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Study on Engine Learning Experiencing Low Power On Cummins QSL 9.3L Engine

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Abstract: The Cummins QSL 9.3L diesel engine is a production engine from CLG or Cummins Liugong. This type of engine is typically used in heavy equipment such as Wheel Loaders. A diesel engine is an internal combustion engine where the combustion process occurs inside the engine itself, and pure air is compressed within the combustion chamber, resulting in high air pressure. It operates in four strokes. This engine experienced low power, causing it to malfunction, which led to abnormal operation. Various checks were conducted, including inspection of diesel fuel, fuel tank inspection, engine oil level check, visual inspection of the air cleaner, water separator check, Fuel Feed Pump check, and Clearance Valve Lash check. The problem identified was the mismatch of Valve Lash clearance in the engine, resulting in low power. The repair step involved adjusting the Valve lash using a Feeler Gauge. The purpose of this research is to provide an explanation of troubleshooting and to perform repairs on engines experiencing low power.

Keywords: Engine Low Power; Valve Lash; Wheel Loader; Troubleshooting

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1. Introduction

A wheel loader is a tractor with rubber tires equipped with a bucket. Wheel loaders are versatile tractors widely used in construction work, especially related to infrastructure construction[1]. Diesel engines in heavy equipment and transportation industries worldwide, including the Cummins QSL 9.3L engine, are known for their power, performance, and outstanding durability. This engine is utilized in various applications, ranging from commercial trucks to construction equipment and industrial machinery.

Engines play a significant role in heavy equipment units as the primary driving force. Various types and brands of engines are used for the main propulsion of heavy equipment units, necessitating a thorough understanding of each type of engine used

The Cummins QSL 9.3L diesel engine is a product of CLG (Cummins Liugong). This type of engine is typically used in wheel loader-type heavy equipment. With its capacity tailored to its needs, this engine is very popular in the heavy equipment industry.

A diesel engine is an internal combustion engine where the combustion process occurs inside the engine itself (internal combustion engine), and pure air is compressed inside the combustion chamber (cylinder), resulting in high air pressure. The diesel engine operates in four strokes[2].

The principle of a diesel engine's operation is to convert chemical energy into mechanical energy. Chemical energy is obtained through a chemical reaction, namely the combustion of fuel (diesel) and oxidizer (air) inside the cylinder (combustion chamber)[3]. A diesel engine is a piston combustion engine whose ignition process does not involve electric spark ignition. Only air enters the cylinder during the intake stroke[4].

Low power engine is a condition where the power generated by the engine decreases, resulting in the unit's inability to operate at its maximum capacity[5]. One of the causes is low power. When the engine experiences low power, it can lead to various problems, including decreased performance, increased fuel consumption, and even further damage to engine components.

Troubleshooting is a type of problem-solving for systems experiencing issues. The purpose of this research is to identify the troubleshooting experienced by the Cummins QSL 9.3L Engine operating as a Learning Engine or Prototype Engine and to determine what damages occur in engines experiencing Low Power and to repair the engine accordingly

2. Materials and Experiment Methods

The author begins by defining the topic, which involves identifying issues with the Cummins QSL 9.3L Engine. The problem statement in this case is to analyze the root causes of Low Power in the Cummins QSL 9.3L Engine owned by LVTC Campus. Based on data collected from field observations, several issues are identified, such as inadequate maintenance of the engine and susceptibility to contamination. Therefore, the author aims to analyze the Cummins QSL 9.3L Engine using the Root Cause Analysis (RCA) method. To analyze the factors causing the engine to experience Low Power, the author conducts a literature review to find relevant sources in books/journals related to Low Power Engines. From the analysis, the author identifies the factors causing the Low Power in the engine and suggests preventive measures through regular maintenance. Subsequently, testing steps are conducted, including Fuel Tank Inspection, Oil Level Inspection, Visual Inspection of the Air Cleaner, Fuel Filter Water Separator Inspection, Fuel Feed Pump Inspection, and Clearance Valve Lash Inspection on the engine[6].

In problem-solving method, Root Cause Analysis (RCA) is employed. According to Dogget (2005), there are several RCA tools available, including Fault Tree Analysis, Event Tree Analysis, Systematic Cause and Analysis Tool (SCAT), and Fishbone Diagram (Satryawan, 2016). In this research, the author uses Fishbone Diagram and Root Cause Table to analyze the causes of the QSL 9.3 engine experiencing Low Power. The Fishbone Diagram method aims to identify the root causes and determine the subsequent effects. This method helps to visualize the problem more comprehensively, enabling the author to identify a broader scope of causes and effects accurately. The author then details the factors causing the problem, leading to the discovery of the root cause using the Root Cause Table.

The initial step involves checking the condition of the engine oil. Ensure the engine is turned off and the unit is positioned on a level surface. Then, visually inspect the engine oil by reading the dipstick level. The result shows that the engine oil level is between the upper and lower lines or that the volume of engine oil is within normal range.

Problem Solving Methods

Dogget (2005) mentions several Root Cause Analysis (RCA) tools that can be used to identify the root causes of problems[7]. Among them are Fault Tree Analysis, Event Tree Analysis, Systematic Cause and Analysis Tool (SCAT), and Fishbone Diagram[8]

Tools and Materials

Before conducting this research, pay attention to the key points in conducting field research, which require the use of personal protective equipment and work equipment as follows: Gloves, Safety Shoes, Coveralls, Safety Glasses, Tools, feeler gaug

Flowchart

For Cummins diesel engines experiencing low power, we implement several methods in data and information collection including observation, interviews, literature review using the 8-step Troubleshooting, troubleshooting, and repairs. The research steps mentioned above can be seen through the flowchart.

Table 1. Engine Specification Cummins QSL 9.3L

Model	QSL 9.3L
Type	In line, 4 stroke, Direct Injection
Intake	TCAC
Displacement	9.3L
Rated Power	162-180 KW (220-245 HP)
Rated Speed	2200 RPM
Peak Torque	1187N.m
Emission	National III/Tire IIIA
Wet Weight	770 KG
Size	1128*805*1085 mm
Application	Wheel Loader
Firing Order	1-5-3-6-2-4

Here are the specifications of the Cummins QSL 9.3L Engine, a diesel engine used for wheel loader units [9]. The standard specifications are as follows:

Re-measurement of valve clearance using a feeler gauge, which is used to adjust valves. With Torque Value [10].

3. Results and Discussion

The engine lacks power during operation, leading to inadequate engine performance, difficulty in starting, and excessive fuel consumption. After conducting inspections using various methods including observation, interviews, literature review, troubleshooting, and repairs, there is a possibility of issues causing the engine to experience low power.

"Implementation and testing of the system are stages in applying a designed and built system. Here is the display of the implementation and testing of the Expert System diagnosing Engine Low Power in Caterpillar heavy equipment at PT. Trakindo Utama."[11]

Possible Causes of Engine Low Power:[12]

a. Poor quality diesel fuel

b. Insufficient oil

c. Dirty fuel tank

d. Clogged air cleaner

e. Clogged water separator

f. Fuel pipe leaks

g. Clogged fuel feed pump

h. Clogged line pump

i. Incorrect valve clearance

After identifying the possible causes of engine low power, the next step is to inspect each component that could be contributing to the issue.

Component Inspection Steps:

a. Fuel tank inspection

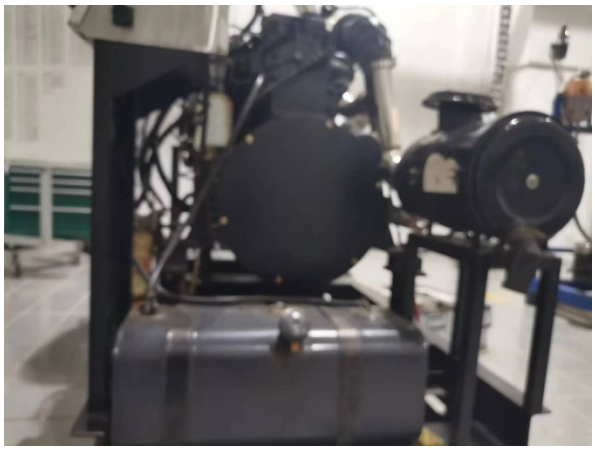

Figure 1. Fuel tank

As a fuel storage place, the fuel tank plays a crucial role in the fuel system. The visual inspection of the fuel tank did not reveal any leaks or fuel tank cap leakage, which could lead to fuel contamination, such as water contamination.

b. Engine oil level check

Figure 2. Oil Level

Checking the oil level of the QSL 9.3L diesel engine. The diesel oil level check showed no shortages, and the oil content appeared to be in good condition and suitable for use.

c. Visual inspection of the air cleaner

Figure 3. Air Filter

The visual inspection of the air filter element showed no dust or dirt buildup on the air filter, and after inspection, the air filter element was reinstalled into the engine.

d. Water separator check

Figure 4. Water separator

Checking the water separator by draining the fuel mixed with water or contaminated with water by opening the drain plug on the water separator. This check revealed water in the water separator, and draining the water separator removed contaminants from the diesel fuel.

e. Fuel Feed Pump Check

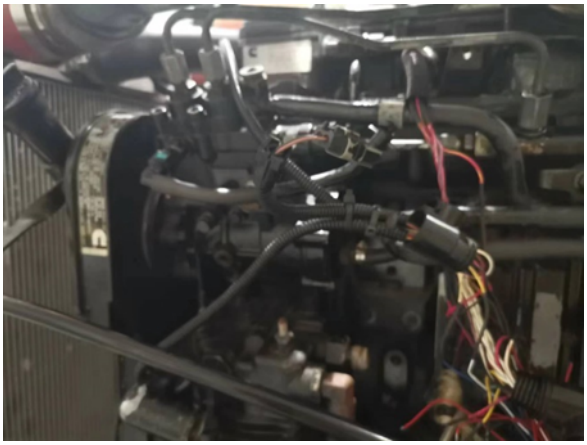

Figure 5. Fuel feed pump

Its function is:

Supplying fuel to the fuel pump at low pressure, ranging from 1.2 - 2.6 kg/cm2. Together with the priming pump, it supplies fuel to the system when the engine is in an air-intruded condition (engine hunting = air entering the fuel system)[13].

Checking the fuel feed pump revealed no fuel pump leaks, and the pressure measurement on the fuel pump was normal. Fuel in the injection pump chamber must always be sufficient, requiring fuel to be delivered to the injection pump under pressure because the pump element cannot deliver enough fuel at high speeds. Therefore, the filling pressure is adjusted to 1.8 – 2.2 kg/cm2 (25.6 – 3 psi) by the piston spring[14].

f. Valve Clearance Check

Figure 6. Valve Clearance

The next step after conducting all visual and specified tool inspections, from the easiest to the most difficult, was identifying the root cause of the engine experiencing low power, which was the mismatch of valve lash clearance on the Cummins QSL 9.3L engine, leading to decreased engine performance.

The next step is to rotate the crankshaft clockwise until cylinder number 1 is in the compression position, where the piston is at Top Dead Center. In this position, you can perform the initial clearance check as follows[15].

Table 2. Checking Top 1 Valve Clearance

Top 1	Result Valve Clearance check	
	Intake	Exhaust
1	O,25 mm	0,50 mm
2	0,28 mm	-
3	-	0,40 mm
4	0,25 mm	-
5	-	0,50
6	-	-

From the Top 1 inspection, it was found that the valve clearance did not comply with the specifications of the QSL 9.3L diesel engine, specifically for the intake cylinder 2 and the exhaust cylinder 3. This deviation from the standard valve lash is a potential cause of the engine experiencing low power.

Table 3. Checking Top 6 Valve Clearance

Top 1	Result Valve Clearance Check	
	Intake	Exhaust
1	-	-
2	-	0,55 mm
3	0,25 mm	
4		0,51 mm
5	0.30 mm	
6	0,35 mm	0,40 mm

From the table above, after measuring the valve lash, discrepancies were found in the standard valve lash for intake cylinders 5 and 6, and for exhaust cylinder 2 and 6. Therefore, based on this measurement, there is a potential cause for the QDL 9.3L engine to experience Low Power

The standard specifications for the QSL 9.3L Engine are as follows:

Table 4. Standard Valve Lash Clearance Specifications

Intake	0,254 mm (0.010 in)
Exhaust	0.508 mm (0.020 in)

Repair Process:

The repair process involves readjusting the valve lash according to the specified reference, with the valve lash readjustment process performed in accordance with the working procedure. After completing all the inspection sequences, the issue of Low Power Engine due to non-compliant Valve clearance was identified. The steps for remeasuring are as follows:

Ensure the engine is in the top dead center (TDC) position to determine the position of cylinder number 1 and then

Figure 7. Determining Top 1 Cylinder

Determining the valves that can be adjusted at the top compression of cylinder 1 can be done by referring to the diagram/table of the cylinder working process or by physically moving the rocker arms. If the rocker arm moves freely, it indicates that the corresponding cylinder can be adjusted.[16][17].

Figure 8. Adjust Valve Lash

Figure 8 above shows the process of readjusting the Valve Lash clearance on the Cummins QSL 9.3L Engine using a feeler gauge, which is used to measure the gap between the rocker arm and the valve.

4. Conclusions

After conducting the inspection and repair procedures on the Cummins QSL 9.3L Engine, the author made observations, inspections, and repairs on the engine experiencing low power due to the mismatch of Valve Lash clearance. The conclusion drawn is as follows:

The Cummins QSL 9.3L Engine experienced low power due to insufficient maintenance, resulting in low power. The cause of the low power engine is the mismatch of Valve Lash Clearance in the engine. The repair efforts undertaken on the low power QSL 9.3L Engine involved various inspections from easy to hard, which were carried out until the problem was identified. Subsequently, adjustments were made to the valve lash according to the existing specifications.

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