



Optimization Strategy to Reduce Unplanned Low Power Engine Breakdowns on PC-2000 Units at PT Antareja Mahada Makmur

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ABSTRACT

Low-power machine breakdowns that occur unplanned (unscheduled) on the PC-2000 unit are one of the main obstacles in maintaining operational efficiency in the workshop area of PT Antareja Mahada Makmur Jobsite Mifa Bersaudara. This study aims to identify the main causes and design optimization strategies to reduce the frequency of these events. The research methodology included analysis of historical damage data, technical inspection of the affected machine components, and evaluation of the quality of the fuel used. Based on the analysis, it was found that the use of B35 fuel (35% biodiesel) is one of the significant factors affecting engine performance, especially in the combustion system and fuel injection components. The implementation of preventive maintenance-based strategies, including increased frequency of fuel injection system inspections, replacement of vulnerable components, and use of fuel additives to improve combustion efficiency, reduced the frequency of breakdowns by 40% within three months of implementation. The results of this study emphasize the importance of mitigating the impact of B35 fuel use on engine performance through a planned maintenance approach. Recommendations include developing technical guidelines specific to biodiesel fuel use and training technicians to support more reliable operational sustainability.

Keywords: B35 fuel, Preventive maintenance, Low Power.

INTRODUCTION

In recent years, the Indonesian government has encouraged the use of biodiesel fuel through a mandatory biodiesel program, including the implementation of B35 fuel (Li et al., 2023; Ruscanto & Firdausi, 2020; Umroni et al., 2024; Wirawan et al., 2024). The use of biodiesel fuel, particularly B35 (35% palm oil-based biodiesel and 65% fossil fuel), has been launched by the Indonesian government as a strategic step to reduce dependence on fossil fuels and support national energy security. Despite the positive environmental benefits, implementing B35 in the industrial sector faces significant technical challenges, especially in the use of heavy equipment in extreme conditions (Abdullah et al., 2023; Haslinah et al., 2024; Rahman et al., 2020).

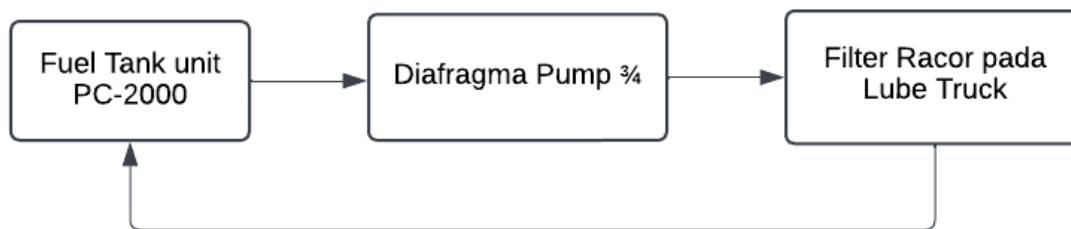
One of the most affected equipment is the PC-2000 unit at PT Antareja Mahada Makmur Jobsite Mifa Bersaudara. Operational data showed an increase in the frequency of low-power machine breakdowns of up to 40% following the implementation of B35, resulting in reduced productivity and increased maintenance costs (Huang, 2014; Prauzek et al., 2023). These breakdowns were mainly caused by damage to the fuel injection system, where the properties of B35—such as high viscosity, greater water content, and the formation of carbon deposits—contributed to component damage.

Previous research has identified several issues related to biodiesel use, but often does not address the specific impact of B35 on heavy engine performance, especially in the context of planned maintenance. Therefore, there is a research gap that needs to be filled, namely the development of maintenance strategies that can effectively address the negative impacts of B35.

This research aims to identify the main causes of low-strength engine failures on PC-2000 units and design optimization strategies that can reduce the frequency of such events. By focusing on preventive maintenance-based solutions that include increasing inspection frequency and using fuel additives, this research seeks to make a new contribution to the maintenance management of machines using biodiesel. As such, the results of this study are expected to improve the operational reliability of PC-2000 units and maintenance efficiency in the future.

RESEARCH METHODS






This study uses a technical implementation-based approach and performance analysis to reduce the frequency of low power engine breakdowns on PC-2000 units due to the use of B35 fuel. The main method used was the installation of additional Racor Fuel filters on lube truck units and schedule flushing fuel tanks on PC-2000 units as a solution to improve fuel filtration quality.



Flowchart of fuel tank flushing

This activity starts from the stage of collecting data on the low power breakdown of the PC-2000 unit model for the period April - May in the unit maintenance process at PT Antareja Mahada Makmur jobsite MIFA Bersaudara; determining the tools that will be paired with fuel flushing tools and the duration of testing in data collection, while the steps of this research include:

Table 1. Stages of the method used in suppressing low power breakdown

No.	Activities	Implementation	Documentation
1	Problem Identification and Initial Analysis	<p>Collected historical data of low power engine breakdowns on PC-2000 units for the last six months.</p> <p>Analyzed the damage patterns caused by the use of B35 fuel, including its impact on the fuel injection system.</p>	
2	Screening Technology Selection and Installation	<p>Selecting the Racor Fuel Filter in addition to the main fuel filter based on technical recommendations.</p> <p>Installed an additional filter on the PC-2000 unit's fuel line to ensure maximum filtration of contaminants, such as water, particles and carbon deposits found in B35 fuel.</p>	
3	Unit Operational Testing	<p>Conducted operational test of PC-2000 unit with B35 fuel after installation of additional filter.</p> <p>Observe engine performance under various working conditions during the test period, including engine power stability, fuel consumption, and fuel filtration success.</p>	
4	Data Collection and Analysis	<p>Measure changes in machine performance, such as a decrease in breakdown frequency and downtime duration.</p> <p>Comparing the test result data with historical data before filter installation to evaluate the effectiveness of the implemented solution.</p>	
5	Evaluation and Refinement	<p>Analyze the reliability of auxiliary filters under different working conditions, and determine filter replacement or maintenance intervals to ensure optimal performance.</p> <p>Provide understanding to operators regarding the function and usefulness of the additional filtration.</p>	

With this method, the research is expected to provide practical solutions that not only reduce the frequency of breakdowns, but also increase the operational efficiency of the PC-2000 unit in supporting activities at PT Antareja Mahada Makmur Jobsite Mifa Bersaudara.

RESULTS AND DISCUSSION

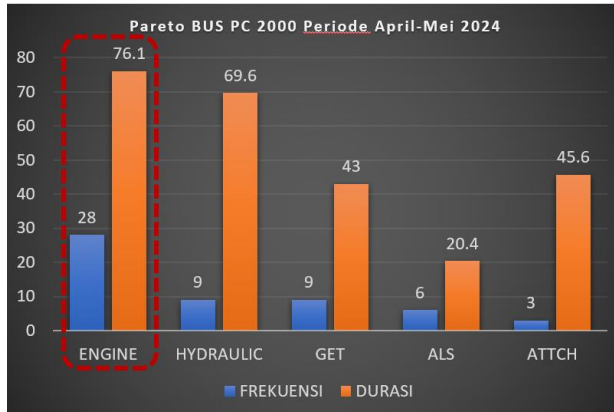


Figure 1. Pareto Breakdown Unschedule

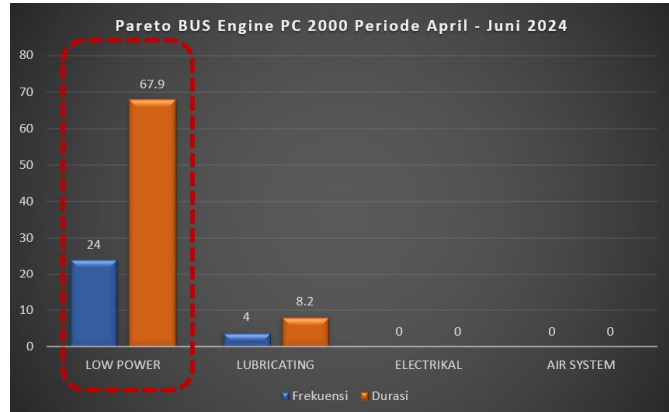


Figure 2. Symptom BUS engine

In April - June 2024, the frequency of breakdown events against the PC-2000 unit model was 28 times with a breakdown duration of 76.1 hours, with a symptom of 24 times among them breakdown low power or caused by not optimal combustion.

So it was carried out an improvement with several technical stages, such as:

1. Add filtration to the lube truck unit to run a regular fuel tank flushing program.
2. Conduct fuel tank flushing treatment in loader units periodically at intervals of Hours meter ± 4000 .
3. Shortening the replacement interval of the racor fuel filter in units with a duration of 125 hours (Half service).

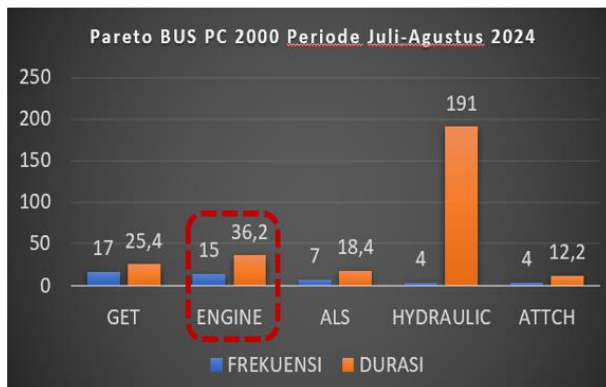


Figure 3. Pareto Breakdown Unschedule after the program

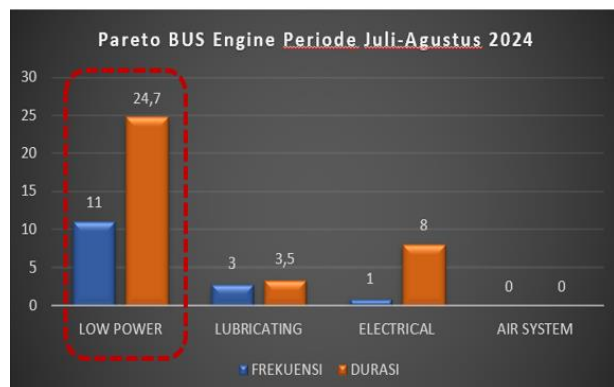


Figure 4. Symptom BUS engine after the program

It can be seen from the graph above that after carrying out the program according to the method used, the low power breakdown graph shows a decrease of 54.61% which is quite drastic from the breakdown event which was originally 24 times in the April - May period to 11 times in the July - August period, this shows the effectiveness of the application of the method used.

This also has an impact on the costs incurred with the method that has been carried out:

SEBELUM IMPROVEMENT PLANT			
DOWN TIME LOW POWER PC 2000	67,9 Jam	2.819.082	Rp. 191.415.667
COST PENGGANTIAN PRE FUEL FILTER	24 kali event x 2 pcs	1.887.950	Rp. 90.621.600
COST PENGGANTIAN RACOR FUEL	24 kali event x 2 pcs	354.356	Rp. 22.678.784
TOTAL			Rp. 304.716.051
SESUDAH IMPROVEMENT PLANT			
BIAYA IMPROVEMENT			
TOOL FLUSHING	Rp 26.370.159		Rp. 26.370.159
DOWN TIME LOW POWER PC 2000	22,7 jam	2.819.082	Rp. 63.993.161
COST PENGGANTIAN PRE FUEL FILTER	11 kali event x 2 pcs	1.887.950	Rp. 41.534.900
COST PENGGANTIAN RACOR FUEL	11 kali event x 2 pcs	354.356	Rp. 7.795.832
TOTAL			Rp. 139.694.052
SAVING COST PLANT			
COST SEBELUM IMPROVMENT – COST SESUDAH IMPROVEMENT			
Rp 304.716.051 – Rp 139.694.052			
Rp 165.021.999			

Figure 5. Saving cost after improvement

CONCLUSION

The conclusion of this study shows that the research objectives, which were to identify the main causes and design an optimization strategy to reduce the frequency of PC-2000 engine breakdowns due to the use of B35 biodiesel, were achieved. The implementation of the optimization method, including the installation of an additional Racor filter and a periodic fuel tank flushing program, successfully reduced the low frequency of breakdowns from 24 times to 11 times, which represents a 54.61% reduction. The research also made significant practical contributions, namely improved unit operational reliability and cost efficiency, through reduced downtime and controlled maintenance costs. Thus, this study not only addresses the technical challenges faced due to the use of B35, but also provides a basis for better proactive maintenance strategies in the future.

For future research, it is recommended to conduct long-term studies to evaluate the impact of using B35 on engine performance and maintenance costs on an ongoing basis. Research could also explore the use of various biodiesel blends to determine their potential impact on engine performance and breakdown frequency. In addition, a comprehensive cost-benefit analysis should be conducted to assess the effectiveness of implementing the proposed maintenance strategies, including the resulting cost savings. Comparisons between different maintenance technologies, such as the more advanced Condition-Based Maintenance (CBM), can also be investigated to address issues caused by biodiesel use. It is also important to

examine the impact of technician training programs in improving maintenance and addressing problems associated with biodiesel, to ensure more reliable operation. Finally, research on the quality and characteristics of different biodiesels, and their effects on engine performance under various operating conditions, would provide greater insight and support the development of more effective maintenance strategies in the industry.

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