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Troubleshooting Engine Overheat on Wheel Loader Liugong Type 856H

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Abstract: The Liugong type 856H Wheel Loader unit was donated by PT. Liugong Machinery to Liuzhou Vocational and Technical College (LVTC) as part of a collaborative effort to support teaching and learning activities at LVTC. During practical use, this Wheel Loader unit experienced engine overheating. The aim of troubleshooting the engine overheating issue was to identify the root cause of the problem. This research was conducted using direct observation methods, specifically employing a 7-step troubleshooting approach. The research findings indicate that the engine overheating in the Liugong type 856H Wheel Loader unit was caused by a malfunctioning thermostat component. According to specifications, the thermostat should begin to open at a temperature of 78°C and fully open at 92°C. However, upon inspection, the thermostat did not open until the temperature reached 90°C. This prevented coolant from flowing to the radiator for cooling. As a result, the hot coolant continued to circulate within the engine, leading to engine overheating. The corrective action taken was to replace the faulty component.

Keywords: Engine Overheat; Cooling System; Troubleshooting

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1. Introduction

A wheel loader is a heavy equipment vehicle used for land clearing, material transport and relocation, as well as leveling or smoothing work areas. Currently, diesel engines remain popular and widely used in heavy machinery due to their significant power output. Diesel engines operate by converting thermal energy into mechanical energy, utilizing the heat from compression to ignite and burn the fuel injected into the combustion chamber[1].

Despite significant advancements in engine technology, the efficiency of converting chemical energy into mechanical power is still limited. Most of the energy in a diesel engine (around 70%) is converted into heat, which must be managed by the cooling system. The primary function of the cooling system is to regulate and control this heat[2].

The cooling system is one of the five critical engine systems crucial for optimal engine performance. Therefore, to make the engine operate more efficiently, the temperature must be reduced to around 140-200°C. Excessive cooling can reduce the thermal efficiency of the engine, so the goal of the cooling system is to keep the engine cool while maintaining its optimal operating temperature. A cooler engine is known to be less efficient, so the cooling system is designed to prevent cooling until the engine has warmed up to its maximum operating temperature, at which point it starts to cool[3][4]. In air-cooled engines, cylinders are mounted separately on the crankcase, allowing air to circulate directly around each cylinder, absorbing heat and maintaining the cylinder head temperature within safe operating limits. The basic principle of this cooling is that the air around the engine is cooler than the engine itself. Major components of an air-cooling system include fans, covers, deflectors, and fins[5]. The cooling system essentially functions to keep the engine temperature within its operational range, preventing overheating or overcooling[6].

If the radiator is not functioning properly, the risk of overheating in all systems increases due to trapped heat that cannot be dissipated efficiently. For instance, environmental conditions such as high temperatures and high humidity can contribute to engine overheating issues. Design standards that are not suited for specific climatic conditions can also result in inadequate cooling systems, leading to engine overheating. This condition occurs when the engine temperature exceeds its normal operating range, potentially causing severe damage such as burned engine seals or parts fusing due to excessive heat[7][8][9]. The primary cause of engine overheating is abnormalities in the engine's cooling system[10]. Overheating can cause stress distribution on the piston during the combustion process under actual engine conditions. It has been found that the stress distribution on the piston is significantly affected by piston deformation. This indicates that overheating issues in engines may be related to high thermal stress on the piston, especially if the piston experiences significant deformation[11]. Problem-solving is a systematic approach used to address issues and find their root causes[12].

In a study conducted by Ardiansyah (2020), problem-solving methods were used to identify the causes of overheating in the Komatsu WA470-6 wheel loader engine, finding that the primary cause of overheating was damage to the cooling system. This study has several differences from Ardiansyah's study: firstly, the research object in this study is the Liugong Wheel Loader type 856H, which has different design and cooling system features compared to the Komatsu WA470-6; secondly, although both studies used the same problem-solving methods, the diagnostic approaches and tools used differ, with Ardiansyah using specific leak detection tools and diagnostic software from Komatsu, whereas this study used tools and software specific to Liugong; thirdly, this study identifies different or additional causes of overheating, such as extreme operating conditions or lack of routine maintenance, which contribute to engine overheating. By comparing and contrasting this study with existing literature, this research provides a more comprehensive insight and demonstrates a unique contribution to understanding and addressing overheating issues in wheel loaders. In this study, problem-solving was used to identify the root cause of overheating in the Liugong Wheel Loader type 856H engine [13]. Problem Limitations This study focuses on identifying the root causes of overheating in the Liugong Wheel Loader type 856H engine using problem-solving methods, but does not include analysis or evaluation of the engine's condition after repairs. Therefore, discussions regarding the effects of repairs on engine performance, changes in operating temperature, and long-term impacts of repairs are not covered, and additional research is needed to evaluate the effectiveness of repairs and their impact on the engine's performance and reliability in the long term.

2. Materials and Experiment Methods

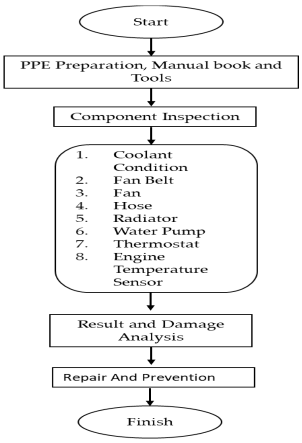
This study uses an observation method through 7-step troubleshooting[14][15]. This observation method involves systematic observation and recording of the problems being investigated. In this study, data collection is carried out by observing the object using sensory tools and conducting direct testing experiments. The purpose of this research is to determine the root cause of the overheating problem in the engine of the Liugong Wheel Loader type 856H[16][17][18].

The study begins with visual inspection of the components in the cooling system. Then, the researchers conduct tests on the components suspected of causing the malfunction after visual inspection.

Tools and Materials

The tools used in this study include a toolbox, personal protective equipment, a manual book, and instrumentation tools such as a thermometer and a multitester.

Flowchart



Conducting a manual inspection on the wheel loader engine and performing the 7-step troubleshooting here are the wheel loader engine specifications.

Table 1. Engine Specification Cummins QSL 9.3L

Engine Guangxi Cummins Industrial Power Co., Ltd.	
Model	QSL9.3
Idle speed	700-800 rpm
Serial number	90069174
Power range	130-560 kw
Firing order	1-5-3-6-2-4

3. Results and Discussion

Before performing maintenance or component replacement, an analysis must first be conducted to ensure that the actions taken correspond to the type of damage. The method used for damage analysis is the 7-step troubleshooting method.

Figure 1. Name plate engine

1. Determine the problem

The wheel loader type 856H engine experiences overheating when used for practical activities. The unit is operated in hot weather conditions.

2. Perform a visual inspection

Visually inspect the overall condition of the engine. Check for any visible leaks.

3. Possible causes

The possible causes of overheating are listed as follows:

a. Condition of the coolant and coolant level
b. Condition of the fan belt and fan
c. Leakage in the hose
d. Radiator malfunction
e. Water pump malfunction
f. Faulty thermostat
g. Faulty temperature sensor

4. Conduct an inspection

a. Prepare personal protective equipment (PPE), manual books, and tools to be used.

Figure 2. Personal protective equipment

b. Check the coolant level and coolant condition.

Ensure the coolant level is in the normal position and that the coolant is not contaminated. Make sure the coolant has not changed color. The coolant level can be checked at the radiator cap. Ensure the engine is not hot during the inspection.

Figure 3. Coolant condition

c. Check the fan belt
Ensure the belt is in good condition (not frayed). Check the belt tension.

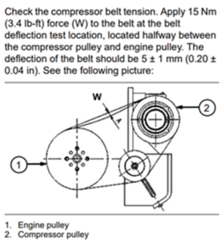


Figure 4. Belt tension

Figure 5. Check Fan belt

d. Check the condition of the fan
Ensure the fan blades are not damaged.

Figure 6. Fan

e. Hoses
   Ensure there are no leaks in the cooling system hoses.

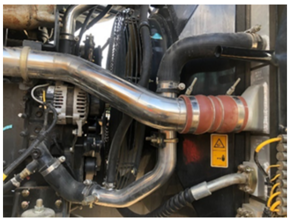


Figure 7. Hose

f. Radiator and radiator cap
   Check the radiator grille. Ensure it is in good condition and not blocked. If dirty, clean it immediately.

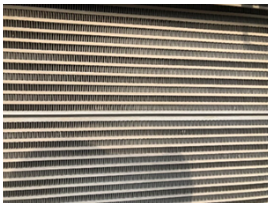


Figure 8. Radiator grille

g. Water pump
   Visually inspect the condition of the water pump. Ensure there are no leaks.

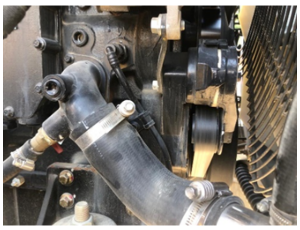


Figure 9. Water Pump

h. Temperature sensor
   To determine if the engine temperature sensor is functioning properly, testing is conducted using a multitester.

Figure 10. Check Visual Temperature sensor

Figure 11. Check Use Multitester Temperature Sensor

i. Thermostat

To determine if the thermostat is in normal condition, it must be tested as follows:

a. Prepare a pot with water, a thermometer, and the thermostat to be tested.

b. Place the thermostat in the pot filled with water and heat the water.

c. As the water heats up, observe the condition of the thermostat and the temperature on the thermometer.

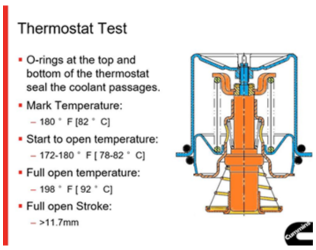


Figure 12. Thermostat specifications

According to the specifications, the thermostat should begin to open at a temperature of 78°C-82°C. At 92°C, the thermostat should be fully open. The full open stroke of the thermostat should be >11.7 mm.

Figure 13. Testing the thermostat at 78 °C temperature

In the initial test at 78°C temperature, the thermostat did not open as measured by the water temperature using a thermometer.

Figure 14. Testing the thermostat at 80°C temperature

In the second test, the thermostat was tested at a water temperature of 80°C but still did not open.

Figure 15. Testing the thermostat at 92°C temperature

From this final test, it was observed that the thermostat only opened when the water reached its boiling point at 92 degrees, which does not meet its specifications.

Based on the inspection results, the conclusion regarding the condition of the components in the cooling system is as follows:

Tabel 2. The results of the inspection

No.	Component	Condition
1	Coolant level	Normal
2	Coolant condition	Good, no contaminant
3	Fan belt	Good
4	Fan	Good
5	Hose	Good, no leakage
6	Radiator	Good
7	Water pump	Good
8	Thermostat	Isn't working
9	Temperature sensor	Good, the resistance corresponds to the temperature

It was found that the cause of engine overheating is a malfunctioning thermostat. According to specifications, the thermostat should open automatically to maintain the coolant temperature within the operating range (70°C - 90°C). However, upon inspection, it was discovered that the thermostat did not open until the temperature reached 90°C. As a result, coolant could not flow to the radiator for cooling. The hot coolant continued to circulate within the engine, leading to engine overheating [15][10].

Repair the damage

The action taken to fix the issue is by replacing the faulty component.

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if the paper does not explain the condition after repair. Provide a discussion limit in the introduction section

Analysis of why it happened

The overheating occurred in the unit due to the thermostat component not functioning according to specifications. After analysis, the damage to the thermostat component was caused by deposits or scale buildup preventing it from opening properly. This lack of proper maintenance on the unit contributed to the problem.

4. Conclusions

The engine overheating in the unit was caused by a malfunctioning thermostat. According to specifications, the thermostat should begin to open at a temperature of 78°C and fully open at 92°C. However, after testing, the thermostat did not open, preventing coolant from flowing to the radiator for cooling. As a corrective measure, the component was replaced because it was not feasible to repair the thermostat.

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