Corrosion Analysis of Oil Drilling Pipes On Mobile RIG # 42.3 / N1500-E In Prabumulih

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Abstract

In the oil, gas, and geothermal drilling industry, the use of drill pipe is very important to increase the length of the drilling depth. Problems that are often encountered in drilling pipes such as broken, bent, and leaking drilling pipes, one of which is caused by corrosion. Corrosion is the degradation of materials (usually metals) due to the electrochemical reaction of these materials with their environment. This study uses a specimen of carbon steel pipe type G105 where this pipe is used in field drilling. From the results of research on the corrosion rate test, the corrosion rate value is obtained in mm / month. This study took the first drill pipe sample ~~starting~~ from May 2018 to October 2019 with the same sample code with a sample size of 69 pipes. Based on the research results, the largest corrosion rate value in the drilling pipe from May 2018 to October 2019 is 0.12 mm / month. In the research, the smallest remaining life of the drilling pipe is 6.2 months. Of the 69 drilling pipes studied, there were 11 drilling pipe samples that had decreased quality to class 2. Based on the results of Scanning Electron Microscopy photos, ~~the~~ condition of the pipe surface morphology after corrosion and there was surface damage after corrosion.

Keywords: *Carbon Steel Pipe, Corrosion, Corrosion Rate, Drilling Pipe, Remaining Life.*

I. Introduction

In the oil, gas, and geothermal drilling industry, the use of drill pipes or drilling pipes is very vital as an addition to the length of the drilling depth. The drilling pipe is a very strong steel pipe designed in such a way as to provide strength in the process of making oil, gas and / or geothermal wells to the desired depth (drilling program). [7]

Other functions of the drilling pipe are as raising and lowering the drill bit, channeling and transmitting the rotating force of the drill table or top drive to the drill bit, and channeling high pressure drilling mud (drilling fluid / fluid) to the drill bit. [3]

Drilling pipe is a very important equipment in drilling operations, in its application the drilling pipe will always experience loads such as torsion, pull, press, due to the flow of drilling mud (drilling fluid / fluid), pressure from the drilling well, and friction loads between the pipes. drilling with borehole walls. In the operation of the drilling pipe, several problems are encountered, such as broken, bent, and leaking or washout pipes. This is very detrimental to the company because the time to replace the new drilling pipe will take a long time, and will disrupt the drilling program which will result in high drilling operational costs.

Corrosion is the degradation of materials (usually metals) due to the electrochemical reaction of these materials with their environment. [1]

Many experts also say that corrosion is a decrease in metal quality due to electrochemical reactions with the environment. [2]

The direct impact of the danger of corrosion is that it costs money to replace metal materials or tools that are damaged by corrosion, if the work is to replace corroded materials, costs for corrosion control and additional costs for making construction with thicker metal (over design). The indirect impact, corrosion can result in losses such as stopping gas supply, decreasing company image, decreasing stock value, and producing low safety. Corrosion takes many forms. Each form of corrosion has different characteristics and mechanisms, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, erosion corrosion, and stress corrosion. [6]

Corrosion is influenced by two factors, including that originating from the material itself and environmental influences. The factors of the material include the purity of the material, the structure of the material, the crystal form, the elements present in the material, the mixing techniques for the material, and so on. Environmental factors include air pollution level, temperature, humidity, presence of corrosive chemical substances, and microbes. [4]

In general, the corrosion mechanism that occurs in a solution starts with the metal which is oxidized in the solution, and releases electrons to form metal ions that are positively charged. The solution will act as a cathode with the most common reactions being the release of H_2 and reduction of O_2, as a result of the reduced H^+ and H_2O ions. This reaction occurs on a metal surface which will cause peeling due to repeatedly dissolving the metal into the solution. [8]

Industrial equipment made of metal in oil and gas locations is very prone to corrosion hazards. Corrosion damage attacks metals in various forms depending on the composition of the oil and the physical properties of the oil. In conditions where the oil is mixed with water, the composition of the oil mixture (water cut) will determine the rate of corrosion. The rate of such corrosion will vary depending on the flow pattern in the pipe. In addition, other physical properties of oil such as gas flow, water flow, inhibitors, and condensate will also result in varying corrosion rates. Oil refineries are highly corrosive environments with almost any type of corrosion can occur in them. To control it, it is necessary to choose the right material for certain operating conditions and a corrosion protection system will be very useful to determine the level of corrosion resistance of the equipment. [5]

The presence of crude oil in the pipeline basically does not cause corrosion. Oil can act as a barrier layer for metallic materials and corrosive elements. However, if mixed with water, oil will become corrosive. Therefore, in many cases, the prediction of the tendency for corrosion to occur in piping can be analyzed by calculating the oil / water flow pattern. The oil / water flow pattern is influenced by the physical properties of the oil and the velocity of the oil flowing into the pipe. Simply put, corrosion will not occur if the flow in contact with the pipe surface is dominated by oil, or in other words, corrosion does not occur at water cuts lower than 30% and flow rates over 1m / s. [10]

In petroleum, light paraffinic contains hydrocarbons of not less than 97%, while in heavy asphaltic types the lowest is 50%. Petroleum specifications resulting from drilling in oil fields can cause corrosion problems in carbon steel. Corrosion behavior that occurs depends on the type and composition of the oil contained in the mixture. The presence of oil mixed with sea water can accelerate the rate of corrosion, but the rate at which corrosion occurs is still influenced by the flow rate, pressure, temperature and the physical properties of the oil itself. [11]

The gas flow in the oil flowing through the pipe will cause gas bubbles and increase the slug flow. In the gas state, oil will readily absorb oxygen which in turn will multiply the cathodic reaction with metals through the oxygen reaction mechanism. [12]

Therefore, the researcher hopes to analyze the reduction in thickness due to corrosion on the drilling pipe, to analyze the corrosion rate on the drilling pipe, and to know the remaining life due to corrosion in the drilling pipe.

II. MATERIALS AND METHODS

This thesis research was conducted in Prabumulih, South Sumatra for specimen selection according to predetermined variables and in the Bangka Belitung State Manufacturing Polytechnic laboratory for SEM (scanning electron microscope) testing. By using a drilling pipe material (G105) with a carbon composition of 0.38 - 0.43, manganese 0.75 - 1.00 max, phosphorus 0.035 max, sulfur 0.040 max, silicon 0.20 - 0.35, chromium 0.80 - 1.10, and molybdenum 0.15 - 0.25. In addition, it also uses several supporting tools, including ultrasonic thickness gauge, welding gauge, pH meter, and SEM (scanning electron microscopy) Park NX 10 for analysis. in Figure 1. describes the methodology used in research.

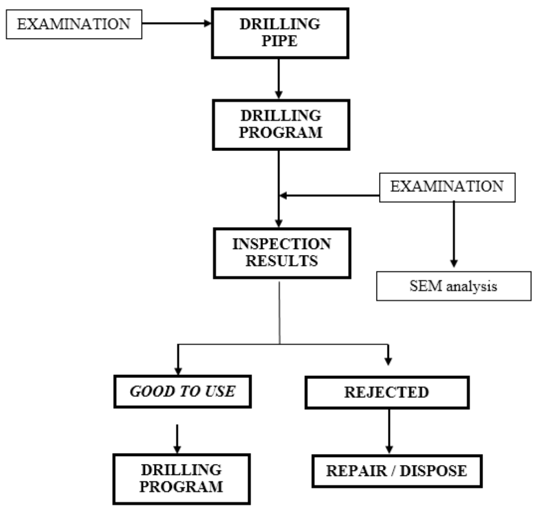

Figure 1. Research Flowchart

III. RESULTS AND DISCUSSIONS

After routine inspection, the drilling pipe is inspected. The data obtained are in the form of internal and external conditions as a whole for the drilling pipe. The following are the results of the inspection which are summarized in table 1 below:

Table 1. The diameter of drilling pipe

No.	Data	First Inspection	Second Inspection
1.	Minimum thickness	8.1 mm	7.2 mm
2.	Maximum Thickness	9.2 mm	9.2 mm

From table 1, it can be seen that the minimum thickness of the pipe on the first inspection is 8.1 mm and the maximum thickness is 9.2 mm. On the second inspection, the minimum thickness of the pipe is 7.2 mm and the maximum thickness is 9.2 mm.

A. Drilling Pipe Thickness Analysis

Judging from the first inspection report, the maximum thickness is 9.2 mm and a minimum thickness of 8.1 mm. Based on the DS-1 Volume 3 standard regarding the classification of drilling pipes, a premium class of 69 samples was obtained. The results of the second inspection show a maximum thickness of 9.2 mm and a minimum thickness of 7.2 mm. Where the premium class is obtained, as many as 58 samples and 11 samples are included in class 2.

B. Analysis of Corrosion Rate and Remaining Life

For the calculation of the corrosion rate consider the first inspection report and the second inspection report with a span of 17 months.

Based on the corrosion rate, the remaining life of the drilling pipe can be predicted to a minimum of 6.44mm. With the interim data, the minimum thickness of 7.2 mm is included in the calculation. By looking at the remaining life, it is close to the minimum standard limit to the minimum limit allowed by the DS-1 Volume 3 standard of 6.44mm (70% of the initial thickness).

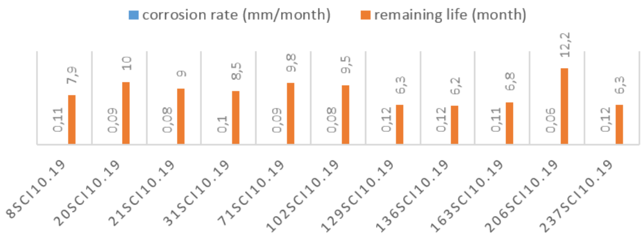

Figure 2. Corrosion Rate and Remaining Life

Based on Figure 2, it can be seen that the difference in corrosion rates for the same type of pipe is due to differences in the rotation speed of the drilling, which when the temperature increases on the pipe surface causes Cl^- activity to increase, thereby reducing the composition of Fe203 by electrochemical reactions and damaging the structure of the oxide layer on the pipe [9]. The smallest remaining age is in the serial number 237SCI10.19, which is 6.3 months, while the largest remaining age is in the serial number 206SCI10.19, which is 12.2 months.

C. SEM testing

SEM testing is used to see the form of corrosion that occurs in the specimen. SEM analysis was performed at 500X magnification.

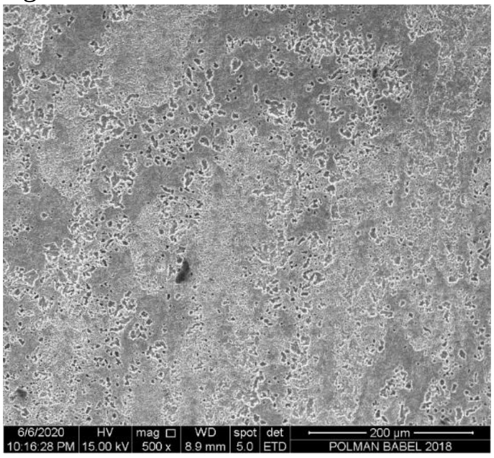

Figure 3. SEM Test Results 500X Magnification for Sample 129SCI10.19

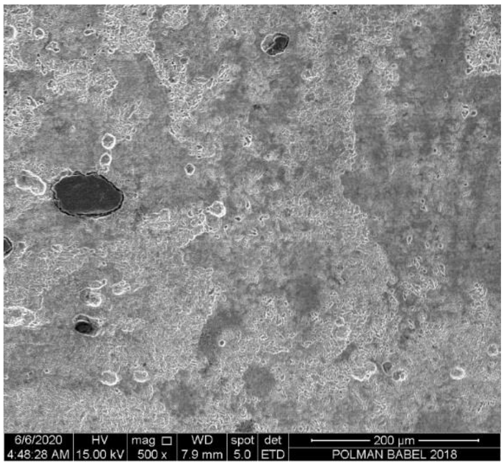

Figure 4. SEM Test Results 500X Magnification for Sample 136SCI10.19

In Figure 5, there is a windmanstatten structure, which is a surface exposed to two temperature differences, so that a layer is formed at a point which causes cooling to slow down causing overheating, then when exposed to lower temperatures it will cause rupture. This is in accordance with the way the drill pipe works with the fluid outside being hot, while the fluid inside the pipe tends to be cooler. The results of this study, the element of oxygen as a trigger for corrosion was found in the specimen.

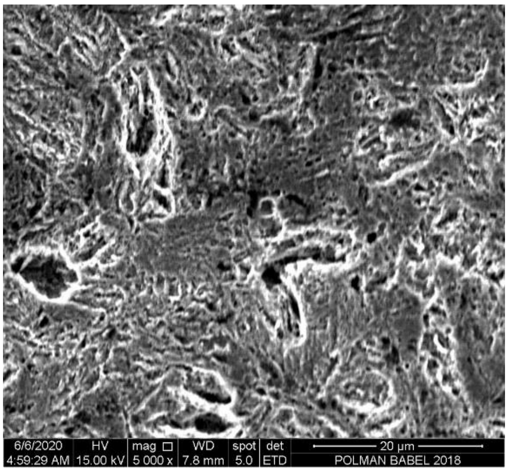

Figure 5. SEM Test Results 500X Magnification for Sample 136SCI10.19

Winmanstatten the structure above shows that the surface morphology of the carbon steel pipe specimen is not smooth, this is the initiation of damage to the surface due to the corrosion process. If this process is continued, the longer the corrosion products will be seen more clearly. When viewed from the results of the relatively small corrosion rate, to produce corrosion products the function of time also affects, the longer the observation time, the greater the corrosion rate value, besides that the corrosion products can be visually observed. This will be followed by changes in surface morphology, these morphological changes can be in the form of holes or cracks. [9]

IV. Conclusions

Based on the results of the research that has been carried out, it can be summarized with the following conclusions, a decrease in thickness of 2.0 mm from the initial thickness was obtained after the use of drilling pipes with a time span from May 2018 to October 2019. From the samples conducted in this study, the highest corrosion rate was 0.12 mm / month. From the results of the inspection with a span of 17 months, the condition of the drilling pipe has decreased its quality to class 2 as many as 11 samples.

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