UTILIZATION OF KETAPANG LEAF TANNIN EXTRACT AS A CORROSION INHIBITOR OF METALS IN 1 M HCl MEDIA

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Abstract — A metal degraded through the process of corrosion when electrochemical reactions occurred with its surroundings. As long as the metal is exposed to corrosive conditions, the corrosion process will continue to compress the metal, degrading its mechanical properties. The objective of this study is to evaluate the performance and determine the optimum conditions of a corrosion inhibitor extract based on variations in the inhibitor concentration and immersion period. The first step was extracting tanins from ketapang leaves using a 120-minute maseration process (85^0C temperature and 200 rpm mixing) with a 1:25 solvent ratio. The extract is introduced to the corrosive medium containing the submerged metal in a variation of the immersion period that has been defined for the calculated final weight using the hemp leaf extract concentrations (700, 800, 900, 1000, and 1100 ppm) and the amount of time the samples were submerged (48, 96, 144, 192, and 240 hours) in a 1M HCl solution. The test sample with the addition of an inhibitor concentration of 1100 ppm and a 240-hour immersion time provided the largest results of the experiment with 39.22 % efficiency.

Keywords: ketapang leaf; inhibitor, corrosion, tannin

I. INTRODUCTION

Corrosion is the process in which metals lose their quality as a result of electrochemical interaction with the environment. Corrosion is highly likely to occur in industrial environments, especially in sectors that use chemicals [1]. This is because the structure of industrial equipment is usually made of metal in areas that are in direct or indirect contact with corrosive and acidic substances. For the industry as a whole, the prevalence of this corrosion phenomenon can result in significant losses. Material selection and design, cathodic protection, and the application of inhibitors are the three main techniques quoted by Aliofkhazraei [2] to reduce the rate of corrosion. Corrosion inhibitors are used because they are the cheapest and can be used by the industry to reduce the rate of corrosion. Its own way of working is by grouping different compounds to produce a thin film layer so that it can be absorbed to the metal surface. Organic and inorganic inhibitors are two types of corrosion inhibitor. Organic inhibitors use natural resources such as leaves, skin, fruits, seeds, and roots that contain antioxidant compounds. The main compounds contained in inhibitors are tannins. Tanins are a potential scattering agent of metal ions, protein sediments, and biological antioxidants. Thus, tannins have a variety of effects on biological systems [3].

Ketapang is a versatile plant that can grow fertile in the lowlands, mountains, forests, raves, beaches, and along the rivers. It is still planted on the side of the highway and used to make medicines. There are a lot of useful ingredients in it, and one of them is tannins. The typical tanin content of the leaves ranges from 11 to 23% and can be used to prevent corrosion. It is known that the tree is not much used in Indonesia, especially in its leaves. If burned or left as garbage, it can result in exhaust gases such as CO_2 and can cause increasing environmental problems. According to Hermanta and Karomah [6], iron that is in the NaCl 3.5% salt environment can be inhibited efficiently by using mahoni wool tanin extract with a maximum effectiveness value at an inhibitor rate of 250 ppm or 39.45%. According to the findings of

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different studies, the addition of 2 g/L of the inhibitor and the soaking of the mixture for 72 hours with the foil leaf can significantly reduce the corrosion rate of aluminum metal in the NaCl medium by 90% [7]. According to the Ramadhani study, adding 40% of herring leaf tannin extract to iron metals with immersion for 6 days resulted in an inhibitor effectiveness value of 47,01% in average salt water. Based on the illustration above, this study was conducted to determine the effectiveness of straw leaves as a corrosion inhibitor in metals in the acidic environment HCl 1 M with the hope of replacing an organic inhibitor that can pollute the environment.

II. METHODS

This research was conducted in the Research Laboratory of Chemical Engineering, Faculty of Engineering, National Development University "Veteran" East Java with some materials, tools, as well as procedures used as follows.

A . Materials

The main materials used in this study are leaves of ketapang obtained from around the campus of the National University of Development "Veteran" East Java and supporting materials are 85% ethanol, Aquadest, Chloric Acid (HCl) from UD Nirwana Eternal as well as the test material of Stainless Steel 304 from Sidoarjo iron store.

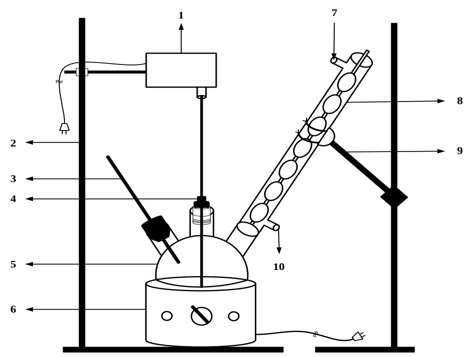
B. Equipment

The tools used in this study are the oven, blender, 100 mesh screen, beaker glass, analytical balance, volumetric flask, measuring cylinder, thermometer, three-neck round bottom flask, heating coat, statif, clem, condenser and mixer motor.

C. Procedure

1. Treatment of the Leaves

The leaves that have already dried and fallen (down) are washed clean first to remove dirt, after which they are ventilated without sunlight about 1 – 2 days. Next, the drying process is carried out to reduce the water level using the oven at a temperature of 100^0C for 60 minutes. The leaves that have been dried are then blended to become powder and then tailored to the size of 100 mesh. Dry leaves of uniform size were subsequently extracted using a process of maseration with 85% ethanol in a ratio of 1:25 and a temperature of 85^0C for 120 minutes and a melting rate of 200 rpm. Subsequently, the filtration is carried out using saring paper to separate the filter from its residues for further testing of tanin levels [9].



Keterangan :
1. Mixer Motor
2. Statif
3. Thermometer
4. Stirer
5. Three-Neck Round Bottom Flask
6. Heating Mantle
7. Water Enters
8. Condensor
9. Clem
10. Water Quits

Figure 1. Extraction Toolkit

2. Treatment of *Stainless Steel*

The metal used is the type of stainless steel 304 in the shape of four-sized plates of 30 mm x 30 mm x 2 mm as many as 30 pieces. Subsequently, the steelings are carried out on the sharp metal side with plastic paper and then washed with water and soaked with ethanol for 15 minutes to sterilize the surface of the sample from the oxide layer. The subsequent dry metal is subject to initial weighing.

3. Preparations of Test Media Solutions

The test medium of the immersive solution used is the 1 M HCl solution. Based on ASTM G31-72 [10] for lab-scale immersion testing, the volume of the immersion solution is 0.2 to 0.4

times the surface area of the test specimen. With the size of stainless steel metal plates of 30 mm x 30 mm x 2 mm, the volume of the test solution used is set at 600 ml.

4. Mechanisms of Immersion Testing

The method used in the corrosion rate testing in this study is the weight loss method, prepared tools such as beaker glass, stainless steel 304, rope and holder. Then fill the beaker glass with a solution of HCl 1 M 600 ml. Then add the result of leaf extraction as an inhibitor with a certain concentration variation into each beaker glass and also prepare the beakers without the addition of inhibitors. Then, insert stainless steel 304 into each beaker glass according to the specified time variable. After the immersion process, the stainless steel is removed and the pickling process is carried out by removing the corrosive material present on the metal surface, then washed with water and soaked with ethanol for 15 minutes, after which the drying is performed in the oven at a temperature of 100^0C for 15 minute, then weighing as the final weight.

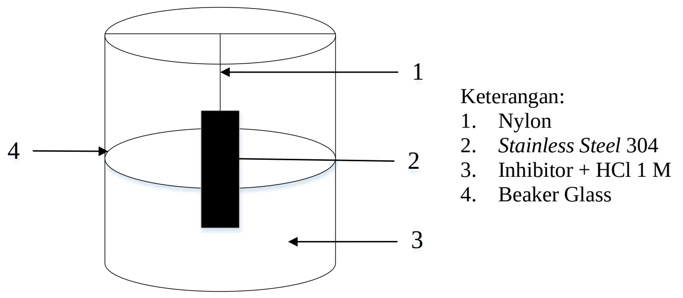


Figure 1. Inhibitor test equipment series

III. RESULTS AND DISCUSSION

A. Raw Materials Analysis Results

Testing the tannin content of ketapang leaf extract was carried out at the Nutrition Laboratory of Airlangga University using the Spectrophotometry method to determine the content of tannin compounds. The results of the analysis showed that the content of tannin compounds in ketapang leaves was 12.37%.

B. Corrosion Rate Calculation Results and Corrosion Inhibitor Efficiency

In the research that has been done, inhibitors from ketapang leaf extract were tested on stainless steel 304 in 1 M HCl media with variable inhibitor concentration (ppm) and soaking time (hours). The calculation results are obtained as in the table below.

Table 1. Corrosion Rate Calculation Results and Inhibitor Efficiency

Immersion Time (hours)	Inhibitor Concentrations (ppm)	Corrosion Rate (mpy)	Efficiency (%)
48	0	123.0888	-
	700	93.9528	23.67
	800	93.0372	24.41
	900	89.8130	27.03
	1000	85.6964	30.38
	1100	81.8095	33.54
96	0	112.4639	-
	700	85.0621	24.36
	800	79.8210	29.03
	900	79.1306	29.64
	1000	75.5604	32.81
	1100	73.7665	34.41

Immersion Time (hours)	Inhibitor Concentrations (ppm)	Corrosion Rate (mpy)	Efficiency (%)
144	0	93.3739	-
	700	69.0759	26.02
	800	66.2230	29.08
	900	64.9584	30.43
	1000	60.3868	35.33
	1100	58.3377	37.52
192	0	82.5059	-
	700	57.0431	30.86
	800	52.7136	36.11
	900	52.2067	36.72
	1000	51.8822	37.12
	1100	50.1600	39.20
240	0	66.1021	-
	700	44.9223	32.04
	800	43.5661	34.09
	900	42.2177	36.13
	1000	41.0664	37.87
	1100	40.1753	39.22

Figure 3 shows the relationship between inhibitor concentration and corrosion rate. It can be seen from the graph that the more inhibitor concentration given to the test specimen, the slower the corrosion rate. The relationship between the two variables is inversely proportional. This is in line with the theory put forward by Priyotomo [11], that tannin molecules adsorbed on the surface of the metal plate will form a protective layer with bonds formed as a result of the reaction of the hydroxyl groups contained in the tannin molecules. This increase will stop when the metal has changed its function and is no longer able to protect the metal material, this is because the interaction between the metal and the inhibitor becomes weak, so that the protective layer that should form on the metal surface dissolves in the media.

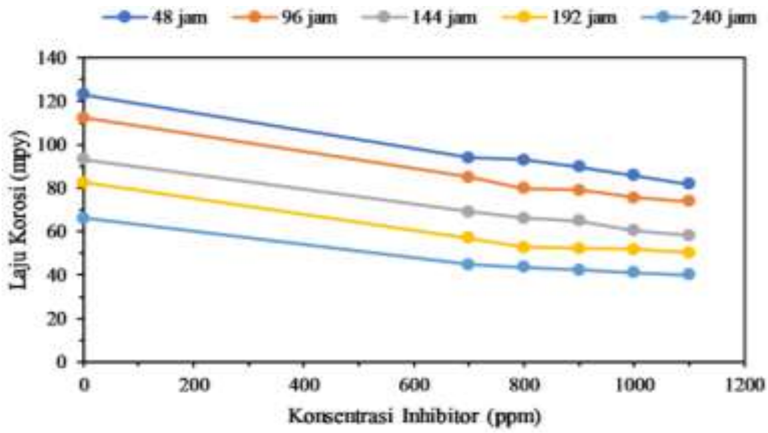


Figure 3. Correlation of inhibitor concentration (ppm) to corrosion rate (mpy)

The relationship between immersion time and corrosion rate can be concluded that the corrosion rate of metals will decrease with increasing immersion time. This is because the corrosion rate tends to slow down because the corrosion layer is thicker and denser, so that the power transmission resistance increases. Based on all tests on various samples with different inhibitor concentrations and soaking times, the combination of 1100 ppm inhibitor concentration and 240 hours of soaking time produced the greatest efficiency value of 39.22%. From the graph, it can be seen that the higher the efficiency value, the higher the inhibitor concentration. As a result, the relationship between the two becomes directly proportional. In this case, the increase in surface coverage from the addition of the inhibitor leads to an increase in the efficiency of the inhibitor [11]. The increase in surface coverage from the addition of inhibitors results in covering the active components that should be eroded by the HCl solution and this is the reason for the increased inhibitor efficiency.

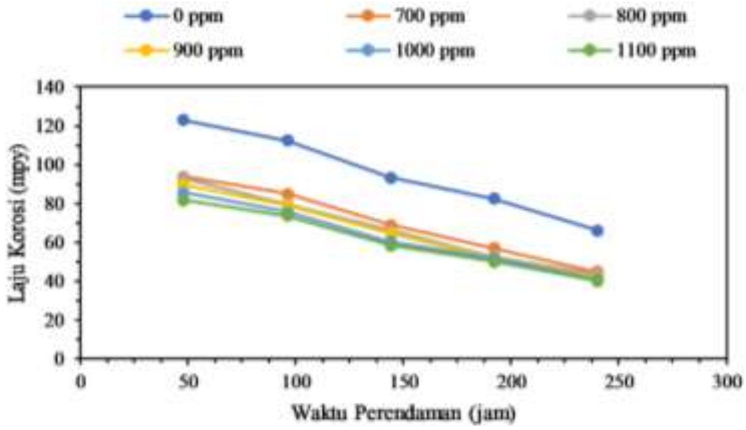


Figure 4. Correlation of immersion time (hour) to corrosion rate (mpy)

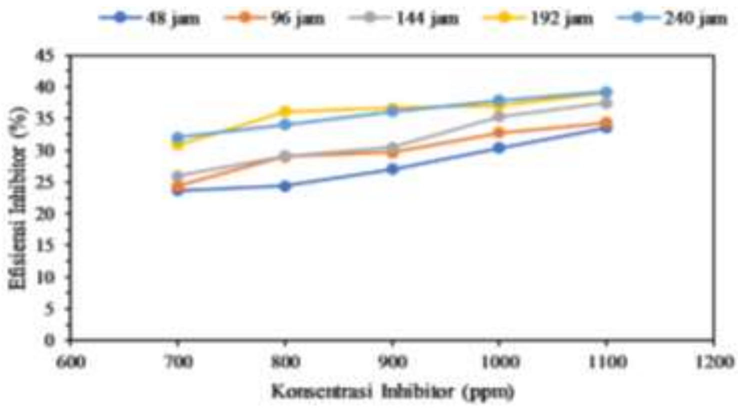


Figure 5. Correlation of inhibitor concentration (ppm) to inhibitor efficiency (%)

The relationship between immersion time and inhibitor efficiency observed from the results of specimen testing showed that the effectiveness value of the inhibitor increased with the length of immersion time, the elements in the ketapang leaf extract formed a stronger adsorption process on the metal surface, and created a more effective protective layer for inhibits the corrosion rate [11]. The corrosion observed during the test using this approach still occurs, but tends to experience a decrease in the corrosion rate. In this condition for finding the maximum point, Mahmudi [12] stated that the efficiency of the inhibitor began to decrease at an inhibitor concentration of 1250 ppm with a soaking time of 240 hours.

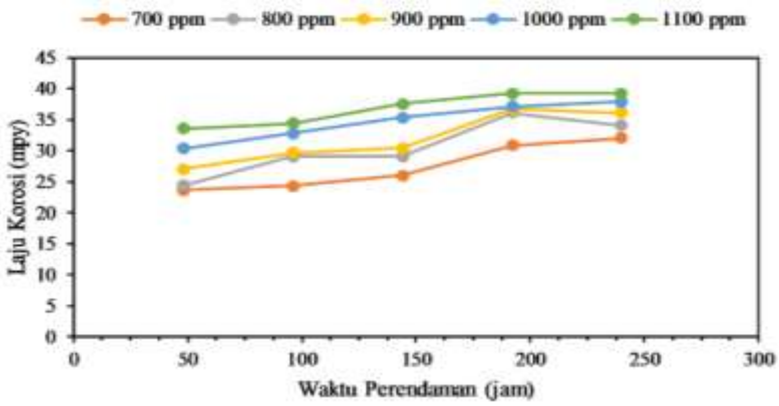


Figure 6. Correlation of immersion time (hours) and inhibitor efficiency (%)

IV. CONCLUSION

The corrosion inhibitor derived from the tannin extract of ketapang leaves has the potential as an organic corrosion inhibitor that is environmentally friendly and economical. The value of the inhibition efficiency is the basis for determining this potential. Where the tannin content of the ketapang leaf extract was 12.37%, the best conditions were obtained at an inhibitor concentration of 1100 ppm with a soaking time of 240 hours and the resulting inhibitor efficiency was 39.22%.

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