



Damage Analysis of Plunger Barrel on Performance of Fuel Oil Injection Pump on Generator Ship MT. Vijayanti

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Abstract: Diesel generator is a machine that can convert mechanical energy into electrical energy, diesel generator has an important role in supporting operational activities on board. The function of the diesel generator is to supply electrical energy, which is comprehensive in the electrical equipment on board. The work process of each part and component on the diesel generator must be properly maintained and checked and maintained so that each part and component of the engine can work optimally according to their respective functions. The purpose of this research is to find out and analyze and find a solution to why the working hours of the plunger barrel component exceed the usage limit and why the maintenance of the fuel oil injection pump pressure area for leaks is still lacking. The research method with research approach uses qualitative methods. Sources of data collected and used in this study were obtained from case studies, problem-solving and qualitative descriptive. Methods of collecting and withdrawing data using observation, interviews, literature study, and documentation. The discussion of this study carried out observations of checking to start from the plant maintenance system (PMS) by the previous crew to the fuel system starting from the fuel tank to the purifier which is directly related to the running of the fuel system at the fuel oil injection pump, as well as checking the fuel injection pump leaking which hinders from performance fuel oil injection is not optimal and makes the fuel pressure drop. The results of the discussion set and reschedule PMS and perform plunger barrel maintenance as well as overhaul the fo purifier and perform maintenance based on working hours. The conclusion is that the plunger barrel working hours exceed the usage limit due to delays in the implementation of PMS and the occurrence of leaks in the fuel oil injection pump area due to: damage to the bowl and main seal ring on the fo purifier, causing the process of separating fuel and dirt from the storage tank to the daily tank into a lot of mixed mud.

Keywords: Diesel Generator, Plant Maintenance System (PMS), Purifier, Fuel Oil Injection Pump, Bowl and Main Seal Ring

INTRODUCTION

The role of sea transportation is very necessary to facilitate the process of transporting goods and services in the maritime world, especially in Indonesia, which is a maritime country with the largest archipelago in the world. The Unitary State of the Republic of Indonesia (NKRI) is a country that has a sea area larger than the land area. This also affects every island in Indonesia.

Efforts made by shipping companies in improving service and user interest are to make the fleet owned by the company always ready to operate smoothly without any obstacles. The company as the provider does not want any disturbance or damage to its marine fleet, which can hamper the process shipping activities, to reduce disruption, damage or things that can hinder, it is necessary to maintain and repair systematically and planned for all components of machinery and equipment on board.

Smooth operations or shipping activities, especially on ships, must be assisted with good engine working conditions, especially on diesel generators. Diesel generator is a machine that can convert mechanical energy into electrical energy, diesel generator has an important role in supporting operational activities on board.

The function of the diesel generator is to supply electrical energy, which is comprehensive in the electrical equipment on board. The work process of each part and component on the diesel generator must be properly maintained and checked and maintained so that each part and component of the engine can work optimally according to their respective functions.

As long as the author makes observations at the practice site, namely on the ship MT. Vijayanti. The author found findings on the 4 stroke diesel generator, namely the ANQING-4 STROKE DAIHATSU 5DK-20, there are 3 components that affect the performance of the diesel generator, including: Plunger Barrel, Is a component of the Fuel Injection Pump Diesel Generator which functions to suppress the fuel so that the fuel coming out of the Fuel Injection Pump has high pressure; Fuel Injection Pump, A pump that functions to pump fuel at high pressure from the fuel tank to the injector; Injectors, Is one of the main components in the diesel fuel system. The injector serves to deliver diesel fuel from the injection pump into the cylinder at the end of each compression stroke where the piston (piston) approaches the diesel generator TDC position.

These three components have an important role in the combustion process in the diesel generator engine. If one of the components has problems and malfunctions, it will have an impact on the fuel, where the fuel pressure drops and then the combustion process in the engine combustion chamber diesel generators will be disrupted resulting in reduced power and diesel generator performance is not optimal, therefore maintenance and repairs are very important to be maintained regularly on every component that is damaged. If the component has exceeded the time limit of 1500 hours for the pressure fuel oil injection pump, it is necessary to replace the new component. So that the condition of the diesel generator is maintained and works optimally.

LITERATURE REVIEW

Definition of Analysis

Analysis comes from the ancient Greek word "analisis" which means to let go. Analisis is formed from two syllables, namely "ana" which means to return and "luein" which means to let go. In general, analysis is an activity that contains a number of activities such as parsing, distinguishing, sorting things to be classified and regrouped according to certain criteria, then look for their relation and interpret their meaning.

According to Sugiono (2015: 335), analysis is an activity to look for patterns, or ways of thinking related to systematic testing, while according to Komaruddin (2001), analysis is a

thinking activity to describe a whole into components so that they can recognize the signs of components, their relationships. each other and their respective functions in an integrated whole. From some of the definitions above, it can be concluded that the notion of analysis is an effort or activity carried out by researchers to seek a review of a problem in which it is hoped that the problem can be interpreted clearly.

Definition of Performance

Damage is any change in something, often a physical object, that degrades it from its initial state. It can broadly be defined as “a change introduced into a system that adversely affects its current or future performance”. Damage does not always mean a total loss of system functionality, but rather the system is no longer operating optimally. According to the American Petroleum Institute, (2011:14) damage is a form of strain aging in which this form of damage is mostly found in older antique carbon steels and low-alloy C-0.5 Mo steels under the combined effects of deformation and aging at medium temperatures. This results in an increase in hardness and strength with a reduction in ductility and toughness.

Definition of Plunger Barrel

Plunger Barrel is a main component in the injection pump whose job is to pump fuel with very high pressure so that it can be atomized by the injector or nozzle, which then divides the fuel into each motor cylinder according to the sequence of spraying at the right amount of time. . The plunger barrel is able to move up due to the pressure from the tappet roller driven by the camshaft and the spring (spring) will push the plunger barrel down.

The parts or components of the plunger barrel are made very precise between the gaps between the plunger barrel or cylinder (plunger housing) so that the fuel that is pressed or pumped will be really maximized and shows the highest pressure and is placed in a small level of damage to help the pump element survive. under high pressure.

In the installation of the plunger barrel, it is necessary to pay attention to the adjustment of the control rack which is installed at the end of the governor through the control that surrounds the plunger which functions to regulate the amount of fuel that will be misted through the high-pressure pipe to the nozzle .

Definition of Fuel Injection Pump

According to E. Karyanto, (1986:102) the fuel pump (pressure fuel oil injection) is a machine tool that has the task of pressing fuel to the atomizer nozzle and dividing the fuel into each cylinder or motor combustion chamber according to the size of the spray. of the machine in question at the right time and quantity.

According to Robert Bosch (1972: 46) is a completeness in a diesel engine whose job it is to press diesel fuel from the tank to the nozzle to be atomized in the combustion chamber. The fuel suppression pump serves to supply fuel to the combustion chamber through a nozzle with high pressure (max 300 kg/cm²). Fuel injected with high pressure will form a mist with very fine fuel particles so that it easily mixes with the air.

The fuel pressure pump on the diesel generator is equipped with a fuel supply pump which is used to distribute fuel from the daily fuel rod to the fuel suppression pump when the fuel tank is far from the diesel generator position. The fuel pump plays a very important role in the performance of the suppression pump in determining the incoming fuel pressure. There is a fuel filter that functions to clean the fuel before it enters the pressure pump. The fuel filter must always be maintained by cleaning it frequently in order to keep the fuel from getting dirt or mud into the pressure pump.

Main Components of Fuel Suppressor

The fuel suppression pump has components that help the process of fuel suppression as part of a system in the operation of the pump. An important component that is very influential in the course of the fuel suppression process. The plunger moves up and down the cylinder. To be able to press the fuel to the atomizer component (nozzle) the two components must work together. The following are the main components of the fuel suppression pump:

a. *Camshaft*

Also known as Noken As, which works by rotating along with the engine speed and serves to push the plunger according to the firing order in such a way that the plunger can kick high-pressure fuel into the nozzle unit.

b. *Tappet Assy*

As a liaison between the camshaft and the plunger, use a roll at the bottom to avoid friction between the tappet and the camshaft cam.

c. *Plunger and barre l*

Components for driving or pumping fuel to the nozzle (nozzle)

d. *Governor*

Works to prevent the engine from overtuning by controlling the maximum engine speed and preventing the engine from turning off by stabilizing the engine speed when the engine speed is low.

e. *Control rack and control sleeve*

These two components are a unity that cannot be separated even though they are in different forms. But it has the same function, which is to supply fuel to the plunger

f. *Delivery valve*

Is a valve whose job is to avoid backflow and control the pressure of the remaining fuel

g. *Pump Body*

Is part of the pump that functions as a cover and protector of the inside of the pump.

How the Fuel Suppression Pump Works

The workings of the first diesel fuel suppression pump from the tank enters the feed pump of the suppression pump, then it is directed to the plunger barrel component which is the space where the diesel will be channeled to the injection system. Then when the engine is turned on, the pump camshaft automatically rotates directly pressing the plunger upwards. Meanwhile, the top of the plunger barrel is filled with diesel. So that the plunger movement will press the diesel fuel up.

On the plunger there is a delivery pipe that opens when there is pressure from the pump direction and then closes when there is pressure on the injector hose with high pressure. Then the diesel is pressed into the injector hose with high pressure then the end of the injector will open so that the diesel will be atomized with a pressure of 250-300 bar. When the gas cable is pulled, the rack adjuster will increase the volume of the plunger barrel so that there will be more fuel supply when the plunger is depressed. So the engine rpm will increase. Then the governor will adjust the injection timing by adjusting the pump camshaft angle.

Definition of Diesel Engine

A diesel engine, also known as a diesel engine, is an internal combustion engine that uses heat of compression to ignite and burn fuel that has been injected into the combustion chamber. Diesel engines have the best thermal efficiency compared to other internal and external combustion engines, because they have a very high compression ratio. Low speed diesel engines can have a thermal efficiency of more than 50%. According to Lloyd Van Horn Armstrong and Charles Lafayette Proctol (2007) from the Encyclopedia Britannica.inc article, a diesel engine is an internal combustion engine in which air is compressed to a high enough

temperature to ignite diesel fuel that is injected into the cylinder, where combustion and emission drive the engine. a piston that converts the chemical energy in the fuel into mechanical energy, which can be used for haul trucks, large tractors, locomotives, and ships. A number of cars are also diesel powered as are some sets of electric power generators.

Diesel Engine Components

In a diesel generator engine there are 3 (three) main components, namely the engine cylinder head, engine crankcase, and engine block. These components are as a support or foundation structure on the diesel generator engine.

Diesel Generator Working Principle

Diesel generator has 2 types, namely type 2 stroke and 4 stroke. On the principle of work, especially diesel generators, many use the 4 stroke working principle. The 4 stroke diesel generator engine is a diesel engine whose combustion uses 4 times the piston stroke 2 times the crankshaft rotation produces 1 time of effort or power.

RESEARCH METHOD

Approach and Data Collection Method

Approach Method:

So that problem solving in this research can be carried out properly and systematically, the authors use several problem approach methods that are considered appropriate to the problems in this study. The following are some of the approach methods used by researchers in conducting research which include:

The case study approach method is an approach method by studying the problems encountered. That is, the problems that exist are studied first by referring to the manual instruction book and documents that can assist in solving the problems that are being experienced by researchers. As long as the author does real work on the MT ship. VIJAYANTI, the author approaches problem solving by reading the manual instruction book.

The problem solving approach method is a continuation of the case study approach that has been carried out previously by researchers which has been described above, so that problem solving is a process of finding problems and solving them based on accurate data and information, so that the right conclusions can be drawn.

Qualitative descriptive approach is a process of research and understanding based on a methodology that investigates a phenomenon based on a methodology that investigates a phenomenon in the problem that occurs. In this approach, the researcher creates a complex picture, examines words, reports detailed views of the respondents, and conducts studies in natural situations.

Data Collection Techniques

To obtain complete, objective, accurate, and accountable data, to find a true picture and view, certain techniques are needed to collect the data. The technique used to obtain data related to the plunger barrel and fuel oil injection pump problems in this study is as follows:

a. Observation (Observation)

Observation is a systematic and well-considered method through direct observation, investigation, and research on the object that is the topic, in this case the plunger barrel and fuel oil injection pump.

The data collection technique was carried out by going directly into the field, by making direct observations of the plunger barrel and fuel oil injection pump. During the practice of sailing (prala) or during the research period for approximately twelve months on board the MT. VIJAYANTI the problems that occur in the machinery that are observed are only the

plunger barrel and fuel oil injection pump, in this case the author observes the operation of the installation and the causes and consequences of the problems that occur .

b. Interview

Interviews are data collection by asking someone to get clearer information to support the truth and the causes of something being studied. This interview was conducted with the Machinist III, Machinist II, and the Head of the Engine Room (KKM) in overcoming the problems that occurred in the onboard machinery, especially the damage to the plunger barrel on the fuel oil injection pump.

c. Documentation Study

The documentation in question is a real picture taken when the incident occurred by taking pictures to be used as concrete evidence that there really was a problem with the plunger barrel and fuel injection pump. In archival documentation and ship documents are used to complete the data obtained, so that the data is more accurate and can be accounted for.

d. Literature review

Literature study is the method used by the author to collect data, where the literature study taken is done by reading books or other sources that are used as references and reference material in writing this research.

Literature study was carried out as a comparison material in research and discussions related to the problems faced in writing this research.

Research subject

The subjects in this study were the plunger barrel and fuel injection pump with positions as components of the generator engine on board the MT. VIJAYANTI.

Data Analysis Techniques

The data analysis technique used is the root cause analysis technique, the root cause data analysis technique is a way of overcoming the problem that aims to identify the root cause of the problem or event. This technique is used because it is in accordance with the data, problems, and research objectives. Data analysis activities using this method are carried out by reading the data-data that has been collected, while the data analysis method of this thesis uses descriptive data analysis, where the author describes all events or events that occur on the ship.

FINDINGS AND DISCUSSION

Descriptive Data

Diesel generator is an auxiliary aircraft on board which has a very important role, namely as the main source and supply of electrical energy for all main machinery or auxiliary engines and lighting on board. Diesel generators produce electricity by utilizing the combustion process in each cylinder to move the piston up and down so that there is a rotation of the crankshaft and rotation of the shaft to produce mechanical power then the mechanical power is converted into a source of electric power by a magnetic induction process.

Diesel generators are equipped with fuel system components that are the source of combustion in the combustion chamber in each cylinder. One of the main components in the combustion system is the pressure fuel oil injection pump. A pressure fuel oil injection pump is a pump that is used to pump fuel by being pressed by the plunger barrel and then channeled to the nozzle to be atomized in the combustion chamber in each cylinder. Inside the pressure fuel oil injection pump, there is the main component that helps the process of suppressing the fuel, namely the plunger barrel.

Occurrence of low-pressure alarm which resulted in flame failure. On July 14, 2020, when the MV. SENTOSA CHALLENGER was about to burn sludge in the incinerator, it

experienced a low-pressure alarm which resulted in flame failure on the incinerator aircraft. What was later found was the problem due to the temperature was not too hot in the water oil tank so that the viscosity of the sludge inhibited the filter in the incinerator combustion process path so that the sludge that wanted to be burned went into the burner but not with maximum pressure, causing a pressure alarm. low in the incinerator is active because of the lack of pressure on the burner. And then to solve all these problems, the watchman on duty took the role of clean the incinerator filter first and after cleaning, the machinist also takes care to open the steam valve coming from the boiler little by little to reach a minimum temperature of 100°C that enters the waste oil tank so that after returning to normal the incinerator can be reused without any obstacles and everything can return to normal. The author experienced several problems that occurred in the plunger barrel and fuel injection pump when conducting research. These problems will be described in detail based on the events experienced by the author on board the MT. VIJAYANTI include:

The plunger barrel working hours have exceeded the usage limit. At the time of carrying out the Balikpapan ship voyage to Makassar where the author was carrying out the duty of duty at 00.00 – 04.00 with the machinist III, at that time suddenly an alarm sounded where the control room monitor showed that the fuel pressure on generator number 1 had decreased. Then we did a check on the plunger barrel and there were findings.



Figure 1. Plungger Barrel Pictures

When checking was carried out on the fuel oil injection pump, it was found that damage was found in the form of scratches on the stain lees plunger barrel. When checking was carried out on the fuel oil injection pump, it was found that damage was found in the form of scratches on the stain lees plunger barrel. Then at the same time, the researcher and the 3 machinists checked the fuel oil injection pump and found signs of an oil leak in the fuel oil injection pump area, possibly due to a lack of attention and care for the fuel oil injection pump area, which resulted in a lot of dirt that interfered with the inlet pipe. fuel. Then the impact on the fuel pressure that drops because the working process on the plunger barrel is not optimal. So that the process of spraying fuel is reduced and the pressure drops.



Figure 2. Diesel Generator Fuel Pressure No. 1

Source: Engine Control Room MT. VIJAYANTI

In the picture above, you can see that the fuel pressure drops and then turns on the low fuel oil level alarm on the diesel engine generator number 1. Then the author and the three machinists do further checks by doing a test engine performance on the diesel engine in the engine room.

Table 1. Auxiliary Engine Performance

MT. VIJAYANTI - ANQING 4 STROKE DAIHATSU 5DK-20															
AUX ENGINE PERFORMANCE REPORT															
CYLINDER	AUX ENGINE NO.1					AUX ENGINE NO.2					AUX ENGINE NO.3				
Exhaust Gas Temp	305	295	321	310	320	380	380	360	370	350	458	454	446	439	430
Jacket CW Out Temp	47	43	50	51	52	60	60	57	58	54	74	72	70	67	66
Jacket CW Press	2,4 Bar					2,4 Bar					2,4 Bar				
LO In Press	3,6 Bar					3,4 Bar					3,8 Bar				
FO Press	4,0 Bar					6,0 Bar					6,0 Bar				
FU inlet temp	10/ °C					10/ °C					10/ °C				

Based on the results obtained after further checking there is a difference in fuel pressure between the diesel engine no. 1 and the diesel engine no. 2 and no. 3 where the fuel pressure in the diesel engine no. 1 has decreased to 4 bar while the diesel engine no. .2 and no.3 the pressure is stable at 6 bar according to the standards listed in the manual.

Data analysis

By analyzing and understanding the problems that exist in this study, the authors take an approach to find the main causes and problems that cause problems in the accommodation air conditioning system. The following are the problems that will be analyzed by the author, namely:

The working hours of the plunger barrel have exceeded the usage limit. This problem is caused by several factors, therefore the author tries to analyze several factors that can cause the plunger barrel to become damaged quickly and the stain lees plunger to break due to low fuel pressure so that the plunger barrel cannot operate optimally. The factors that cause these problems are as follows:

- a) The delay factor in doing PMS (Planned Maintenance System)

Based on the author's observations that in carrying out maintenance and checking the pressure of the fuel oil injection pump it is not in accordance with the PMS schedule.

There is no PMS application on the fuel oil injection pump.

- b) Fuel quality factor

Based on the results of observations, the authors found other factors that caused damage to the plunger barrel, namely the mixing of fuel with water, this was proven during an interview with the 3 driver. which is mixed with water

The fuel oil injection pump pressure area has a leak.

From the data obtained above, it is known that the fuel injection pump area has a leak, which causes the fuel oil injection performance to be not optimal and makes the fuel pressure drop. The author and the machinist III checked the fuel oil injection pump area. Then from the results of these checks , the writer together with the machinist III received instructions , wherein the instructions were recorded and analyzed so that the cause was known .

Troubleshooting

Seeing from the problems above where there are many ways and solutions to repair the damage that occurs to the plunger barrel and fuel oil injection pump, then there must be troubleshooting that must be done in order to increase the performance of the fuel oil injection pump to the maximum. Troubleshooting that can be used are as follows:

a. The plunger barrel operating hours exceed the usage limit.

Based on the problems that exist to overcome the damage to the *plunger barrel*, among others are: Organize and reschedule PMS (Planned Maintenance System) things that are done in managing and rescheduling PMS, among others: Perform data collection and reschedule; Request spare parts; Replacing spare parts whose working hours are up

b. Carry out overhaul and maintenance of the plunger barrel Based on the evaluation of the problems that occur, it is necessary to do overhaul and maintenance based on the manual book, including: Replace damaged parts with new ones; Taking tappet clearance measurements; Cleaning every disassembled component

c. Leaks in the fuel oil injection pump area.

Based on the problems that exist to overcome the damage to the *plunger barrel*, among others are: Doing an overhaul on the fo purifier. In carrying out an overhaul for purifier, several things to do are: Cleaning discs and bowls; Replacing the damaged main seal ring; Perform maintenance on the fuel oil injection pump; Perform maintenance based on working hours and manual book including; Check each valve; Clean dirty components; Reset according to manual book settings.

CONCLUSIONS AND SUGGESTIONS

Conclusions

After the author describes several things related to the problem of the plunger barrel and fuel oil injection pump on the MT ship. VIJAYANTI, it can be concluded that it would be useful on the ship, namely the 3rd engineer should not be late in implementing the *Plan Maintenance System (PMS)* so that the plunger barrel working hours do not exceed the limit and leaks in the fuel oil injection pump area are caused by damage to the bowl and main seal ring on the ship. fo purifier causing the process of separating fuel and dirt from the storage tank to the daily tank into a lot of mixed mud so that the fuel entering the fuel oil injection pump is not channeled properly, therefore it is necessary to overhaul the fo purifier.

Suggestions

From the conclusions above, the authors provide some suggestions for the problems that occur, namely as follows:

1. It is directed to the machinist III to carry out maintenance and checks on the plunger barrel and fuel oil injection pump in accordance with the rescheduled PMS.

2. In order to maintain normal fuel pressure and keep the daily fuel tank from containing water, it is mandatory for the on-guard oiler to carry out regular cleaning of the fuel filter every 1 month.

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