Exhaust Valve Leakage Analysis on Main Engine at KM. Tonasa Lines XV

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Abstract

The exhaust valve is one of the components on the main engine that functions to close and open the flow of exhaust gas from the combustion chamber or liner, both in four-stroke and two-stroke diesel engines. The research was carried out for ±10 months on the Tonasa Line XV ship. The purpose of this study was to determine the cause of the exhaust valve leak. Primary data were obtained directly through interviews with related parties. Secondary data is obtained from data collection institutions and published to the data user community, in this study in the form of journals in e-journals. The results obtained from research identification show that first: the occurrence of spindle and seat valve wear due to a lack of maintenance systems, second: excess working hours of exhaust valves, third: clogged cooling water system. The identification of the research found that the cause of the exhaust valve leak was due to worn spindle and seat valves, excess working hours and blockage of the cooling water path. The ways that can be done to avoid damage are by grinding the spindle and seat valve, maintenance according to working hours, and cleaning the cooling water.

Keywords: Analysis, Valve, Spindle

1. Introduction

The ship has a main engine (Main Engine) which serves as a driving shaft for the propeller to rotate, so that the ship can move from one port to another. The main engine has many supporting components to support the smooth work of the main engine. One of the supporting components of the parent engine is the exhaust valve. The exhaust gas valve serves as a place for the exit of residual combustion gases from the liner or combustion chamber. The exhaust valve is a valve that is used as an opening point for the remnants of combustion gases as an exhaust duct. The valve serves as a discharge of residual combustion gases, in which the opening and closing time of the valve is regulated according to the valve mechanism, another function of the exhaust valve is to transfer heat from the combustion chamber to the exhaust

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duct. [Pongkessu, Paul et al (2019:50)]. The role of the exhaust valve cannot be ignored, because the exhaust valve has a very important role in the smooth work of the main engine as the main driving engine. Therefore, it needs to receive attention and maintenance regularly so that the engine can work well during the voyage. A Planned Maintenance System (PMS) is required.

On the ship where the research uses the main engine with a diesel motor type 2 Stroke diesel engine with 6 cylinder, diesel motor type Mitsubishi UE Diesel Engine type 6UET/75C. On October 15, 2021, the ship will depart from Biringkassi (Indonesia) to Sorong (Indonesia). At the beginning of the voyage the engine works normally the engine sound is heard normally and the temperature of the average exhaust gas temperature of each cylinder is 240-280° when full away. At the time of The Machinist’s watch II precisely at 00-04 WIT when the ship began to enter the sinister sea there was an unusual sound in the cylinder number 1 and also the temperature of the exhaust gas temperature was high around 330°. The head of the engine room (KKM) took action by lowering the RPM (Revolutions per Minute) speed because there was an unusual sound and the exhaust gas temperature increased. The head of the engine room (KKM) requested an order to the bridge to Stop the engine and immediately make repairs. The skipper determines the right position for the next berth, the KKM immediately lowers the ship’s speed from the Full Away position to the Engine Stop position. KKM immediately ordered to immediately make repairs. At the time of repair found damage to the Exhaust valve that causes leakage. After repair and replacement of exhaust valve Spare parts, the main engine can be operated normally again.

Based on the experiences and events experienced by the author during the practice of the sea, the author raised the title “Exhaust Valve Leakage Analysis on Main Engine at KM. TONASA LINES XV”.

2. Research Methodology

Research methods used in the delivery of the problem is a qualitative descriptive method, to describe and describe the object in the research. The definition of descriptive is a writing that describes the actual situation with the object in the study. Descriptive is a writing that describes the actual situation and according to the actual situation at the time of direct research. According to Narbuko (2015), descriptive research is research that seeks to tell the current problem solving based on data, by presenting, analyzing and interpreting it. According to Arikunto (2019), descriptive research is research that is intended to investigate circumstances, conditions or other things that have been mentioned, the results of which are presented in the form of a research report. Therefore, in the later discussion, the author tries to explain the results of all studies and research on an object obtained. The thing that was observed was the analysis of exhaust valve leakage on the main engine in KM. TONASA LINES XV.

3. Results and Discussion

Based on the analysis of the above problems, the treatments are:

1. Causes of rising exhaust gas temperature in the main engine

   The increased exhaust gas temperature on the main engine will have an influence if left unchecked it will cause greater damage to other main engine components, such as the exhaust valve component parts. Rising exhaust gas temperature can be caused by many causes, as for some of the factors that cause rising exhaust gas temperature, namely:
a. Incomplete fogging or spraying of fuel in cylinders
   One of the causes of rising exhaust gas temperatures on the main engine is because the injector is not working properly, caused by wear and blockage of dirt on the injector nozzle.

b. Suboptimal cooling
   Insufficient cooling of the parent engine will lead to an increase in temperature. Decreased cooling performance can be caused by several causes, such as the bearing of the freshwater pump experiencing wear and jammed, leakage in the freshwater pipe, and blockage of the course of fresh water to the main engine will make the temperature will increase.

c. Less lubrication performance
   Non-optimal lubrication will cause a rise in temperature in the exhaust gases. Due to the decrease in lubrication performance, the piston experiences wear which results in an increase in temperature on the main engine.

d. Leakage in the exhaust valve
   The increase in exhaust temperature of the main engine can also be caused by a leak in the exhaust valve, the compression process is not perfect because the compressed air can come out through the hole in the Seat and Spindle Valve.

Based on the events or problems that have been experienced by the author at the time of research, after observation and checking the cause of increased exhaust gas temperature on the main engine in KM. Tonasa Lines XV is on the exhaust valve leak.

2. The factors that cause leakage of the exhaust valve on the main engine:
   a. On the valve spindle and valve seat wear occurs
      Wear on the valve spindle and valve seat can be seen by the appearance of scratches or holes holes on the surface of the exhaust seat valve and exhaust spindle valve settings both always intersect causing scratches and holes can appear. Which is usually caused by the rinse air entering the cylinder or combustion chamber is less clean and there is still water content mixed with air. In the process of flushing the air must be really clean, because the water will become hot when the combustion process occurs so that the heat can cause damage, namely the appearance of scratches or holes on the surface of the valve seat and Valve spindle settings, but it can also cause residues to stick to the rest of the combustion products and accumulate causing scale.

      The air entering the combustion chamber comes from the air in the engine room, the air is sucked by the turbocharger and then cooled by the intercooler after which the air enters the receiving chamber rinse air or scavenging air receiver and proceed to the combustion chamber in the cylinder liner. For the initial start of the engine when the position is still dead slow and slow when the engine speed is still below 155 RPM, an auxiliary blower is needed to suck air from the intercooler and be pushed into the combustion chamber. The cause of the presence of water content in the rinse air is caused in the intercooler there is water that has settled for a long time because the air chamber drain valve on the intercooler has never been checked and cleaned, so the water goes into the rinse chamber.
b. Material fatigue factor or excess limit of working hours
   This material fatigue factor is common when moving parts have exceeded working hours. Therefore, the planned maintenance system must run on schedule according to the instruction manual book to overhaul/replace with new spare or repair/replacement with new spare on the exhaust valve. However, sometimes repairs are not carried out according to schedule due to several factors such as the unavailability of sufficient time to carry out repairs due to the crowded shipping schedule. Things like this are the cause of fatigue in the exhaust valve because it is time for the exhaust valve to be replaced with new parts but the exhaust valve is still used past the working hour limit, it is natural to cause damage to the exhaust valve. There are still many shipowners who do not care about the working hours of an engine. Usually wait until the engine is damaged New repairs or replacement of new spare parts on the exhaust valve components. As a result of late anticipation it can cause more severe damage. In addition, sometimes the limitations of existing spare parts on board also cause delays in maintenance and replacement of engine components do not fit the schedule of working hours.

c. Wear on guide ring and sealing ring
   Wear on the guide ring and sealing ring will cause the control wind pressure is not optimal in pushing the valve spindle. Usually caused by a mixture of water entering the wind control used to push the piston on the exhaust valve. With the entry of water in the cylinder and pushing the piston on the exhaust valve continuously, there will be friction between the water with the guide ring and the sealing ring which will cause damage to the component. If the sealing ring and guide ring are damaged, the control wind pressure will escape and leak. As a result, there will be a delay in pushing the valve spindle which will cause an abnormal sound in the exhaust valve due to a collision
between the valve spindle and the parent engine piston.

d. Suboptimal cooling
The wall on the exhaust valve and its surroundings will be heated by the exhaust gas. Therefore, to prevent excessive heat and deformation of the component, it needs to be cooled, less cooling in the valve housing will cause damage to the valve seat or valve seat and will also affect the valve spindle, which collides directly with the valve seat. The exhaust valve heat absorption process occurs between the valve leaf contact and the valve seat that collide with each other, in these two components there is a heat delivery process from the valve leaf to the valve seat through the surface that is in direct contact with the valve seat, if the heat absorption process is not optimal, it will affect the high temperature of the exhaust valve from the normal temperature which will cause damage to the exhaust valve components. Lack of maximum cooling on the valve is usually caused by a blockage in the passage of fresh water in the seating. Cooling water is useful to absorb heat from the engine so that the engine's working temperature remains normal. Therefore, in order for the absorption of heat in the exhaust gas valve to work properly, the components to be cooled must be clean, there is no blockage due to impurities such as mud, dirt and crust that are usually found on the valve seat.

![Figure 3. Valve Seat Blockage](image)

3. Causes of Planned Maintenance System does not run properly and on schedule:
   a. Managerial
      This obstacle is usually caused by differences of opinion regarding management in preparing schedules and SOP procedures in work arrangements.
   b. Operations
      These barriers usually arise from organizational operations, usually from individual characters, organizational attachment relationships, and existing rules in the organization.
   c. Organization
      These obstacles usually arise due to problems that exist within the organization such as organizational structure, differences of opinion in the organization, and the organization is less conducive.
   d. Personal
      These barriers are usually caused by individuals within the organization itself that are not in line with the existence of sops in an organization.
4. The damage that can occur due to leakage of the exhaust valve is:
   a. The occurrence of damage to the components of the parent machine
      The exhaust valve has a very important role in the smooth work of the main engine. In the exhaust gas valve there are components that intersect each other, namely between the valve spindle and the valve seat. This must be considered for the rinse air that will enter the combustion chamber must be free of water content if there is still water content then this is what can make the valve leaf and valve seat wear with the appearance of scratches and holes if left unchecked it will cause damage to other components and the course of the engine work, resulting in compression is not optimal and will also result in delays in pushing the valve spindle which will cause abnormal sound due to the valve spindle colliding with the parent engine piston.

5. How to solve the cause of the exhaust valve leak on the parent engine
   Inspection and maintenance and repair of exhaust valves must be carried out carefully and maintain safety.
   a. Perform grinding on spindle and seating
      Scratches and holes that occur on the spindle and valve seat can be overcome by grinding using a special grinding machine on board. By means of placing the valve stem to the grinder, after the grinding stone part and the valve lip intersect, adjust the maximum size of 0.05 mm this is done to reduce the amount of material lost during the grinding process. If the damage to the spindle and seat is still within normal limits and not too severe then grinding can be done manually. By clamping the valve head with a special tool and then fastened with bolts, then the valve lip is given a grinding paste to facilitate the surface leveling process, the valve is rotated left and right while being slammed into the valve seat. This process continues until the surface is flat and the valve face can close tightly with the valve seat to prevent leakage.

   ![Figure 4. Reconditioning Of Valve Spindles And Valve Seats](image)

   b. Cleaning the air chamber rinse every month
      Rinse air that enters the cylinder there is still water content in it mixed with air. Due to the large amount of combustion carbon mixed with water in the rinse chamber, you should perform maintenance at least once a month to clean the rinse air chamber by using diesel until it is clean and dry. Dirt in the rinse air chamber is usually in the form of sludge, namely carbon from combustion and water that mix. These sludge deposits can ignite and interfere with the flow of rinse air and combustion in the cylinder.
c. Clean rinse air chamber spout valve

Usually on this spout valve there is often a blockage by dirt in the form of sludge from combustion residues mixed with oil and water so that dirt cannot flow out of the spout valve. This spout valve must be fully opened when the parent engine stops so that the existing dirt flows out.

Figure 5. Rinse Air Chamber Cleaning

Figure 6. Flush Air Spout Valve Cleaning

d. Clean the air chamber spout valve on the intercooler

The air around the engine room chamber is sucked by the turbocharger and then cooled by the intercooler after cooling the air enters the rinse air chamber from the Flushing chamber is passed into the combustion chamber. Inside the intercooler the incoming air is cooled using a fresh water medium before entering the combustion chamber. Therefore, treatment should be done by cleaning and removing the water content in the intercooler through the spout valve so that the rinse air entering the combustion chamber is free of water content.

e. Replacement of guide ring and sealing ring

Due to the absence of the original spare parts, the replacement of the guide ring and sealing ring uses parts that are not original and used. So that this becomes one that must be considered because the use of spare parts that are not original or used has a risk that can be re-damaged at an unwanted time before the limit of working hours. Because the quality of the durability of original parts is different from non-original and used. Therefore, the replacement of these parts must be a special concern for the crew for the smooth operation of the ship.
f. Perform cleaning of the cooling water on the valve seat
   In this treatment effort is done by treating the cooling water by providing chemical
   engine water treatment and cleaning the cooling water holes. Dirt contained in the
   valve seat can inhibit the flow of cooling water. If the cooling of the valve House is
   reduced, it will cause the temperature around the valve house to increase and cause
damage, especially to the valve seat which will be eroded due to the combustion
   process.

g. Take care of the housing valve
   Take care to routinely check the cooling holes on the valve housing so that the
   cooling is evenly distributed and does not overheat the valve House, and clean the
   valve house from the remnants of combustion carbon that sticks.

   ![Figure 7. Maintenance on Housing valve](image)

h. Perform maintenance and repair on fresh water cooling system components
   The action taken if there is a decrease in cooling is to increase the capacity of the
   water cooler in this case by looking at the pressure of the fresh water cooling pump
   around 2.5 -3.0 kg/cm². if the pressure of the pump is reduced then check the
   suction and dirt in fresh water, the dirt if left will inhibit the flow of fresh water from
   the expansion tank to be sucked into the pump. Then check back and make sure that
   the suction faucet and fresh water faucets are fully open, if closed or half open
   resulting in water entering the machine less than the maximum.

i. Replacing fresh water coolant pump bearings
   The decrease in cooling performance in fresh water can be caused also by the pump
   bearings that experience wear and jam this causes the pump to drain fresh water to
   the exhaust valve does not work optimally. Therefore, the replacement of bearings
   with new parts and do not forget to provide lubricant/grease during installation.
j. Make repairs to fresh water cooling pipes that leak
   Leakage in the cooling pipe is also one of the causes of the decline in cooling performance on the main engine, therefore, remedial action must be taken by welding porous pipes or replacing them with new ones, and replacing the packing on the pipe connection because it will affect the amount of fresh water that enters the main engine.

k. Perform planned maintenance system implementation on schedule
   One thing that must be considered to anticipate leaks in the exhaust valve is the implementation of a planned maintenance system on schedule so that the working hours of the exhaust valve do not exceed their limits. What must be done so that this treatment is carried out properly is to communicate between the ship and the company about the exhaust valve replacement schedule before working hours run out, Besides that both parties coordinate with each other the problem of the availability of spare parts on board this also sometimes results in working hours of exhaust valves over the limit. The importance of coordination between the two parties to support the success of the planned care system, considering that treatment and repair are things that can not be delayed. For the issue of repair and maintenance time, the ship and the company in order to coordinate with each other so as not to collide with the ship’s operational schedule, there must be good communication between the ship and the company so that the implementation of maintenance and repair according to the planned schedule and ship operations
become smooth.

6. Planned maintenance system against exhaust valves
   Planned maintenance System is a maintenance system that is carried out on machinery parts and other equipment on the ship in a planned and continuous manner in order to extend the life of the engine part and avoid unwanted damage. The implementation of STDs becomes part of the examination. The goals of the treatment are:
   a. Extend the life of the machining parts.
   b. Ensure the maintenance of ships in accordance with a predetermined schedule.
   c. To avoid damage when the ship is in operation.
   d. to improve the reliability of the vessel during Operation.

4. Closing

a. Conclusions

   1) The cause of leakage in the exhaust gas valve due to the condition of the valve seat and valve spindle that are worn out scratches and holes affect combustion performance.
   2) There is still water content in the intercooler and the rinse air spout chamber valve so that the air entering the combustion chamber still contains water.
   3) To prevent the sealing ring and guide ring from wearing out, it is tried to keep the control air entering the cylinder free of water content.
   4) Lack of communication between the ship and the company regarding the schedule of machine maintenance and the availability of spare parts on board so that maintenance is often late which results in machine components experiencing excess working hours.
   5) Decreased cooling performance in the engine so that the temperature rise in the exhaust valve components that can cause damage to the exhaust valve components.
   6) The management of the organization must have maturity in its organization and be able to arrange new rarities in an effort to improve performance in implementing SOPs.

b. Suggestion

   1) Rinse air entering the cylinder must be free of water content to maintain the condition of the valve seat and Valve spindle remain tight and tight.
   2) Perform maintenance cleaning of the rinse air chamber once every month from carbon impurities and sludge so that the rinse air entering the cylinder is clean of water content.
   3) Create good communication between the ship and the company regarding the planning of maintenance and repair schedules and communicate about the availability of spare parts on board. In order to create a system of scheduled and well-planned care.
   4) Checking the condition of the coolant pump performance whether during the voyage or not, checking includes faucets, coolant pump bearings, and also coolant pump pipes.
   5) Improve the SOP so that the performance in the company runs smoothly and makes it easier for the company to advance an organization.