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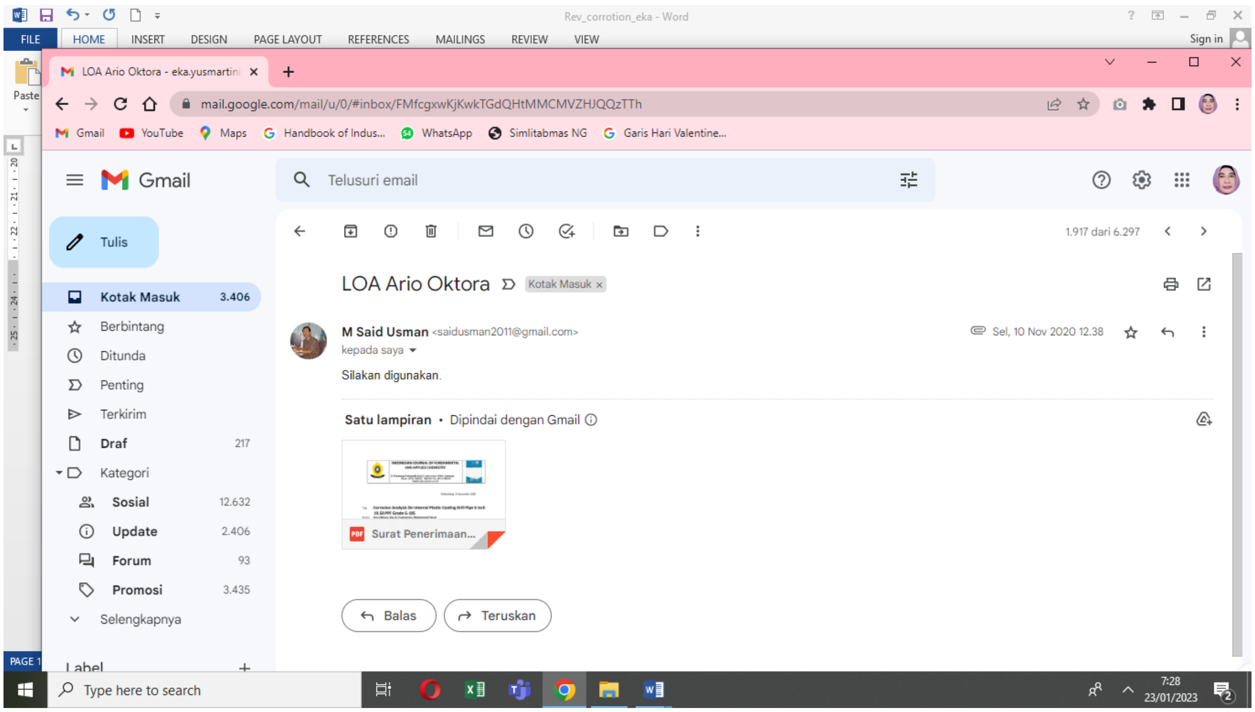

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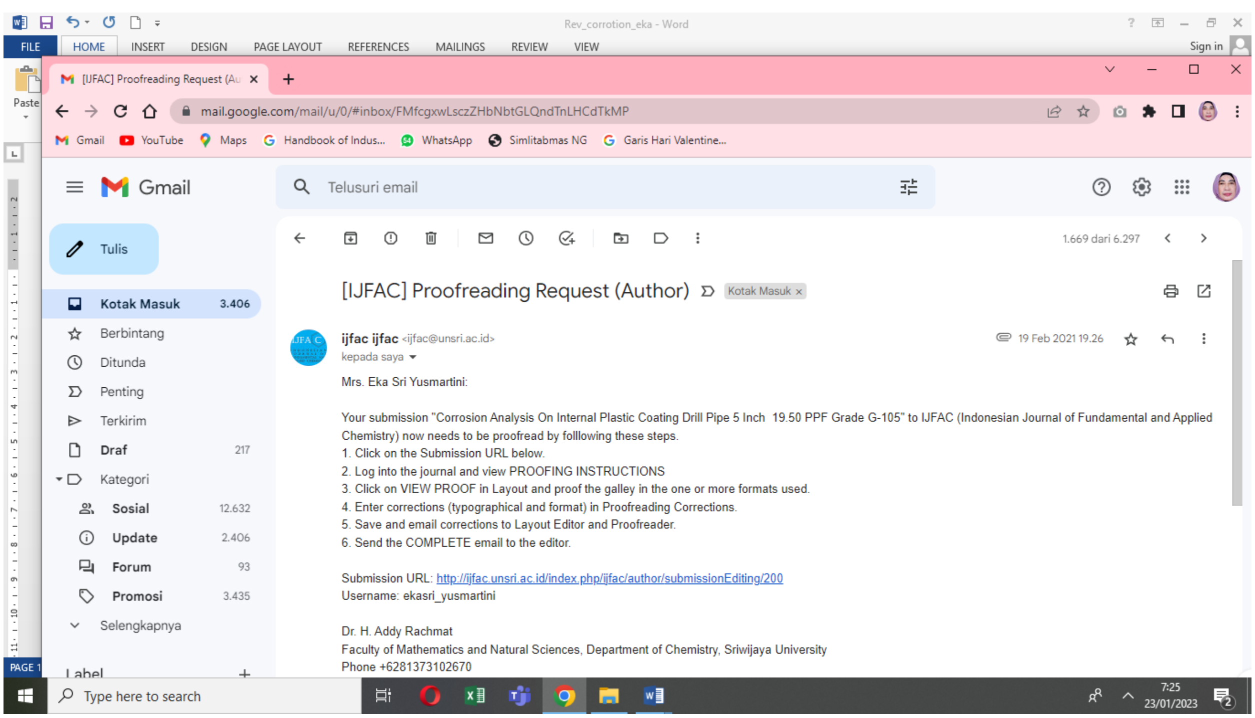

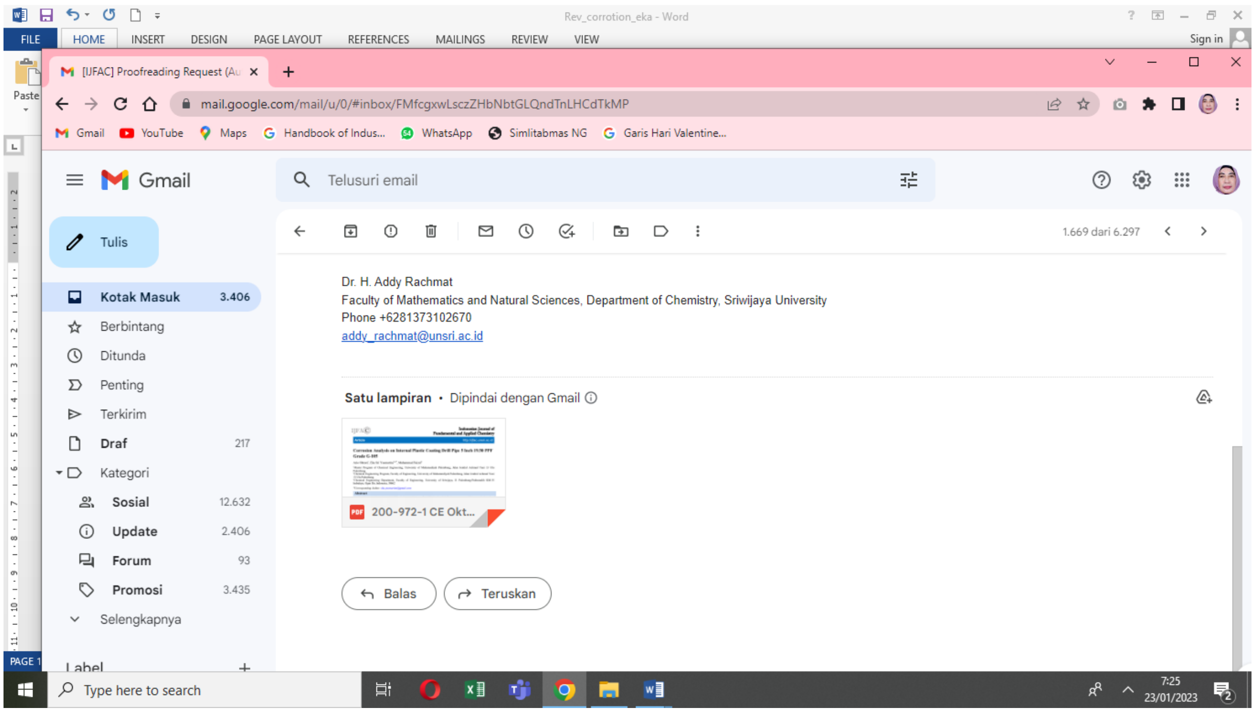
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Palembang, 8 November 2020

Title : **Corrosion Analysis On Internal Plastic Coating Drill Pipe 5 Inch 19.50 PPF Grade G-105**

Author : **Ario Oktora, Eka Sri Yusmartini, Muhammad Faizal**

Dear Ario Oktora,

I am pleased to inform you that your paper "**Corrosion Analysis On Internal Plastic Coating Drill Pipe 5 Inch 19.50 PPF Grade G-105** " has been accepted for publication in Indonesian Journal of Fundamental and Applied Chemistry for **Volume 6 No 1 February 2021**.

Thank you for submitting your work to Indonesian Journal of Fundamental and Applied Chemistry.

Yours sincerely,

Dr. Muhammad Said
Chief Editor

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Corrosion Analysis On Internal Plastic Coating Drill Pipe 5 Inch 19.50 PPF Grade G-105

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Abstract

In the oil, gas and geothermal drilling industry, the use of a drill pipe is vital for its use as an addition to the length of the drilling depth. Another function of the drill pipe is to channel high pressure drilling mud (drilling fluid/fluid) to the drill bit. During the drill pipe operation, several problems were encountered, such as broken, bent, and leaking or wash-out drill pipes. This is very detrimental to the company because the time to replace a new drill pipe will take a long time, and will disrupt the drilling program, which will result in high drilling operational costs. This study analyses the corrosion of the drill pipe, which can cause damage to the drill pipe. The analysis on the drill pipe includes analysis of thickness, corrosion rate, remaining life, internal plastic coating damage, and SEM. The results show that the storage and use of drill pipes greatly affect the conductivity of the drill pipe.

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Keywords : Drill Pipe, Corrosion

Abstrak (Indonesian)

Pada industri pengeboran minyak, gas, dan panas bumi penggunaan pipa bor atau *drill pipe* sangat vital penggunaanya sebagai penambah panjang kedalaman pengeboran. Fungsi lain dari *drill pipe* adalah menyalurkan lumpur bor (cairan/fluida pemboran) bertekanan tinggi ke mata bor. Dalam operasinya *drill pipe* dijumpai beberapa masalah seperti *drill pipe* putus, bengkok, dan bocor atau *wash-out*. Hal tersebut sangat merugikan perusahaan karena waktu untuk penggantian *drill pipe* yang baru akan memakan waktu yang lama, serta akan mengganggu *drilling program* yang akan berdampak pada biaya operasional pemboran yang timbul menjadi tinggi. Penelitian ini menganalisa korosi pada *drill pipe* yang dapat menyebebkan kerusakan pada *drill pipe*. Analisa pada *drill pipe* meliputi analisa ketebalan, laju korosi, sisa umur, kerusakan *internal plastic coating,* dan SEM. Hasilnya menunjukan penyimpanan dan perlakuan pemakaian *drill pipe* sangat mempengaruhi kondosi dari *drill pipe*.

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Kata Kunci : Pipa Bor, Korosi

INTRODUCTION

In the oil, gas and geothermal drilling industry, the use of a drill pipe is vital for its use as an addition to the length of the drilling depth. A drill pipe is a very strong steel pipe designed in such a way as to provide strength in the process of making oil, gas, or geothermal wells to the desired depth (drilling program) (Joko, 2005). Another function of the drill pipe is to raise and lower the drill bit, distribute and continue the rotary table or top drive to the drill bit, and channel high pressure drilling mud (drilling fluid or fluid) to the drill bit,

Drill pipe is a very important equipment in drilling operations, in its application the drill pipe will always experience loads such as torsion, tension, compression, due to the flow of drilling mud (drilling fluid or fluid), pressure from inside the drilling well, and friction loads between drills pipe with borehole walls. During the drill pipe operation, several problems were encountered, such as broken, bent, and leaking or wash-out drill pipes. This is very detrimental to the

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company because the time to replace a new drill pipe will take a long time, and it will disrupt the drilling program, which will result in high drilling operational costs.

Corrosion in the drill pipe can interfere with the performance of the drilling program, because the driller cannot provide maximum drill bit rotation and drilling mud pressure. This is the effect of depletion of the drill pipe due to corrosion or what is often called a downgrade of the drill pipe. Where the drilling mud functions as a coolant for the drill bit, removes cutting from the hole, and minimizes friction between the drill pipe and the borehole wall.

Corrosion of drill pipes is a serious problem that has attracted the attention of previous researchers (Rhodes, 2001; Fischer et al., 1972; Prakoso and Anggoro., 2018). Failures due to fatigue and corrosion that often occur in drill pipe tubes and failures in joint drill pipe tools are very rare. Corrosion plays the most important role in reducing the service life of the drill pipe. In recent years, one alternative to control or reduce corrosion by using an anti-corrosion coating material on the inside of the drill pipe or what is often called the internal plastic coating (IPC).

Internal plastic coating (IPC) is an epoxy resin coated on the inside of the drill pipe with a layer thickness between 5mm and 15mm. Internal plastic coating (IPC) is able to increase or protect the inside of the drill pipe from corrosion and increase hydraulic efficiency, thereby extending the life of the drill pipe. To keep the performance of the Internal plastic coating (IPC) at its prime, it is necessary to carry out regular inspections. Based on the DS-1 Volume 3 standard regarding Drill Stem Inspection, the drill pipe must be checked every time it is used or every 1500 hours to 3000 hours of use or what is often called rotating hours.

To get the maximum drill pipe performance, it is necessary to carry out regular inspections or inspections. Where this inspection method already exists in the DS-1 Volume 3 standard, one of the inspections that is often a problem is to find out the condition of the Internal Plastic Coating (IPC). The officer performing this inspection (Inspector) can only carry out the inspection by the eyes through the reflection from the mirror. For drill pipe with a diameter of 5 inch 19.50 PPF grade G-105 with an inner diameter of 3.25 inches where the length of the drill pipe can reach 45 Ft (13,716 meters) it will be very difficult to see damage to the IPC with the eyes. Therefore, the author will make a tool to monitor the level of corrosion in the IPC and to prevent failure due to fatigue and corrosion that often occurs in drill pipe tubes which can cause wash-out with methods that apply to the DS standard 1 Volume 3.

RESEARCH METHODOLOGY

Each drill pipe that will be used in the drilling program is subjected to an initial inspection to ensure the condition of the drill pipe is still suitable for use. After the drill pipe is used, every multiple of 1500 hours of running hours will be inspected in non-real time conditions or not when used in drilling. This research uses the Automatic Drift with Internal Cam prototype tool (Figure 1), which consists of two main parts, namely the transmitter and receiver. The transmitter functions to move the components in the receiver, including the servo, which functions as a camera driver and direction. Where this tool can see the visual condition of the inside of the drill pipe.

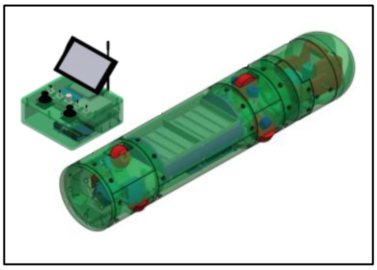

Figure 1. Prototype Automatic Drift with Internal Cam

The research flow diagram of this research can be described in Figure 2.

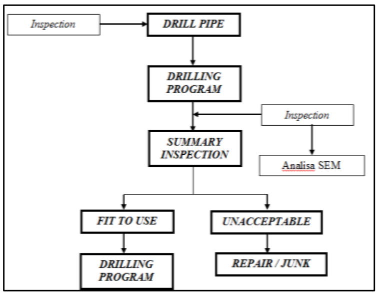

Figure 2. Research Flowchart

RESULT AND DISCUSSION

Observational Data

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After passing the running hours, the drill pipe is inspected. The data obtained are in the form of internal and external conditions as a whole drill pipe. Inspection data on running hours of 1500 and 3000 are shown in Table 1.

Table 1. Initial Data and Drill Pipe Inspection

No	Test Parameters	Preliminary Data	Running Hours 1500	Running Hours 3000
1	Minimum Thickness	-	7.0 mm	6.7 mm
2	Maximum Thickness	9.2 mm	9.2 mm	9.2 mm
3	IPC Condition 1	IPC 1	138 samples	77 samples
4	IPC Condition 2	-	-	35 samples
5	IPC Condition 3	-	-	16 samples
6	IPC Condition 4	-	-	10 samples

Drill Pipe Thickness Analysis

Based on the data shown in Table 4.1, it can be seen the results of the first inspection with running hours of 1500 hours, where the maximum thickness is 9.2 mm and the minimum thickness is 7.0 mm. Meanwhile, the results of the second inspection with 3000 hours of running hours obtained a maximum thickness of 9.2 mm and a minimum thickness of 6.7mm. The condition of the drill pipe at running hours of 1500 hours and 3000 hours showed a decrease in average thickness of 20% to 30% from the initial conditions.

The condition of the drill pipe at running hours of 1500 hours and 3000 hours is classified with the DS-1 volume 3 standard, regarding the classification of the drill pipe. Based on the DS-1 Volume 3 standard, drill pipes that have decreased in thickness to a maximum of 20% from their initial thickness are classified as Premium Class. Meanwhile, drill pipes that have decreased in thickness between 20% and 30% from the initial thickness are classified as Class 2. Meanwhile, drill pipes that have decreased by more than 30% in initial thickness are no longer recommended for use. The classification of the use of drill pipe after running hours of 1500 hours and 3000 hours is shown in Table 2.

Table 2 Thickness Classification of Drill Pipe

No	Classification	Running Hours 1500	Running Hours 3000
1	*Premium Class*	136 samples	117 samples
2	*Class 2*	2 samples	21 samples
3	*Not Feasible*	-	-

Analysis of Corrosion Rate and Remaining Life

Drill pipe depletion is caused by several factors. These factors include, among others, during the storage treatment of drill pipe. The storage of the drill pipe in an open space allows corrosion of the drill pipe. Apart from these factors, which is quite influential is the initial treatment of use. The pre-treatment of using drill pipes should be cleaned before use. Furthermore, it would be better if it were done cleaning after use. If this is not done, it will affect the corrosion rate of the drill pipe.

The corrosion rate is carried out to find out how long the drill pipe can be used for proper use. Calculation of the corrosion rate is carried out by equation (1), where the data used are the data in the first inspection report and the second inspection report with a span of 10 months to reach 1500 hours of use as shown in Table 4.1. The first inspection data was carried out in May 2018 and the second inspection data was carried out in March 2019.

Corrosion Rate:

$$CR = \frac{T_{int} - T_{act}}{Y_{act} - Y_{Int}}$$

$$CR = \frac{9.2mm - 6.7mm}{Mei\ 2018 - Maret\ 2019}$$

$$CR = \frac{2.5mm}{10\ month}$$

$$CR = 0.25\ mm/month$$

Furthermore, based on these data, calculations are carried out to predict the remaining useful life of the drill pipe up to a minimum limit of 6.44 mm (Standard Ds-1) using the actual minimum thickness data in Table 1.

Remaining Life:

$$RL = \frac{T_{act} - T_{req}}{CR}$$

$$RL = \frac{6.70mm - 6.44mm}{0.25\ mm/\ month}$$

$$RL = \frac{0.26\ mm}{0.25\ mm/\ month}$$

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$$RL = 1.04\ month$$

The calculation results of the corrosion rate and the predicted usage are shown in Table 3.

Table 3. Corrosion Rate and Remaining Life Prediction

No	Samples Number	First Inspection Thickness (mm)	Second Inspection Thickness (mm)	Corrosion Rate (mm/month)	Remaining Life (month)
1	Sample 1	9.2	7.1	0.21	3.14
2	Sample 2	9.1	6.7	0.24	1.08
3	Sample 4	9.2	6.7	0.25	1.04
4	Sample 5	9.1	6.8	0.23	1.57
5	Sample 10	9.1	6.8	0.23	1.57
6	Sample 15	9.0	6.7	0.23	1.13
7	Sample 24	9.2	6.8	0.24	1.50
8	Sample 32	9.2	6.8	0.24	1.50
9	Sample 36	9.2	7.1	0.21	3.14
10	Sample 59	9.2	7.1	0.21	3.14
11	Sample 60	9.1	6.8	0.23	1.57
12	Sample 61	7.0	6.8	0.02	18.00
13	Sample 73	7.0	6.9	0.01	46.00
14	Sample 85	9.2	7.0	0.22	2.55
15	Sample 86	9.2	7.1	0.21	3.14
16	Sample 106	9.1	6.9	0.22	2.09
17	Sample 109	9.2	7.0	0.22	2.55
18	Sample 120	9.2	6.8	0.24	1.50
19	Sample 121	9.2	7.0	0.22	2.55
20	Sample 123	9.1	6.8	0.23	1.57
21	Sample 127	9.2	6.8	0.24	1.50

Based on the data shown in Table 4.3, it can be predicted that the use of a drill pipe is close to the minimum allowable limit for the use of a drill pipe, so that it will affect the performance of the drill pipe because it can cause leaks during use.

In addition, the factors causing the corrosion rate can also be caused by the chemical composition of the drill pipe forming material. By using the API 5 DP Specification for Drill Pipe standard, there are two chemical elements that are not allowed to be more than required, namely Phosphor and Sulfur with a percentage of 0.020% and 0.015% respectively. Where one of these elements can increase strength and resistance to corrosion. When compared to the chemical composition data obtained from drill pipes for phosphorus and sulfur content, respectively 0.009% and 0.0027%, it can be seen that the phosphorus content and sulfur value meet the requirements of the API 5 DP Specification for Drill Pipe standard. This is consistent with what was reported by Rodrigues (2015) that the phosphorus content can inhibit the corrosion rate.

The presence of crude oil in the pipeline 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. In addition, during the drilling process, it is inseparable from the mud that will always circulate in the well; this drilling mud can also affect the corrosion rate of the drill pipe. Based on drilling mud data from PT CJT-A2 (JAS-021) well PT Pertamina EP Asset 3, Curug Jati, Jati Asri, Subang, West Java drilling mud report which is presented in Table 2.2, it is stated that 85% of the content of the mud is water with pH 10. According to Sunjono (2014) alkaline properties can cause the corrosion rate of the drill pipe. Therefore, it can be said that the alkaline water factor is also one of the causes of the corrosion rate.

Internal Plastic Coating Analysis

To inhibit corrosion of the internal parts of the drill pipe, the drill pipe has been coated with plastic coating, however, from the analysis and inspection reports, it was found that corrosion was quite significant in some drill pipes. The storage of the drill pipe in an open space and exposed to the sun allows the internal plastic coating to peel off so that it cannot completely protect the inside of the drill pipe and the pressure of the drilling mud when the user can erode the internal plastic coating itself, causing corrosion to the parts in the drill pipe. To find out the actual condition of the plastic coating, the Automatic Drift with Internal Cam prototype was used.

In Figure 4.1, it is shown a comparison result of the internal plastic coating conditions using the DS-1 Volume 3 reference. Figure 1 is the condition of the internal plastic coating without any damage. Figure 2 is the condition of the internal plastic coating, which is damaged by 30% of the total length of the pipe or from the surface area of the drill pipe. Figure 3 is the condition of the internal plastic coating, which is damaged by 30% to 50% of the total length of the pipe or from the surface area of the drill pipe. Meanwhile, Figure 4 is the condition of the internal plastic coating, which is damaged more than 50% of the total length of the pipe or from the surface area of the drill pipe.

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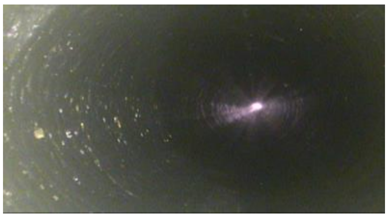
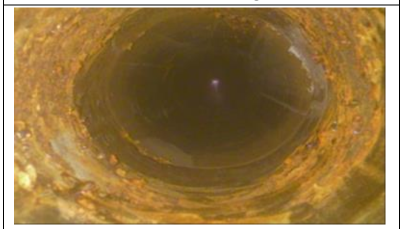


Internal Plastic Coating Kondisi 1

Internal Plastic Coating Kondisi 2

Internal Plastic Coating Kondisi 3



Internal Plastic Coating Kondisi 4

Figure 3. Internal Plastic Coating Conditions

Scanning Electron Microscopy Testing (SEM)

SEM testing was carried out at the Bangka Belitung State Manufacturing Polytechnic Laboratory using the INSPECT S50 tool on samples with running hours of 1500 and 3000.To see the corrosion that occurred in the specimens.

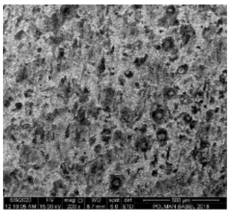


Figure 4 Results Test SEM of 1500 Running Hours 200X Magnification

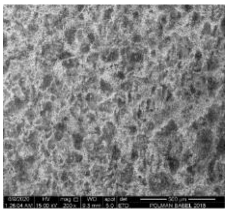


Figure 5 Results Test SEM of 3000 Running Hours 200X Magnification

In the picture above, it is a display of the SEM drilling pipe test results after use for 1500 hours and 3000 hours of running hours. It can be seen in the image that there is a darker colored image, this is known as pitting corrosion, and this is the same as the results obtained by Bayuseno (2012). Fitting corrosion is more pronounced at 3000 hours running hours. In addition, due to the use of drill pipes with high drilling mud pressure, it causes corrosion erosion, the occurrence of erosion corrosion is influenced by flow velocity (Bayuseno, 2012)

CONCLUSION AND RECOMMENDATION

Conclusion

Based on the results of the research that has been done, it can be summarized with the following conclusions:

1. A reduction in thickness of 2.2 and 2.5mm from the initial thickness is obtained after the use of drill pipe with a span of 1500 hours to 3000 hours
2. From the samples conducted research, the highest corrosion rate is 0.25 mm/month
3. From the results of the inspection with a span of 10 months, the internal condition of the plastic coating has decreased in quality. With the worst condition (IPC4) as many as 10 samples
4. The resulting Automatic Drift With Internal Cam prototype tool works well and can make it easier to monitor the internal plastic coating conditions

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Recommendation

In order to maximize the life of drill pipe, it is advisable to:

1. More attention is paid to drill pipe storage, so that it is not directly exposed to environmental conditions that cause corrosion
2. Check and clean the drill pipe with clean water before and after use
3. Install a protector on the pin and drill pipe box so that no foreign objects enter the drill pipe
4. To know the characteristics of the chemical composition and the concentration of the elements contained in the drill pipe, it is advisable to analyze using XRD or XRF.

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