Effect of Cigarette Butts Extraction on the Corrosion Rate of ASTM A36 for Jacket Platform

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Abstract: Jacket platform is one type of offshore building that used for the offshore oil exploitation process. In general, the Jacket is designed with an operating life of 20 to 25 years and in operation must be guaranteed the safety and strength of the Jacket structure. One of the safety factors that must be considered is corrosion growth in all parts of the Jacket structure. To overcome corrosion problems, there is a need for alternative corrosion improvements, namely the prevention of corrosion by using corrosion inhibitors. The organic inhibitor that can be used as corrosion inhibitors, one of which is cigarette butts, because it is contains a lot of nicotine. Nicotine can be used as an inhibitor by donating nitrogen atoms to nicotine to Fe^{2+} atoms so that complex compounds $[Fe(NH_3)_6]^{2+}$ are formed. This compound has a higher stability than Fe so that it can be used as protection in corrosion. The purpose of this research is to solve the cigarette butts problem by creating it a corrosion inhibitor to minimize the cost of material replacement, maintenance costs, and over-design. This study is an experiment by using ASTM 36 steel, material will be blast cleaned in advance with abrasive material Steel Grid. Second steps in this study is the coating process by mixing epoxy paint and extraction of cigarette butts, then immersed in corrosive medium namely sea water of Kenjeran. Corrosion rate testing is carried out by using the weight loss method. The highest corrosion rate occurred at 1% mixing with a corrosion rate of 24.61 mpy and the lowest corrosion rate at 2% mixing with a corrosion rate of 13.78 mpy Based on this research it can be concluded that the nicotine that can be used as cathodic protection on coatings.

1 INTRODUCTION

A Jacket Platform is a very common welded tubular space frame with three or more near vertical tubular chord legs with a bracing system between the legs. These platforms are virtue of their immobility, designed for long term use. The platform exhibits a low natural period and deflection against environmental loads (Samanta, 2016). In the generally Jacket is made of steel material because it is designed with the operating life for 20 years. One of the factors that can lower the strength of the jacket structure is the occurrence of corrosion (Ardianto, 2017).

The major failure mode of oil and gas structures is corrosion damage (Yasseri, 2017). The process of corrosion in the jacket platform occurs with high intensity because almost any aqueous environment can promote corrosion, which occurs under numerous complex conditions in oil and gas production, processing, and pipeline systems (Champ-Tech, 2012). Corrosion in the jacket platform can reduce the operating life of the jacket, this incident caused the oil and gas companies in Indonesia suffered disadvantages due to corrosion in the offshore building reach to hundreds of millions of dollars are equivalent to 2-5% of a country's Gross Domestic Product. Therefore, it is necessary to reduce the corrosion level of the jacket platform (Harjanto, 2014).

One of the most promising methods to improve the protective ability of coatings is the use of corrosion inhibitors (MCI) (Golovin, 2019). Inhibitors had been shown to be one of the major tools for tackling corrosion in the oil and gas industries. (Popoola, 2013). Microencapsulation technology greatly simplifies the process of compounding the polymer protective coating and allows to isolate the active components from the reactive groups of polymer resins and hardener at the stage of curing, correctly form the polymer base of the coating and avoid the negative effect of the inhibitor on the

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adhesion of the coating to the protected substrate (Golovin, 2019). An Inhibitor with an effective corrosion reduction performance is generally an organic compound consisting of atoms N, O, P, and S (Hatch, 1984).

One of the groups of organic compounds containing such components is nicotine, on the other hand hazardous substances have been identified in cigarette butts – including arsenic, lead, nicotine and ethyl phenol (Eriksen, 2013). Nicotine is widely contained in tea, coffee, tobacco and cigarette butts, but the component of nicotine on cigarette butss more than coffee and tea is equel to 3,43% (Rodgman, 2006). Nicotine can be used as an inhibitor by donating the nitrogen atom in the nicotine to the atom Fe^{2+} so that the compound is formed $[Fe(NH_3)_6]^{2+}$. This compound has a higher stability than the Fe so that it can be used as a protection in corrosion (Haryono, 2010).

In general, tobacco is the main ingredient of cigarette composition, but when cigarettes turn into cigarette butts, the cigarette butts Filter absorbs chemical content in cigarettes as much as 80% (Novotny, 2009). This is caused by paper and cellulose acetate, that collects chemicals that are produced by smoking. (Novotny, 2014). This plastic component of filtered cigarettes may not degrade in the environment for many years (Bonanomi, 2015). There are numerous advantages of using tobacco extract as a metallic corrosion inhibitor is a natural, renewable, environmentally benign, and relatively inexpensive source. The active constituents in tobacco can be commercially extracted in a simple operation using only water as an extraction medium (Fouda, 2014).

Almost six-trillion cigarettes are produced globally each year, with approximately one-third to two-thirds of those cigarette butts being possibly deposited in the environment and ending up in parks, beaches, streets, and communities (Granados, 2019). According to the World Health Agency (WHO) survey about 36.3% of the population of Indonesia is an active smoker and Indonesia produces at least 52 million sticks of cigarette butts waste every year. Therefore, cigarette butts are potential to be used as an alternative to corrosion inhibitor material and can tackle cigarettes butt garbage in Indonesia. Previous research stated that the use of tobacco as a corrosion inhibitor on spikes still have a 23% lower corrosion rate reduction compared to using cigarette butts waste with an average value of corrosion rate of 0.16 mpy (Andeka, 2015). The greater the addition of cigarette butts extract then the higher the rate of the corrections. Therefore, this research needs to be done to assess the utilization of waste cigarette butts as a corrosion inhibitor material on the platform jacket.

The purpose of this research is to determine the parameters that affect the use of cigarette butts as coating material and to know the reliability of coating coatings from the cigarette butts. There are also benefits achieved from this research the first is to utilize waste cigarette butts so as to reduce the amount of waste in Indonesia and for the protection of oil rig building so as to reduce the accommodation and maintenance cost. As for the potential results that can be created from this work is the scientific article. The second is a reference for scientists/societies/institutions.

2 METHOD

2.1 Time and Place of Execution

The research began on April 1, 2019 until July 13, 2019. The first stage author do is to find cigarette butts in the surrounding area Faculty of Marine Technology, ITS. Then proceed with the purchase of specimen and perform various stages of testing in the laboratory environment of ITS Metallurgical Material Department and in CV Cipta Agung.

2.2 Tools and Materials

The equipment used in this research was spychrometer (wet and dry thermometer), evaporator, dry abrasive blast cleaning, WFT measuring instrument (Wet Film Comb), DFT measuring device (Dry Film Thickness), (pull of test) power test equipment, FTIR (Fourier Transform (Infrared), stereo microscope, and optical microscope.

The materials used were methanol, cigarette butts, tobacco, original powdered tea, paint jotun penguard Primer grey compenent A and B, thinner Jotun No. 17, Kenjeran sea water, sandpaper No. 150, glue stardard setting epoxy adhesive, and ASTM A36 steel with specimen sizes is 20 mm x 20mm x 6 mm and 50 mm x 50 mm x 6 mm, where the properties of ASTM A36 shown in figure 1.

Physical Properties	Metric
Density	7.85 g/cc
Mechanical Properties	**Metric**
Tensile Strength, Ultimate	400 - 550 MPa
Tensile Strength, Yield	250 MPa
Elongation at Break	20.0 %
	23.0 %
Modulus of Elasticity	200 GPa
Compressive Yield Strength	152 MPa
Bulk Modulus	140 GPa
Poissons Ratio	0.260
Shear Modulus	79.3 GPa
Component Elements Properties	**Metric**
Carbon, C	0.260 %
Copper, Cu	0.20 %
Iron, Fe	99.0 %
Manganese, Mn	0.75 %
Phosphorous, P	<= 0.040 %
Sulfur, S	<= 0.050 %

Source: http://www.matweb.com/

Figure 1: The Properties of ASTM A36 Steel.

ASTM A36 steel based on figure 1 including steel that has a low carbon composition, which is equel to 0, 26 % (low carbon steel).

3 RESULTS AND DISCUSSION

3.1 Extraction Inhibitor Solution Result

Figure 2: Extraction results of inhibitors from (a) cigarette butt waste (b) tea (c) tobacco.

After extraction process is done, then obtained result of cigarette butts extract, tea extract, and tobacco extract. Solution of extract corrosion inhibitor has thick brown characteristic with the volume of each cigarette butts extract as much as 15 mL with pH 6.2, tobacco extract 13 mL with pH 7.8, and as much as 18 mL with pH 7, 3 On every 1 scale of the reaction size (batch).

3.2 Surface Preparation and Blast Cleaning Testing Results

The result of the surface preparation test was determined by using a value parameter of RH (humidity ratio) and dew point. This parameter derived from dry bulb and wet data respectively at 30 °C and 25 ° C. According to the test parameters, it can be noted that cigarette butts have a RH and Dew Point value of 67% and 23% respectively.

This indicates that the cigarette butts extract has a normal moisture level in accordance with with the standard namely less than 85% (ASTM D-3451-06, 2017). The results of visual observation Blast cleaning SA2 1/2 shown in Figure 3, namely Steel SS 400/JIS G3101/ASTM A36 is a type of Steel with low carbon content so that the Blasting process is needed to clean the surface of the Steel due to oxidation process.

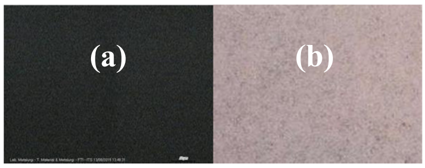

Figure 3: (a) Steel A36 before the blast cleaning process SA $2^1/_2$ (b) Steel A36 after blast cleaning process SA $2^1/_2$.

3.3 Surface Roughness and Coating Measurement Results

After the blasting process is done on the steel, the next process is the measurement of roughness done using ASTM D4417-2014 standard. According to the ASTM D4417-2014 standard range of steel roughness is 37 µm to 137 µm. In this roughness measurement the average roughness value obtained was 94.6 µm for specimens measuring 50 mm x 50 mm x 6 mm and 96.3 µm for specimens measuring 20 mm x 20 mm x 6 mm. This indicates that the surface roughness value has been accordance with standards. At this stage the WFT (Wet film Thickness) and DFT (thick dry film) values were obtained at the same time, 120 µm and 55 µm in compliance with ISO 2808-2007(R2010) standard.

3.4 Adhesion Test Result

The nature of adhesion between cigarette butts extract with steel is an important parameter in its application when coated on the jacket platform and in this research the adhesion properties are measured through the "*Pull Off*" method in accordance with D4541 2017 standard, which the results can be shown in Figure 4. Overall, the variation of cigarette butts extract 2% has a high adhesion power compared with other varieties. The result from the tobacco extract has the adhesion of lower. This becomes the advantage of cigarette butts as a corrosion inhibitor on the jacket platform in physical terms because it has a high adhesive power due to great adhesion power.

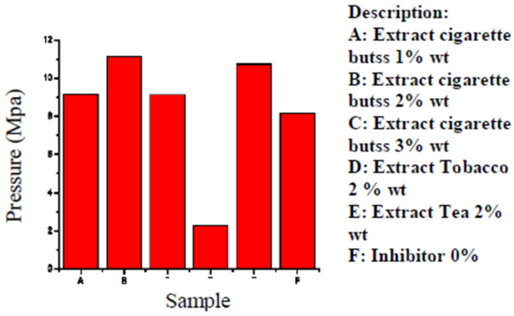

Figure 4: Adhesion Testing Results.

3.5 Measurement of Salinity of Seawater Results

The sea water of Kenjeran as much as 500 mL is heated at temperature 200 °C using the electric heater until it shrinks and becomes granules salt. At this stage, the salinity of seawater obtained is 3.32‰, which means that in seawater there are 0.032 grams of salt/mL of seawater so that the salinity obtained is 0.032 ppt with pH 8.2.

3.6 Corrosion Rate Testing Results

Testing of steel corrosion rate with specification of dimensions 20 mm x 20 mm x 6 mm is done through weight loss test with data obtained Inserted into the equation (1).

$$CR\ (M) = \frac{W \times K}{D\ As\ T} \quad (1)$$

Description:
CR = Rate of corrosion (miles per year (mpy))
W = Weight change from specimen (gram)
K = Constant factor (3, 45x106)
D = Density of specimen in units (g/cm³)
As = Area of specimen (cm ²)
T = Time (hours)

The constant parameters in equation (1) are the factor constant (K) is 3.45 x106, the material density is 7.85 g / cm³ and the surface area of all materials is 12.8 cm2, while the observation time is 144 hours (6 days). Based on the calculation obtained in equation (1), the corrosion rate values are obtained for all variations, both variations in mass percent of cigarette butt extract and other inhibitor type extracts which can be shown in Figure 5.

The lowest corrosion rate obtained in cigarette butts extracts of 2 % which is 28.6 mpy, even that value is still lower than tea and tobacco extracts at the same mass percent which shows that cigarette butts extract is a type of corrosion inhibitor that has the highest corrosion inhibition rate compared to other inhibitor materials.

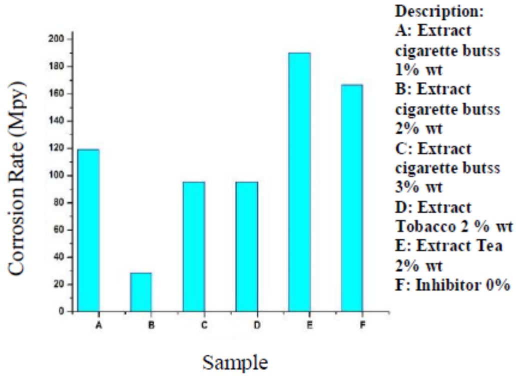

Figure 5: Corrosion Rate Results (mpy).

The calculation of corrosion rate can be evidenced by the efficiency of inhibitors calculated through the equation (2).

$$EI = \frac{XA - XB}{XA} \times 100\% \quad (2)$$

Description:
XA = rate of corrosion without inhibitors
XB = corrosion rate with inhibitors

By using the equation (2), the result of the efficacy of B inhibitors was obtained 83%. It is also reinforced by the use of FTIR test results to identify the bonds contained in the compound, which can be shown in Figure 6. The red waves show FTIR spectra results from cigarette butts extract inhibitors. Based on these results, the sharp peaks are shown in the number of waves 3323.12 cm^{-1} and 1019.79 cm^{-1}. The sharp and strong ribbon spectrum is shown at 1019.79 cm^{-1}. It shows the C-N group stretching and on the 3323.12 cm-1 ribbon showing the NH stretching cluster.

The blue color waves show FTIR spectra results of mixing of cigarette butts extract inhibitors with epoxy paint with sharp peaks at 2918.79 cm^{-1}, 1455.32 cm^{-1}, and at 1011.27 cm^{-1}. On the Spectrum 2918.79 cm^{-1} tape shows the N-H cluster stretching. As for 1011.27 cm^{-1} indicates the C-N group stretching. Wave of black color showed FTIR results from paint 100% without added inhibitors.

Based on figure 6, it can be concluded that the nicotine substance found in inhibitors does not lose its ability as an inhibitor of resistor corrosion, because when added to the paint, the nicotine is still present and not lost, which means the ability of the inhibitor is not interrupted, according to the desired results.

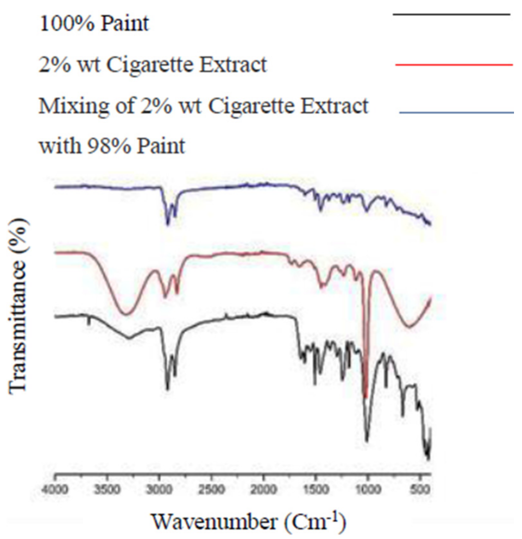

Figure 6: FTIR Spectra of Cigarette Butts Extract, 100% Paint, 2% wt Cigarette Extract, and Mixing of 2% wt Cigarette Extract with 98% Paint.

3.7 Material Characterization Results

Physical characterization of morphology of the steel surface is performed to compare the corrosion behaviour on the surface of the steel before and after coated by a corrosion inhibitor. Characterization is performed with the stereo microscope that the result can be shown in Figure 7. Based on the characterization, the addition of a 2% cigarette butts Extract can be seen that the corrosion is inflicted at the lowest in comparison to other variations. Corrosion spots can be seen clearly in the variation of the addition of cigarette butts extract by 1% which indicates that the inhibitory efficiency of the highest corrosion rate is obtained in the addition of a 2% cigarette butts extract. It is in accordance with the results Obtained at the corrosion rate measurement that the lowest corrosion rate is also obtained when the addition of 2% cigarette butts extract.

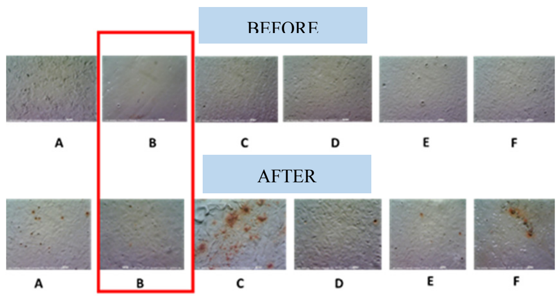

Figure 7: Observation Results of Stereo Microscope on Extract Sample (A) Cigarette butts 0.3% (B) Cigarette butts 0.2% (C) Cigarette butts 0.1% (D) Tobacco (E) Tea (F) Cat 100%.

4 CONCLUSIONS

Based on research the extract of cigarette butts potentially as alternative corrosion inhibitors on the jacket platform. The higher the percentage of mass extract cigarette butts, the smaller the rate of corrosion with the optimum cigarette butts extract of 2% with a corrosion rate of 28.6 mpy. In addition, cigarette butts extract has a higher corrosion rate reduction efficiency than in other types of corrosion inhibitors.

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