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Submission date: 07-Apr-2023 10:39AM (UTC+0700)
Submission ID: 2058119967
File name: mage_to_the_generator_set_using_the_fishbone_analysis_method.pdf (754.69K)
Word count: 2218
Character count: 11400

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Cite as: AIP Conference Proceedings **2578**, 070004 (2022); https://doi.org/10.1063/5.0116742
Published Online: 03 November 2022

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Analysis of Engine Piston Damage to the Generator Set Using the Fishbone Analysis Method

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Abstract. The generator set unit operating at PLTD Leung Bata-Aceh suffered damage to the piston component, which initially indicated thick white smoke coming out of the breather. The purpose of this study was to determine the root cause of piston damage. The method in this study using fishbone analysis. Based on the research results, the damage to the piston top was caused by the imperfect angle of the injector, so that the injector spray widened on the outer side of the piston crown top, causing the piston surface to be damaged on the edge. Corrective steps so that the same incident does not occur again, the injectors must be tested before use, they must be tested, to determine the performance of the injectors used.

INTRODUCTION

Diesel engine generator set operating at PLTD Leung Bata-Aceh for the back operation of the Diesel Power Plant within the PLN (State Power Plant) environment. Generator set capacity of 1825 kVA, with an operating power of 1000 kW or 1 MW per unit. This diesel engine generator set uses diesel fuel supplied by PLN for the operational needs of the plant. Each generator that operates is adjusted to the power needs of PLN. While operating the generator, it is necessary to carry out routine maintenance starting from changing the oil, oil filter, fuel filter, and cleaning the air filter.

Monitoring of operating units is carried out by an operator on duty manually, starting from recording exhaust gas temperature, engine oil pressure, coolant temperature, recording kWH, to recording fuel consumption. If there is a change in generator set parameters, the operator on duty always provides information to the leader operator to take action to stop the unit. However, when monitoring one of the operating units there is an indication of an abnormality in the use of engine oil. To avoid fatality damage to the generator set unit, the operator is in charge of extra monitoring.

When the generator set unit operating at the PLTD was damaged, it started from thick white smoke from the engine breathing pipe (breather), where the white smoke coming out of the breather was quite thick and white. Under these conditions, the operator on duty immediately stops the operation of the working unit. After checking the

The 3rd International Conference on Engineering and Applied Sciences (The 3rd InCEAS) 2021
AIP Conf. Proc. 2578, 070004-1–070004-6; https://doi.org/10.1063/5.0116742
Published by AIP Publishing. 978-0-7354-4233-7/$30.00

maintenance data on the unit that had added oil, as well as finding that the breather smoke was quite thick and under the attached list, where the addition of oil from September 13, 2013, to September 19, 2013, the addition of oil tended to increase, according to table 1.

TABLE 1. History unit

Scope of Work	SMU (Service Meter Unit)	Description
PM500	2,542	Preventive Maintenance
Add oil	2,784	Add oil 40 liter
Add oil	2,830	Add oil 30 liter
Add oil	2,881	Add oil 30 liter
Add oil	2,904	Add oli 60 Liter
Operation Abnormal	2,922	Engine blowby

From the data on the addition of oil, it is known that the engine indicates damage to the combustion process, wherein the combustion process piston moves from TMB to TDC and vice versa, to compress air for the combustion process.

The piston which is an important part of the engine functions to form the combustion chamber with the cylinder liner and cylinder head, withstand the explosion pressure when the gas burns, and works outward through the connecting rod and crankshaft [1] . To carry out its function, the piston ring functions as an insulator so that compression does not go down to the oil pan and oil does not enter and burn in the combustion chamber.

In the process of repairing the cylinder head and injectors # 5 and # 12 due to damage to the walls of the combustion chamber where the maximum temperature appears on the edge of the combustion chamber [2] and become one of the parts that are often damaged [3,4] . Damage to piston components in diesel engines caused by failure of adjustment bolts [5] .

In Figure 1, the liner wall flows scratches caused by friction with the piston that is damaged. Scratches that occur cause the liner not to be used again and the damage to the liner is the result, not the cause. Figure 1 scratch on the inner liner was found during a fault investigation component.

FIGURE 1. Fuel leakage from the liner and piston.

Whereas Figure 2 shows the piston debris attached to the liner wall, discovered during a fault investigation of the generator set. The piston material attached to the liner wall is caused by the piston working at high temperatures. The piston moves in the process of experiencing stress, temperature, pressure which often occurs due to thermal and mechanical fatigue [6]. Figure 2 piston material debris was found during the investigation.

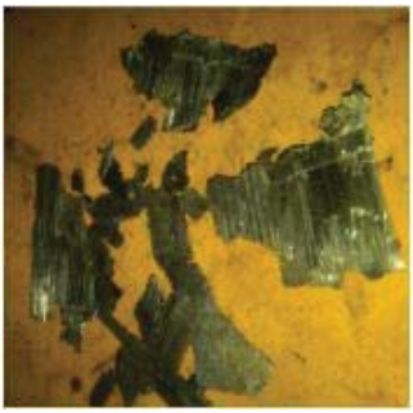

FIGURE 2. Flakes of piston material.

To find the cause of the damage to the cylinder liner and then take precautions, this study aims to identify the cause of the cylinder wall damage by using the "fishbone" diagram introduced by Ishikawa [7]. The purpose of this study was to determine the root cause of the top crown piston damage.

METHOD

This study using the fishbone analysis method to determine the root cause of piston damage. As for the research process, this piston damage begins with primary data and secondary data to collect the data needed in the study. Then identify the damage that occurred, as well as pre-analysis of the components. Then, the analysis is finalized to determine the solution in the research being carried out.

Collecting data on the history of maintenance that has been carried out, then problem identification on the initial findings of blowbys up to the findings of component damage. Pre-analysis of the possibilities that occur to determine the cause. While the analysis using fishbones categorizes the potential problems that occur. The conclusions in this study are in accordance with the predetermined objectives.

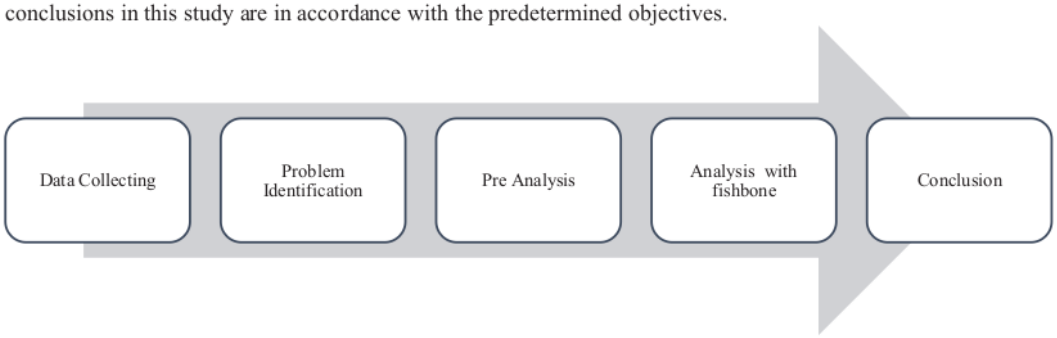

FIGURE 3. Research flow

RESULT AND DISCUSSION

The shape of the piston crown top is irregular because the angle of spraying the injector is not normal [8], this is known to be the shape of the corrugated piston crown top. When the piston material melts it closes the ring groove causing the piston ring to stack and contact with the liner [9].

Damage to piston skirt #12 experienced the same as piston # 5. Self-explanatory on the top crown the piston spray injector is abnormal. If this is left for a long time then the condition of the #12 piston will have a shape similar to that of cylinder #5 [5].

FIGURE 4. Top melting piston crown on cylinder # 12.

In Figure 5, it is explained that the high scratches piston wall where the piston works at high temperature so that the piston wall is melting and the town crown piston is indicated as a black discoloration on the side that gets the spray from the injector (right photo), ash on the town crown piston is caused by the abnormal angle at the injector [10] . Changes in the thermal expansion coefficient for the alloy in the raw state and after heat treatment and the piston made of the new composite material before the motor test and after this test [11]. As for the piston components that are used using aluminum, it is adjusted to the diesel engine serial number from the manufacturer.

FIGURE 5. Spray injector on piston-cylinder #5

Heavy scratches on the liner walls due to the tow crown piston melting and closing the piston ring seat so that it contacts with the liner (scuffing). Measurement of the secondary motion of each piston was carried out to analyze piston friction, and the following findings were obtained. Cast iron pistons exhibit limited lubrication at die center over-compression (TDC). This is probably due to the larger piston tilt angle due to the greater piston clearance. Steel pistons exhibit hydrodynamic lubrication conditions at TDC and BDC through each cycle, due to good oil supply [12] .

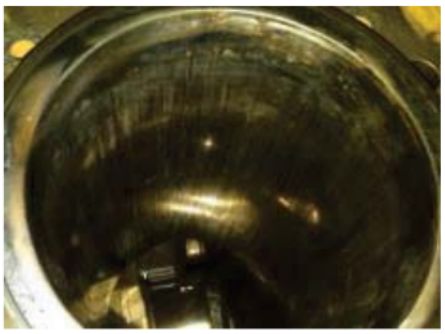

FIGURE 6. Wall liners high scratches

3.1 Fishbone analysis

The analysis was carried out using fishbone analysis where in this study there were 4 categories in determining the root cause of piston damage (Top piston crown).

A. Man.
   At the time of installing the injector, the technician failed to install it, and the tip of the injector collided with the engine component. Then it was wrongly installed, where this condition was caused by the knowledge of the technician who did not understand the injector installation process.
B. Material
   Angle spray injector is damaged due to the design of the manufacturer because it does not match the engine type or product failure.
C. Machine
   Piston damage caused by high operating load or overload is not identified for piston damage, then the damage caused by fuel containing biodiesel is not indicated. Meanwhile, the error in using the injector is not indicated [7]. The delay in the execution of the engine overhaul will affect the performance of engine components. In determining the unit's overhaul work there is no maintenance strategy, so the overhaul work is based on the unit's condition.

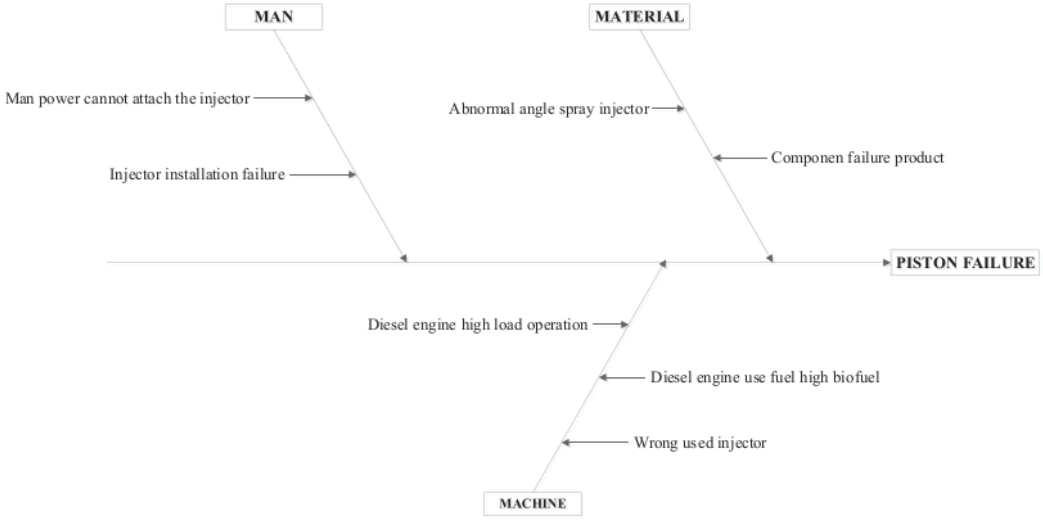

FIGURE 7. Fishbone analysis

CONCLUSION

Trending in addition to 150 liters of engine oil starting high school: 2,784-2,922, during the unit operating 138 hours, at the hour meter 2,922 a blowby occurred in the operating unit, where the damage was caused by damage to the piston components. Based on the fishbone analysis, the damage was caused by an abnormality in the angle of the injector.

ACKNOWLEDGMENT

We would like to convey our gratitude to LPPM STTMC for supporting the publication of articles

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