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THE EFFECT OF INHIBITOR LEVEL OF RAMBUTAN RIND EXTRACT AND HCL SOLVENT CONCENTRATION ON THE CORROSION RATE OF ST 37 STEEL

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KEYWORDS

inhibitor
rambutan rind extract
HCl solvent
corrosion rate
ST 37 steel

ABSTRACT

The steel processing industry using the pickling process method uses HCl solvent as a steel cleaner. Besides being a cleaner, HCl solvent is also corrosive and be a factor in the corrosion of the steel from the pickling process. Corrosion can be controlled using corrosion inhibitors made from organic materials. Organic materials contain tannin compounds that can react by forming complex compounds on the steel surface so they can protect the steel from corrosion attacks. In this study, the organic materials used as inhibitors were the rambutan rind extract with a concentration of 0.5%; 1.0%; 1.5%; and 2.0% in a concentration of 0.1 N HCl solvent; 0.5 N; and 1.0 N. The test sample used was St. 37 steel. The purpose of this study was to investigate the effect of inhibitor levels of rambutan rind extract and concentration of HCl solvent on the corrosion rate of St. 37 steel. The method used to calculate the corrosion rate is the weight loss method and the data analysis technique used is Two-Way Anava. The results showed that there was an effect of inhibitor levels of rambutan rind extract and the concentration of HCl solvent on the corrosion rate of St. 37 steel. The corrosion rate has the lowest value in the variation of the inhibitor mixture of 2.0% and 0.1 N HCl with the highest efficiency value of 63.13%.

INTRODUCTION

Steel has a carbon content lower than 1.7% C and malleable (Margono and Slamet, 1981). Steel is strong, ductile, and easy to process in manufacturing. So, steel widely used for various purposes. South East Asia Iron and Steel Institute (Seaisi) shows that steel consumption in Indonesia has reached 6.4 million tons or increase 11% in January-June 2016. Steel can be contaminated to form corrosion due to environmental conditions. Corrosion damages metals through a chemical or electrochemical reaction (Schweitzer, 2003). Corrosion is caused by processing steel with the pickling process method which uses HCl as a steel cleaner. Besides being a cleaner, HCl solvent is also corrosive and a factor in the corrosion of the steel from the pickling process.

The losses caused by corrosion are enormous. In developed countries, about 3.5% of state income is used for repair, maintenance, and replacement of metal-based equipment (Trethewey, 1991). Corrosion can also cause accidents. Corrosion accidents can be seen in the case of the collapse of the spiral slide in the Atlantis Taman Impian Jaya Ancol swimming pool which resulted in four casualties. The slide is brittle due to salt corrosion (Suprapto, 2011). Corrosion prevention needs to be done so as not to cause big losses. Efforts that can be made to reduce corrosion damage can be taken to control and protect metals, such as material selection, coating, cathodic protection and the addition of inhibitors (Jones, 1996).

Corrosion control with inhibitors can be done by adding organic inhibitors. Organic materials can be used as organic inhibitors because they contain tannin compounds that can react with metals and form complex compounds for protection. Organic material with tannin content in it can be found in henna leaves as much as 10.2% (Wildani, 2009), papaya leaves as much as 5-6% (Widjastuti, 2009), and tea leaves as much as

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7-15% (Sari, 2013) and 23.35% on rambutan rind (Desinta, 2015). Rambutan rind contains higher tannin compounds than other organic materials, making it possible to act as a corrosion inhibitor. This study aims to investigate the effect of inhibitor levels of rambutan rind extract and concentration of HCl solution on the corrosion rate of St. 37 steel. The inhibitor levels of rambutan rind extract and the concentration of HCl solvent were each made different, so that the resulting corrosion rate was different.

RESEARCH METHODS

There are two independent variables in this study, the inhibitor levels of rambutan rind extract with a variation of 0.5%; 1.0%; 1.5%; and 2.0% and the concentration of HCl solvent with a concentration of 0.1 N; 0.5 N; and 1,0 N. Whereas the dependent variable in this study is the corrosion rate of St. 37 steel. The data in this study were obtained using the observation method. Observations were made by utilizing the measurement results of the corrosion rate test through the weight loss method or weight loss on the test sample that had been given treatment.

The research instrument used in this study is a measuring instrument that is used to obtain data on the independent and dependent variables. The measuring instrument used to obtain data on the independent and dependent variables is a KERN digital scale with an accuracy of up to 0.001 grams. The data analysis used in this research is two-way Analysis of Variation (ANOVA) or Two Way Anova. Calculation of data analysis using SPSS version 19 software.

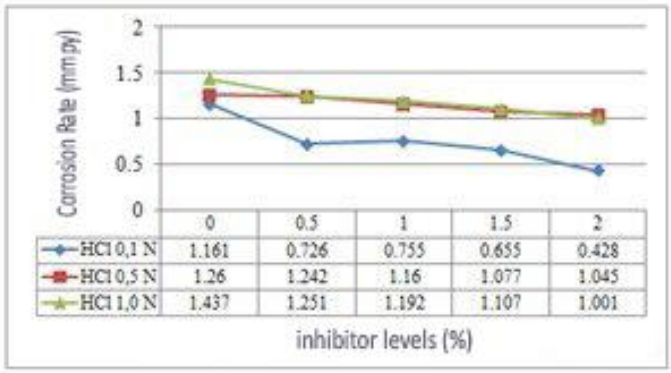
The research procedure in this study are as follows:

1. Preparation of research tools and materials
2. Preparation of test samples
3. Making rambutan rind extract
4. Making 5% rambutan rind extract inhibitor main solvent
5. Preparation of HCl solvent 0.1 N; 0.5 N; and 1.0 N
6. Making immersion media
7. Immersion process
8. Cleaning test sample
9. Final weighing and calculation of corrosion rate
10. Data Analysis

RESULTS AND DISCUSSION

Result of Calculation of the Corrosion Rate of St. 37 Steel.

The results of calculating the corrosion rate of St. 37 steel manually using the corrosion rate equation are then presented in the table. The table for calculating the corrosion rate can be seen in Figure 1.



	0	0.5	1	1.5	2
HCl 0,1 N	1.161	0.726	0.755	0.655	0.428
HCl 0,5 N	1.26	1.242	1.16	1.077	1.045
HCl 1,0 N	1.437	1.251	1.192	1.107	1.001

Figure 1.Graph of St. 37 Steel Corrosion Test Results

Figure 1 represents the results of the corrosion test in the form of a line graph, so that you will see an increase or decrease in the corrosion rate caused by each of the variables used. Based on Figure 1 it can be explained that the corrosion rate of St.37 steel in HCl medium without the addition of rambutan rind extract inhibitor was 1.161 mmpy for steel in 0.1 N HCl medium, 1.260 mmpy for steel in 0.5 N HCl medium, and 1.437 mmpy for steel in 1.0 N HCl medium. Steel that immersed in 1.0 N HCl medium had the highest corrosion rate. The results also showed that the magnitude of the corrosion rate for each sample was different. The inhibitor levels of rambutan rind extract and the concentration of the HCL solution were varied, thus affecting the magnitude of the corrosion rate in each test sample. The highest corrosion rate occurred at a mixed variation of 0.5% rambutan rind extract and an HCl

concentration of 1.0 N. Conversely, the lowest corrosion rate occurred at a mixed variation of 2.0% rambutan rind extract and a HCl concentration of 0.1 N.

The inhibitor efficiency test of rambutan rind extract was then carried out to determine the efficiency of each inhibitor in HCl medium and what is the minimum inhibitor level in the corrosive environment (HCl solvent) which is the most optimal and effective to inhibit the rate of corrosion in it. The inhibitor efficiency test is calculated using manual calculations with the corrosion inhibitor efficiency formula. The results of the calculation of the efficiency test for the rambutan rind inhibitor are then presented in Figure 2

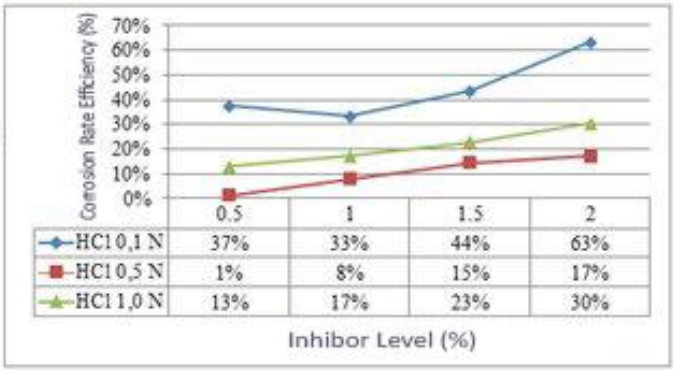


Figure 2. Inhibitor Efficiency Graph

Based on Figure 2, the data shows that there is one of the highest corrosion inhibitor efficiency values. The highest inhibitor efficiency values were at the inhibitor levels of 2.0% and 0.1 N HCl, namely 63.13%. While the value of the smallest inhibitor efficiency was at the inhibitor level of 0.5% and the concentration of 0.5 N HCl, which was only 1.42%. Based on Figure 2 it can also be seen that the more inhibitor levels are added, the inhibitor efficiency value will increase. In Figure 2, the graph depicting the highest level of inhibitor value is in the HCl 0.1 N graph. While the inhibitor efficiency value is low at a concentration of 1.0 N HCl.

Effect of Inhibitor Levels from Rambutan Rind Extract on the Corrosion Rate of St.37 Steel

In general, the inhibitor of rambutan rind extract had an effect on the corrosion rate of St.37 steel when compared to without the addition of the inhibitor. This is evidenced in Figure 2 which explains that the greater the level of rambutan rind extract inhibitor given, the corrosion rate of St.37 steel will decrease. The results showed that the inhibitor level had the highest efficiency value at 2.0% inhibitor level in 0.1 N HCl with an efficiency value of 63.13%. These results are in line with research conducted by Lusiana et al. (2015) who used mangosteen rind as an inhibitor of corrosion of St.37 steel. Lusiana concluded that the greatest inhibitor efficiency occurred at a concentration of 2.0% with an efficiency value of 26.05%. In the mixture in a mixture of 2.0% inhibitor and 0.1 N HCl, it can be said that the rambutan rind extract inhibitor can be absorbed well on the steel surface and Fe-tannin has covered the entire steel surface.

Effect of Concentration of HCl Solvent on the Corrosion Rate of St.37 Steel

The concentration of the HCl solvent directly affects the magnitude of the corrosion rate on St.37 steel. This is evidenced in Figure 2 which illustrates that the greater the concentration of the HCl solvent added, the higher the corrosion rate that occurs. The addition of HCl solvent with different concentrations will cause different corrosion rates. One of the research results shows that the corrosion rate has increased from 0.726 mmpy at a concentration of 0.1 N HCl solution to 1.251 mmpy at a concentration of 1.0 N HCl with the addition of an inhibitor level of 0.5%.

The corrosion rate also increased from 0.755 mmpy to 1.192 mmpy in a concentration of 0.1 N HCl solvent to 1.0 N with the addition of a 1.0% inhibitor. The results of this study are in line with the results of research conducted by Septianingsih et al. (2014) regarding the effect of variations in hydrochloric acid concentration on the corrosion rate of ASTM A 139 low carbon steel without and with 0.2% potassium chromate inhibitor. As a result, Septianingsih concluded that the greater the environmental concentration of HCl, the greater the corrosion rate of ASTM A 139 steel. The results of these studies indicate that the HCl solution affects the corrosion rate of steel.

St.37 steel contains 0.12% C; 0.10% Si; 0.50% Mn; 0.05% S, 0.04% P; 0.02% Al; 0.10% Cu and the rest is Fe. Fe is very susceptible to corrosive environments so it can easily react to form corrosion. St.37 steel with Fe content in it will form a reaction with a corrosive HCl solvent. This chemical reaction can be in the form of a direct reaction of Fe with HCl or a reaction with water and oxygen mixed into it. These reactions will form a corrosion reaction on the steel surface. The reaction between steel and HCl can be seen in equation 1 below.

$$Fe + 2\,HCl \rightarrow FeCl_2 + H_2 \quad \text{(Eq.1)}$$

In the research conducted, HCl was dissolved in water to form a corrosion medium. Water compounds will affect the reaction between Fe and HCl, so that the chemical reaction between the three can be seen in equation 2 below.

$$Fe + 2\,HCl + 4H_2O \rightarrow FeCl_2.4H_2O + H_2 \quad \text{(Eq. 2)}$$

Equation 2 is the corrosion reaction equation formed by Fe, HCl and H2O. The formation of a corrosion reaction on the steel surface, will cause a damage which can reduce the quality of the steel itself.

Effect of Inhibitor Levels of Rambutan Rind Extract and Concentration of HCl Solution on the Corrosion Rate of St.37 Steel

Inhibitor of rambutan rind extract and HCl solvent as a corrosion medium generally had an effect on the corrosion rate of St.37 steel. Based on the research findings obtained, there are differences in the influence of variables on the corrosion rate of the test sample. This study also shows that there is one level of inhibitor of rambutan rind extract that is the most effective at inhibiting the corrosion rate at a certain concentration of HCl solvent. At the inhibitor level of 2.0% rambutan rind extract, the average corrosion rate was low. It is possible that the more inhibitor levels of rambutan rind extract are added, the lower the rate of corrosion.

CONCLUTION

Based on the research results it can be concluded that, the more inhibitor levels are added, the corrosion rate decreases, the lowest corrosion rate is in a mixture of 2.0% inhibitor in 0.1 N HCl with a corrosion rate value of 0.428 mmpy. The higher the concentration of HCl solution used, the corrosion rate will increase, the highest increase in corrosion rate occurs at 1.0 N HCl without the addition of an inhibitor with a corrosion rate of 1.437 mmpy. The increase and decrease in the corrosion rate is influenced by the differences in each mixture in the corrosion medium, in a mixture of 2.0% inhibitor in 0.1 N HCl the lowest corrosion rate will provide the greatest inhibitor efficiency, namely 63.13%, while the mixture is 0.5% inhibitor in 1.0 N HCl will give an efficiency value of 12.94%.

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