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Analysis of Troubleshooting Effect on the Performance of Gas Engine G-102 B (TBG620 V16K) in Central Processing Area of PT. XYZ

[1]*Syaiful, [2]Muhammad Ashwin Asyhari, [3]Muchammad

[1,2,3]Mechanical Engineering Department, Faculty of Engineering, Diponegoro University, Jl. Prof. H. Soedarto, SH, Tembalang-Semarang 50275, Indonesia

***Abstract* - PT. XYZ is a part of the largest oil and Gas Company in Indonesia, responsible for managing and developing oil and gas production activities in the East Java. The Central Processing Area serves as the facility for processing fluids produced from the East Java fields. The processed output consists of three phases: Gas, Oil, and Water. The operation of the Gas Engine G102-B TBG620 V16K running 24 hours a day to generate electricity at the central processing area of PT. XYZ requires regular maintenance, including scheduled preventive maintenance and unplanned or corrective maintenance. In the event of troubleshooting, such as a decrease in temperature in chamber 2B or a temperature sensor reading of 280 °C in that chamber, immediate corrective maintenance is necessary. Based on observations conducted in the power plant area, two possibilities causing the temperature decrease in that chamber were identified. The first possibility was the need for spark plug replacement, and the second was a malfunctioning temperature sensor resulting in incorrect readings. Therefore, the spark plug replacement was performed first, requiring a gas engine shutdown for approximately 2 hours for repairs. After the spark plug replacement, it was discovered that there was no change in the temperature reading in chamber 2B, which remained at 280 °C. Hence, the corrective maintenance performed did not have a significant impact because the issue was caused by a faulty temperature sensor. However, it was observed that there was a 1.16% increase in the generated power compared to before the corrective maintenance was conducted. The difference in power output could be attributed to variations in the quality of gas used in the combustion process of the gas engine.**

Keywords: Gas engine, sparkplug, corrective maintenance, troubleshoot.

I. INTRODUCTION

Oil and gas industry is one of the important industries in Indonesia. The country has abundant oil and natural gas resources and is one of the largest oil producers in Southeast Asia[1].

PT. XYZ has a Central Processing Area (CPA) facility located in East Java Province. By definition, the CPA is the central area in the processing process, serving as the facility for processing fluids produced from the East Java fields. The processed output consists of three phases: Gas, Oil, and Water. The gas engine is part of the Power Plant that supports the stability of the electricity supply in the CPA area. A gas engine is a gas-powered machine used as a source of electricity in power generation.

The Gas Engine G102-B is one of the engines that generate electrical energy at the Central Processing Area of PT. XYZ. This gas engine is a product of Power Systems with the product code TBG620 V16K. It utilizes gas fuel as the primary energy source to drive the generator and generate electric current. The gas engine is fueled by sweet gas produced through the sulfur separation process in the Sulfur Recovery Unit (SRU). The sulfur recovery unit's task is to process acid gas rich in H2S into liquid elemental sulfur and prevent the release of acid gas into the atmosphere[2].

Internal Combustion Engine (ICE) is the main consumer of fossil fuels as the primary energy source widely used in vehicles, industrial machinery, agricultural machinery, and stationary power generation units[3]. In recent decades, various types of alternative and renewable fuels in liquid form (ethanol, RME, HVO, etc.) or gas form (LPG, CNG, LNG, biogas/biomethane, etc.) have been researched as alternatives for internal combustion engine (ICE) fuels to replace standard fossil fuels such as gasoline and diesel [4].

II. RESEARCH OBJECT

In the oil and gas industry, a gas engine refers to a type of internal combustion engine specifically designed to operate with gas fuel or other gas fuels. A gas engine is an engine that utilizes natural gas as its fuel source. Stationary gas engines are commonly used in industrial applications and have output variations ranging from 500 to 8000 kW.

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Modern gas engines are typically available in stoichiometric and lean-burn combustion configurations [5].

Figure 2.1: Gas Engine G102-B TBG620 V16K PT.XYZ

The Gas Engine G102-B TBG620 V16K has been running for 99,147.57 hours or approximately 11 years. With proper and regular preventive maintenance, the performance of this gas engine can be maintained to ensure it continues to generate maximum power output in order to sustain the production process in the Central Processing Area (CPA).

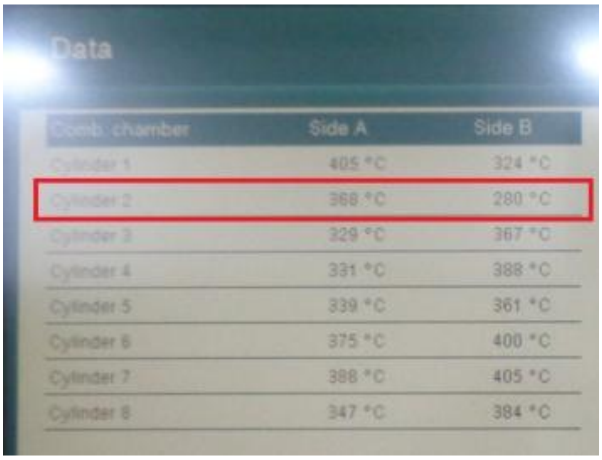

Figure 2.2: Temperature reading on the Gas Engine Chamber by the PLC

After performing preventive maintenance of 1000 hours, which involved oil replacement, oil filter replacement, and cleaning, a problem was discovered regarding a decrease in chamber temperature. Normally, the temperature is above 300°C, but it dropped to 280°C in Chamber 2B. If this problem is not promptly addressed and the temperature continues to decrease to 250°C, it can cause the engine to experience knocking and eventually lead to engine breakdown, resulting in a complete stoppage of operation.

2.1 Type and Specifications of Gas engine TBG620 V16K

Gas Engine TBG620 V16K utilizes a Turbocharger and Mixture charge cooling for cooling purposes, increasing combustion efficiency, and reducing pollutant emissions. With a V-engine configuration, this engine has 16 cylinders capable of producing a power output of 1400 kW[6], and it runs on sweet gas produced from the Central Processing Area. Based on the studied Gas engine TBG620 V16K's manual book, the following are the specification data and factory check obtained for the G102-B gas engine.

Table 2.1: Data Specifications and Factory Check

General		
Work procedure	Otto four-stroke engine with four-valve technology	
Mixture charging	Turbo charging with mixture cooling	
	Liquid-cooled mixture cooler	
Cylinder arrangement	V-engine with 90° cylinder angle	
No. of cylinders	16	
Actuator	V16 engine	Heinzmann St G 30 - 01
Combustion gas type	V16 engine	Gases of gas group 1
Speeds	at 60 Hz	1800 rpm
Power	Gas group 1 - 60Hz V16 engine	1400 kW
Mean effective pressure	15.8 bar	
Exhaust temperature	523 °C	
Exhaust mass flow wet	7332 kg/h	
Combustion air mass flow	7084 kg/h	
Ventilation air flow	28313 m^3/h	
Total displacement	V16 engine	70.8 dm^3

2.2 TEM Message Indicator

Following up on the issue, based on the troubleshooting section in the manual book and the table below, there are two possibilities: either the spark plug is nearing the end of its lifetime[6] causing a decrease in temperature in Chamber 2B, or the temperature sensor in that chamber is damaged, resulting in inaccurate temperature readings.

Table 2.2: TEM message indicator

TEM message	Possible cause	Remedy
	Ignition control unit defective	Check ignition control unit, renew if necessary

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Engine misfiring	Ignition coils defective	Check ignition coils, renew if necessary
	Electrode spacing at spark plug too great	Check spark plug, adjust / renew if necessary
	Spark plugs defective	Check spark plugs, renew if necessary
	Pickup (camshaft or control shaft) gap too great / near limit	Check gap and set if necessary

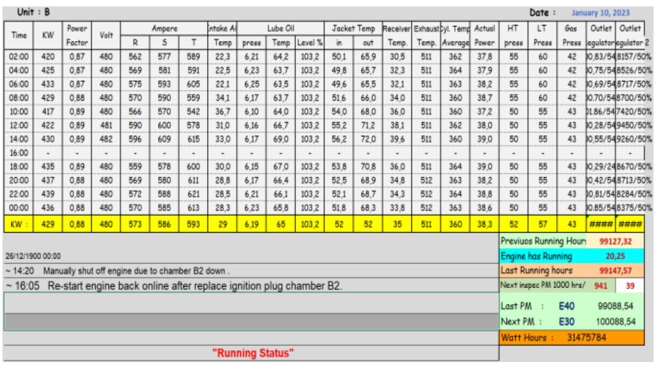
III. RESULTS AND DISCUSSION

3.1 Corrective Maintenance

Figure 3.1: Spark Plug MWM for gas engine

After conducting observation and troubleshooting analysis, it was decided to perform corrective maintenance by replacing the spark plug as shown in Figure 3.1 in the Chamber 2B section. After the replacement, which took approximately 60 minutes, the engine resumed normal operation. However, the indicator on the PLC monitor panel still showed a temperature of 280°C, as shown in Figure 3.2 above.

3.2 Data Daily Log Sheet



Unit : B   Date : January 10, 2023

Time	KW	Power Factor	Volt	Ampere R	Ampere S	Ampere T	Intake Air Temp	Lube Oil press	Lube Oil Temp	Lube Oil Level %	Jacket Temp in	Jacket Temp out	Receiver Temp.	Exhaust Temp.	Cyl. Temp Average	Actual Power	HT press	LT Press	Gas Press	Outlet Regulator	Outlet Regulator 2
02:00	420	0,87	480	562	577	589	22,3	6,21	64,2	103,2	50,1	65,9	30,5	511	362	37,8	55	60	42	)0,83/54	8157/50%
04:00	425	0,87	480	569	581	591	22,5	6,23	63,7	103,2	49,8	65,7	32,3	511	364	37,9	55	60	42	)0,75/54	8526/50%
06:00	433	0,87	480	575	593	605	22,1	6,25	63,5	103,2	49,6	65,5	32,1	511	363	38,2	55	60	42	)0,69/54	8717/50%
08:00	429	0,88	480	570	590	559	34,1	6,17	63,7	103,2	51,6	66,0	34,0	511	360	38,7	55	60	42	)0.70/54	8700/50%
10:00	417	0,89	480	566	570	542	36,7	6,10	64,0	103,2	54,0	68,0	36,0	511	360	37,2	50	55	43	)1.86/54	7420/50%
12:00	422	0,89	481	590	600	578	31,0	6,16	66,7	103,2	55,2	71,2	38,1	511	362	38,0	50	55	43	)0,28/54	9450/50%
14:00	430	0,89	482	596	609	615	33,0	6,17	69,0	103,2	56,2	72,0	39,6	511	360	39,0	50	55	43	)0,55/54	9260/50%
16:00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18:00	435	0,89	480	559	578	600	30,0	6,15	67,0	103,2	53,8	70,8	36,0	511	364	39,0	50	55	43	)0,29/24	8670/50%
20:00	437	0,88	480	569	580	611	28,8	6,17	66,4	103,2	52,5	68,9	34,8	512	363	38,2	50	55	43	)0,42/54	8713/50%
22:00	439	0,88	480	572	588	621	28,5	6,21	66,1	103,2	52,1	68,7	34,3	512	364	38,8	50	55	43	)0,81/54	8284/50%
00:00	436	0,88	480	570	585	613	28,3	6,23	65,8	103,2	51,8	68,3	33,8	512	363	38,6	50	55	43	)0.85/54	8375/50%
KW :	429	0,88	480	573	586	593	29	6,19	65	103,2	52	52	35	511	360	38,3	52	57	43	####	####

26/12/1900 00:00

~ 14:20 Manually shut off engine due to chamber B2 down .

~ 16:05 Re-start engine back online after replace ignition plug chamber B2.

Previuos Running Hours	99127,32
Engine has Running	20,25
Last Running hours	99147,57
Next inspec PM 1000 hrs/	941 / 39
Last PM : E40	99088,54
Next PM : E30	100088,54
Watt Hours :	31475784

"Running Status"

Figure 3.2: Data Daily Log Sheet for Gas Engine unit B on January 10, 2023

The following is the Daily Log Sheet data for the Gas engine TBG620 V16K Unit B on January 10, 2023. On that date, there was trouble in Chamber 2B, where the temperature decreased, resulting in a decline in performance. Corrective maintenance was conducted at 14:00. After completing the corrective maintenance, an improvement in performance was achieved, particularly in terms of the generated power output.

3.3 Calculating the average output power generated in a day

This calculation is performed to determine the daily performance in producing output power from the gas engine.

$$kW_{avg} = \frac{1}{n}(x_1 + x_2 + x_3 + \cdots + x_n)$$

$$kW_{avg} = \frac{1}{11}(420 + 425 + 433 + 429 + 417 + 422 + 430 + 435 + 437 + 439 + 436)$$

$$kW_{avg} = 429\ kW$$

3.4 Calculating the increase in output power after corrective maintenance

This calculation is conducted to determine the increase in output power resulting from the corrective maintenance activity, specifically the spark plug replacement in Chamber 2B.

$$power\ increase = \frac{(kW_a - kW_b)}{kW_b} \times 100\%$$

$$power\ increase = \frac{(435 - 430)kW}{430\ \ kW} \times 100\%$$

$$power\ increase = 1{,}16\ \%$$

3.5 Calculating the performance of power generated based on the manual book

This calculation is performed to determine the percentage comparison between the output power generated based on the manual book and the actual output power generated at the CPA location.

$$power\ difference = \frac{(kW_{avg} - kW_{mb})}{kW_{mb}} \times 100\%$$

$$power\ difference = \frac{(429 - 1400)kW}{1400\ \ kW} \times 100\%$$

$$power\ difference = -69.36\ \%$$

The results obtained from the above calculations indicate that the average output power generated by Gas Engine G-102 B in a day is 429 kW. After troubleshooting in Chamber 2B

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and performing corrective maintenance, there was an increase in power generated by the gas engine by 1.16% compared to before the spark plug replacement. According to the manual book of the Gas Engine TBG620 V16K, a performance decrease of 69.36% was observed, as it should ideally be able to produce a power of 1400 kW but only achieved 429 kW.

IV. CONCLUSION

Based on the discussion and analysis of the performance of the Gas engine TBG620 V16K before and after the corrective maintenance at PT. XYZ, the following conclusions can be drawn:

1) The maintenance carried out on the Gas Engine TBG620 V16K followed the manual book and was conducted smoothly. The maintenance included preventive maintenance and corrective maintenance.
2) The corrective maintenance, which involved the replacement of the spark plug based on the troubleshooting in Chamber 2B of the Gas Engine TBG620 V16K, did not have a significant impact due to the underlying cause being a temperature sensor malfunction.
3) Based on the calculations, it was found that there was a 1.16% increase in the output power generated after the corrective maintenance, specifically the replacement of the spark plug in Chamber 2B. Additionally, there was a difference of 69.36% between the actual power output and the power output indicated in the manual book. This difference in power can be attributed to the variation in the quality of sweet gas used for combustion in the gas engine.

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