in very corrosive medium. The objective of this work is to study the potential of lignocelluloses and silica extracts from paddy plant waste acts as green corrosion inhibitor for carbon steel in acidic medium.

METHODOLOGY

Silicate-based corrosion inhibitor was prepared by using silica extracted from rice husk ash. White-like silica powder yielded after burnt in muffle furnace at 600 ° C for 2 hours. This silica powder was treated with 2.5M NaOH and 2.5M $H_2SO_4$to produce pure silica powder. Finally, the mixtures between pure silica powders with 3M NaOH generated the silicate-based corrosion inhibitorranging from 5 to 25 ppm. For organic-based corrosion inhibitor, dark brown powders of lignocelluloses were obtained from rice straw extraction by chemical process (solvent extraction). The different concentrations of lignocelluloses ranging from 500 to 2000 ppm were used to produce corrosion inhibitors solution. Weight loss method was used in this corrosion test. Low carbon steel coupons (chemical composition in wt%: Fe 99.3%, C 0.12%, Mn 0.5%, P 0.04% and S 0.045%) was cut to produce coupons with sphere shape. The coupons were polished with 800 and 1200 grade abrasive papers, washed and rinsed according to ASTM standard method (ASTM G1-03. 2004). The coupons were then immersed in 2 set of corrosion inhibitor solutions with and without silicate and lignocelluloses solution respectively for 3 hours.

RESULT AND DISCUSSION

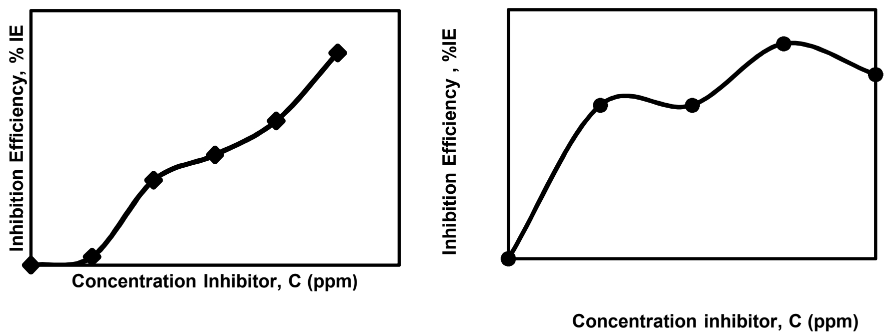
Characterization of silica and lignocelluloses has been performed via XRD and FTIR respectively. Figure 1(a) shows the various X-ray diffraction pattern of rice husk ash after burnt in furnace at 600 °C within 2 hour. The amorphous phase of silica in rice husk ash was identified at 600 °C and 700 °C. In order to make sure rice husk ash is an amorphous phase, rice husk ash from burning process at 600 °C was chosen as it consumed lower combustion energy compared to 700 °C. It is proved that amorphous silica was produced at lower temperature than 700 °C as it is supported by others study of previous research by Xiong et al., 2009. There are some advantages of amorphous silica. It has ultra fine size, high percentage of porosity and greater surface area than crystalline silica (Matori et al., 2009). This property is important as it leads to high reactivity of silica. Hence, it probably ensemble for certain application such as an elemental Si, SiC, Si_3N_4 and Mg_2Si (Amutha, 2010).Figure 1(b) showsthe FTIR analysis of lignocelluloses sample comprised the signal peak for functional groups such as hydroxyl (-OH), methoxyl (-OCH_3), methyl (CH_3) and aromatic rings. Lignin has showed typical signal peak at wavenumber of1515 cm^{-1}, celluloses at 1419 cm^{-1} and hemicellulose at 1203 cm^{-1}as reported by others (Sun, 2005).



(a) (b)

Figure 1.(a)XRDpattern of rice husk ash (b)FTIR spectrumof lignocelluloses from rice straw

Figure 2 shows the corrosion inhibition efficiency of the carbon steel in 1 M HCl in the presence of silicate-based corrosion inhibitor and lignocelluloses solutions. Figure 2(a) shows that the addition of silicate-based corrosion inhibitor improved the inhibition efficiency of the carbon steel. The trend showed that the increasing of silicate concentration of corrosion inhibitor resulted with increasing of inhibition efficiency. The result of corrosion inhibition efficiencies of silicate-containing corrosion inhibitor were achieved as 1 %, 10 %, 13 %, 17 % and 25 % towards addition of 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppmcorrespondingly. However, by using fewconcentration (ppm) of silicate solution, it was be able to protect the carbon steel in acid medium.Figure 2(a) shows the highest corrosion inhibition efficiency of the carbon steel in lignocelluloses was achieved up to 78% at 1500 ppm. The percentage of inhibition was seemed to increase with increased in inhibitor concentration. This result could be explained by the more amountsof inhibitors compounds adsorb on the low carbon steel surface (from 500 to 1500 ppm). The adsorbed lignocelluloses compounds were reduced the surface area that is available for the attack of the aggressive Cl^-ion from the HCl solution.However, addition of 2000 ppm lignocelluloses cause increased in corrosion rate and reduced the inhibition efficiency. This might due to the interaction among the remaining compounds (unabsorbed molecule, anion and cation species) with the layers of adsorbedmolecule in the metal-electrolyte interface.



(a) (b)

Figure 2. Corrosion inhibition efficiency of carbon steel in 1 M HCl in the presence of (a)silica extracted from rice husk (b) lignocelluloses extracted from rice straw

Figure 3 provides supporting evidence which showed that the silicate-based corrosion inhibitor and lignocelluloses solution helps in protecting carbon steel specimens (Figure 3a) from corrosion attack. These physical observations were taken accordingly from the highest inhibition efficiency of the weight loss measurement. Treatment in silicate-based corrosion inhibitors reduced the surface roughness of carbon steel specimen (Figure 3c) from the corrosion attack compared to untreated specimen (Figure 3b). Carbon steel specimen treated in lignocelluloses solution (Figure 3d) also showed the corrosion inhibition with the adherent of organic protective layer on the metal surface.

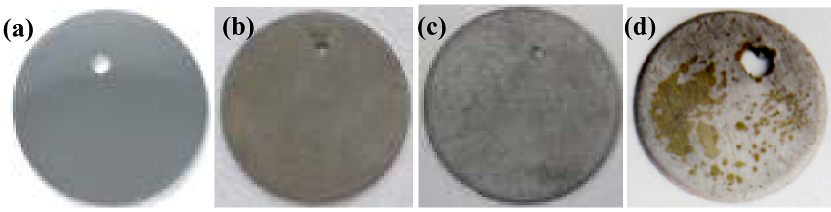


Figure 3. Photograph of the (a) original specimen (b) untreated specimen (c) treated specimen in silicate-based corrosion inhibitor (d) treated specimen in lignocelluloses corrosion inhibitor.

CONCLUSION

Utilization of silicate-containing corrosion inhibitor and lignocelluloses yields from rice husk ash and rice straw, respectively have good potential on preventing carbon steel from corrosion attack.

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