International Journal of Multidisciplinary Research and Publications
ISSN (Online): 2581-6187

Nossel Damage Analysis on Caterpillar Engine 3304 Wheel Loader 950 Unit

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Abstract**—***The fuel system is the process of flowing fuel from the tank to the fuel pump before the fuel is sprayed into the combustion chamber. The fuel pump used is a plunger pump type. The components in this fuel system include the fuel tank, water separator, feed pump, fuel filter, fuel injection pump, nozzle, and governor. This analysis aims to analyze the damage that occurs to the fuel system components, the factors that cause it, and how to resolve it as well as the solution and determine the specifications of the fuel pump that will be used for the 950 wheel loader fuel system. The method used in this research uses a results data approach. visual inspection and measurements of fuel system components compared to the SIS manual. From the visualization measurement data, the following data was obtained: Length under test force is 19.6 mm, Free length after test is 45.7 mm, Outside diameter is 17.0 mm, and Diameter of wire is 1.5 mm. Meanwhile, data from spring specifications according to SIS are: Length under test force is 26.4 mm, Free length after test is 47.8 mm, Outside diameter is 17.8 mm, and Diameter of wire is 1.3 mm. From the data obtained, it meets the spring specifications according to SIS.*

Keywords**—** *cooling system components, visual inspection, measurement, testing, SIS Caterpillar*.

I. INTRODUCTION

Along with advances in science and technology, the automotive sector is no exception, including motorbikes, light vehicles, and heavy equipment. Automotive manufacturers, especially light vehicles, are now making many innovations in fuel systems, both petrol, and diesel, so that the resulting vehicles have economical fuel consumption. One of the most important systems in a diesel motor is the fuel system. The fuel system is a system found in a diesel engine that functions to supply fuel from the tank to each cylinder via the injector, in the right amount and at the right time in the form of very fine particles/mist, thus producing perfect combustion. to get maximum power/power. The fuel system is the process of flowing fuel from the tank to the combustion chamber. The fuel system also plays an important role in reducing exhaust emissions. The fuel system on a diesel motorbike has a very important role in producing combustion energy as a system that functions to provide and supply high-pressure fuel into the cylinder. In the operation of a diesel motor fuel system, there are special requirements including: it must have a high pressure suitable for penetration into the cylinder, and on time. In a diesel motor, the fuel flow starts from the fuel tank, feed pump, fuel filter, and pump. injection, high-pressure pipe, and nozzle. Fuel system failure can have a major impact on the unit as well as the fuel system components. If a failure occurs in the fuel system, the unit will experience low power and can even cause the unit to not operate.

II. RESEARCH METHODOLOGY

Place and time of research

The location of this research activity is at the Samarinda State Polytechnic heavy equipment engineering study program workshop which is by the SOP.

Object of research

The object of this research is to observe and analyze the symptoms that cause damage from damage to fuel system components on the 3304 Caterpillar engine 950 wheel loader unit. This 950-wheel loader unit is one of the heavy equipment that functions to lift material to be transferred to other equipment or placed in a dump. trucks. When the loader does this, the bucket can then be pushed towards the material.

Figure 1. Wheel Loader CAT 950

Tools and materials

The tools used in the research include Tool Box, Nozzle Tester, Pressure Gauge, Safety Helmet, Safety Glasses, Safety Shoes, and Safety Gloves. Meanwhile, the materials used in the research include Majun, engine oil, diesel, and cooling/air conditioning.

Research stages

1. Prepare the fuel system on the Caterpillar 3304 wheel loader 950 engine
2. Know and analyze problems in the fuel system
3. Carry out a thorough check of the fuel system components
4. Disassemble the fuel system components
5. Repair damaged components according to the literature
6. Reinstall the fuel system components that have been repaired
7. Double-check to see that all components are working normally
8. Carry out routine maintenance to extend the service life of the fuel system

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III. Research Result and Discussion

Fuel System Analysis Results

In analyzing the components of the fuel system, data from visual inspection results and measurements of the fuel system components are compared with the manual, including:

1. Guideline for Reuseable and Salvage Operation for Nozzle Chamber with media number SEBF8061-03
2. Specification manual for Fuel System components with media numbers SENR7590-01 (Injection Nozzle), SENR7590-01 (Fuel injection Pump), SENR7590-01 (Fuel Bypass Valve)
3. Applied Failure Analysis textbook, (2014) Cileungsi Training Center PT. Trakindo Utama, Jakarta
4. Service Information System (SIS) standard guide

From the results of this comparison, it was found that the types of material damage that occurred in the Fuel System components were:

1. Corrosion (Corrosion)

In simple terms, corrosion is defined as metal damage due to a reaction with a corrosive environment. Corrosion can also be interpreted as metal damage due to electrochemical reactions with its environment. This damage occurs in several components of the Fuel System.

2. Adhesive Wear

Adhesive Wear Sticky wear is the one that expands the fastest. In sticky wear, two moving surfaces make contact without sufficient lubrication or cooling. These moving connections produce through friction, raising the surface temperature to the melting point, and causing the surfaces to stick together.

3. Erosive wear

Erosive wear occurs in all engine systems. Filters and filter replacement intervals are designed to control erosive wear (and abrasive wear) within permitted limits. If the customer uses an inappropriate filter, the dirt ingress control function will not work so erosive wear and abrasive wear occur at levels that are not permitted.

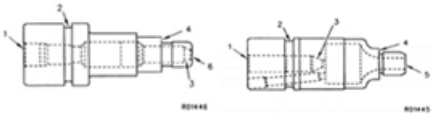
4. Cavitation Erosion

Cavitation erosion occurs when air bubbles/water vapor bubbles burst on the metal surface. All fluids contain gas solutions that form air bubbles in areas of low pressure, and abnormal system conditions can trigger the appearance of additional water vapor bubbles. When these bubbles enter a high-pressure area, they explode, producing liquid pressure at very high speeds

Visual Inspection

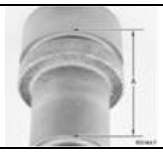
Nozzle

A. Nozzle Chamber



Notes : 1). Injector inlet, 2). O-Ring Grove, 3). Nozzel seat, 4). Gasket Face, 5). Chamber Outlet, 6). Injector Outlet

O–Ring Groove

 *GRPTS* no.media *SEBF8061-03*  Actual	The damage that occurs between the O-ring groove and the gasket face is corrosion (rust) due to the heat generated from the combustion chamber over a long period of time so that the part becomes porous or eroded due to rust. Most of the components that are damaged cannot be reused because they can cause more fatal damage. This damage is found in all nozzle chambers.

O-ring Groove – gasket face

 *GRPTS* no.media *SEBF8061-03*  Actual	In the O-ring groove above, the visible damage is corrosion, which causes the diameter of the O-ring groove to shrink and causes the service life of the o-ring to become shorter. This corrosion is caused by the service life of components and also electrochemical reactions with the environment. The way to overcome this is to clean the rust by sanding the O-ring Grove at least until the surface is flat. This damage occurred in all nozzle chambers.

Lower Half of the Threads

 *GRPTS* no.media *SEBF8061-03*  Aktual	In this section, the threads of the four nozzle chambers have no problems with damage. All parts of the threads are in good condition, there is only a little contamination on the threads, this can be easily resolved by cleaning the dirt on the threads.

Gasket Face

 *GRPTS* no.media *SEBF8061-03*	In the Gasket Face section, the corrosion can clearly be seen which is very severe, the corrosion causes the gasket to become porous and causes the ring gasket to not come off or stick. The

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 Aktual	problem that occurs in this section is that it cannot be used, because if it is used it will cause compression leaks in the area. combustion chamber so that the combustion chamber will not work optimally.

B. Nozzle Seat

At the top of the nozzle seat, there is visible corrosion caused by high temperatures, where the hot metal surface is open to air and oxidation occurs. Meanwhile, at the bottom, there is contamination due to careless dismantling or without proper procedures. The damage above does not in any way affect the working of the nozzle in the fogging process in the combustion system.

The conclusion from the visual analysis in the Nozzle section is that the nozzle on the 3304 wheel loader 950 Caterpillar engine can no longer be used due to a lot of fatal material damage.

Bypass Valve

In the Bypass Valve section, no damage problems occurred and this component can be used again without problems

Piston

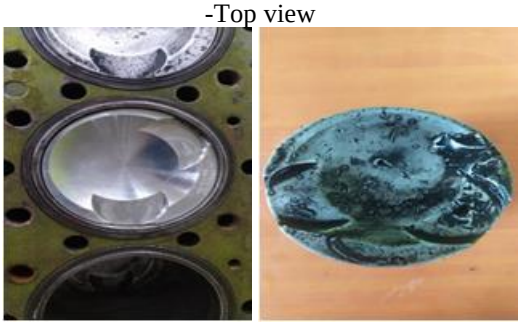
- Side View

(1) (2)

Piston number two on the engine experiences Adhesive Wear, when adhesive wear progresses it will cause a seizure on the metal surface and stick to the surface of nearby components, eroding the metal from the softer surface. This piston skirt is attached to the liner and some of the soft parts of the skirt are missing. If the component continues to operate in adhesive wear conditions, it can cause the component temperature to rise to the melting temperature, and the component loses strength and breaks apart.

Apart from adhesive, the piston also experiences erosion, erosion is worse at the top of the hole than at the bottom. This is a reflection of the load and movement of the piston against the broken retainer and shows that the downward movement of the piston is more violent and sudden than the upward movement of the piston. This erosion wear is caused by broken piston rings. It can be seen here that the damage is worse at the top of the ring land than at the bottom, due to the piston load and movement.

-Top view



(1) (2)

Piston number two at the top appears to be experiencing Cavitation Erosion, this is caused when the fuel fogging process forms air bubbles in areas of low pressure, and abnormal system conditions can trigger the appearance of additional water vapor bubbles. When these bubbles enter a high-pressure area, they explode, producing liquid pressure at very high speeds. Cracks (cracks) are very small and will increase until metal fragments occur, producing small holes.

Measurement

a. Bypass Valve
- Measuring instrument:
1. Vernier Caliper

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2. Spring tester

Measure Results
1. Diameter of Wire

Personal measurement results: = 1.5 mm
Spring specifications according to SIS: = 1.3 mm (0.5 in)

2. Outside Diameter

Personal measurement results: = 17.0 mm
Spring specifications according to SIS: = 17.8 mm (70 in)

3. Length under test force

Personal measurement results: = 19.6 mm
Spring specifications according to SIS: = 26.4 mm4. Free

4. Length after test

Personal measurement results: = 45.7 mm
Spring specifications according to SIS: = 47.8 mm

2. Visual measurement data

Length under test force	19,6 mm
Test force	-
Free length after test	45,7 mm
Outside diameter	17,0 mm
Diameter of wire	1,5 mm

IV. CONCLUSION

The conclusions of this research are from the visualization measurement data, the following data is obtained: length under test force is 19.6 mm, free length after the test is 45.7 mm, the outside diameter is 17.0 mm, the diameter of wire is 1.5 mm Meanwhile, data from spring specifications according to SIS are: length under test force is 26.4 mm, free length after the test is 47.8 mm, the outside diameter is 17.8 mm, the diameter of wire is 1.3 mm. From the data above, it still meets the spring specifications according to SIS

ACKNOWLEDGMENT

The researcher would like to thank the Center for Research and Community Service at the Samarinda State Polytechnic (P2M POLNES) which has provided the opportunity to research and received a research journal grant with the scheme: Study Program Assignment research as well as all parties who have supported the smooth running of this research.

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