

Analysis of the Declining Work of Injectors on the Combustion of Diesel Engines on Mt. Edricko 8

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ABSTRACT

The fogging of fuel into the combustion chamber is determined by the good condition of *the nozzle* on the injector. If the *nozzle* is in a state of constraint, then the *nozzle* cannot fog fuel optimally. This study aims to analyze the factors that cause the decline in injector performance to the combustion process of diesel engines on the mt. Edricko 8 ship. This research was carried out on board the mt. Edricko 8 ship owned by pt. Bitumen marasende for one year. To carry out research by taking data on the object being researched related to the title. The results of the study show that the decreased performance of the injector to the combustion process of the diesel motor is the clogging of *the nozzle* hole due to dirty fuel due to lack of maintenance of the supporting components of the fuel system, incomplete combustion causing carbon attached to the surface of the nozzle tip and dripping of fuel on the *nozzle* which results in the formation of gases in the combustion chamber.

Keywords: *Injector, Nozzle, Diesel Engine.*

ABSTRAK

Pengabutan bahan bakar ke dalam ruang bakar ditentukan oleh bagus tidaknya kondisi *nozzle* pada injektor. Bila mana *nozzle* tengah dalam keadaan berkendala, maka *nozzle* tidak bisa mengabutkan bahan bakar secara optimal. Penelitian ini bertujuan untuk menganalisis faktor-faktor yang menyebabkan menurunnya kinerja injektor terhadap proses pembakaran mesin Diesel di kapal Mt. Edricko 8. Penelitian ini di laksanakan di atas kapal Mt. Edricko 8 milik PT. Bitumen Marasende selama satu tahun. Untuk melaksanakan penelitian dengan mengambil data – data pada objek yang diteliti yang berkaitan dengan judul. Hasil penelitian menunjukkan bahwa menurunnya kinerja injektor terhadap proses pembakaran motor Diesel adalah tersumbatnya lubang *nozzle* akibat dari bahan bakar yang kotor karena kurangnya pemeliharaan terhadap komponen pendukung sistem bahan bakar, pembakaran tidak sempurna sehingga menyebabkan adanya karbon-karbon yang menempel pada permukaan ujung *nozzle* dan menetesnya bahan bakar pada *nozzle* yang mengakibatkan pembentukan gas dalam ruang bakar.

Kata Kunci : Injektor, Nozzle, Mesin diesel.

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1. INTRODUCTION

Ships play a crucial role in the global transportation system, both for passenger mobility between islands and for logistics distribution in international trade. The smooth operation of the ship does not only rely on the main engine as the main driver, but is also supported by the synergy of various auxiliary machinery. Generally, this drive system uses an internal *combustion engine mechanism*. In the system, there is a vital component called a nozzle that is responsible for distributing and speeding the fuel precisely into the *combustion chamber*.

MT. EDRICKO 8 uses a Diesel Engine that must be properly maintained so that the diesel engine works optimally. Injectors as fuel dispensing and atomizer components play an important role in diesel engine operations, nozzles that are not in the best condition will result in fuel delivery and fogging that are not optimal. Symptoms that can result from nozzle damage include reduced fuel flow, dripping nozzles so that engine torque output decreases and damage other components in the chamber. As a prospective driver, you need to prepare yourself so that you can identify, maintain the engine, and repair engine components if there is damage, including the nozzle components. The author got a case of nozzle problems that the author experienced when carrying out PRALA on the MT ship. EDRICKO 8 senipah was on March 27, 2023, when the ship was moving to Ciwandan and Morowali. At that time the writer was on duty at 00.00 – 04.00 stand by ECR (*Engine Control Room*), and when the writer went down to check the main engine and generator motor I saw that the exhaust gas temperature of the main engine on my ship had an increase in the exhaust gas in cylinders no 2 and 5 normal exhaust gases on the MT ship. EDRICKO 8 is 300^{oC} to 350^{oC} degrees rose to 500^{oC} and 400^{oC} the incident was immediately reported to massinis 3 who was on guard with the writer and massinis 3 went down to check that thick black smoke was seen on the chimney. Stating that there is a problem in the fuel distribution of massinis 3, it is suspected that there is damage to the injectors in cylinders nos. 2 and 5. As a result of this

incident, *the engine crew* will carry out checks and repairs on the main engine after the ship has finished processing and docking.

Therefore, it is important to neutralize the effect of the decrease in injector pressure on the combustion process in the main motor engine. A deep understanding of the relationship between injector pressure and combustion characteristics can be the basis for preventive maintenance measures, fuel system improvements, as well as improved operational efficiency on board. This study aims to examine how a decrease in injector pressure affects combustion efficiency, engine performance, as well as its impact on fuel consumption and exhaust emissions in the ship's main engine. It is hoped that the results of this study can contribute to system optimization efforts in ship diesel engines.

2. METHOD

The author applies the qualitative experimental method of this researcher. The selection of the method is based on the fact that the source of the data is based on the observation of the performance of the injector, even before it is used after the injection is carried out. The technical data that is collected is to use a numerical pairaimeter such as a calculator to work on injectors and fluctuations in the temperature of the main engine in the MT engine. Edricko 8. The use of this aingkai baitaii is aimed at making the aillisis of the country objective, measurable, and has a high vailiditais.

The research approach is carried out through two different methods: *Field Research*: Conducted through observational studies in kaipail during the period of the practical period to obtain the real operational of the machine.

Library Studies (Librairy Reseairch): Prepared by studying various scientific literature, engineering journals, and machine manuals related to the injection system of baikair injection.

3. RESULTS AND DISCUSSION

3. 1. Specimen Data Of Objects Studied

1. A brief history of mt. Edricko 8

Mt. Edricko 8 is a tanker that loads asphalt this ship has an overall length of 97.0 meters and a width of 15.7 meters, and has a gross tonnage of 3321 tons.

And equipped with an akasaka four-stroke main engine, type a-41, normal output of 3,300 hp x 230 rpm. And supported by auxiliary engines (auxiliary engines 1, 2, and 3) yanmar type s 165 l (420ps 1200 rpm x 3 units). Auxiliary engine 4 perkins type tu 6 3544 series (82 ps 1800rpm). The specification of the main engine fresh water cooler used in the main engine at mt.edricko 8 is type fch2f-25biu. This main engine fresh water cooler uses fresh water media to cool the main engine.

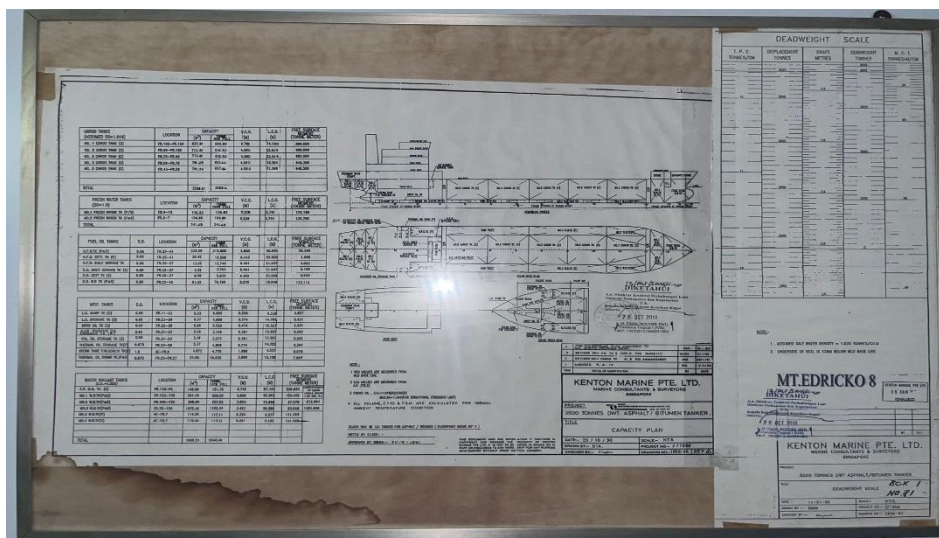
Figure 3. 1 kapal mt. Edricko 8



Source: mt ship. Edricko 8

The following are the data from the ship where the author conducted research while carrying out marine practice in mt. Sambu, is as follows:

Figure 3. 2 ship particular mt. Edricko 8



Source: mt ship. Edricko

2. Pictures of injector components

an injector is a component in an internal combustion engine that functions to spray fuel into the combustion chamber in a controlled manner. Injectors play a key role in the combustion process by ensuring that fuel is optimally blended with the air, resulting in efficient combustion and reducing exhaust emissions.

Figure 3. 3 injector components



source : mt ship. Edricko 8

Injectors consist of several injector components and have their own tasks and functions, for more details, here are the injector components:

- a. *Nozzle*: is spraying fine fuel, regulating spray patterns, and optimizing combustion.
- b. *Holder*: holds the *nozzle* in position, ensures proper installation, and prevents fuel leakage during the spraying process.
- c. *Spindle guide*: keeps the *spindle* shaft straight, ensures stable spindle up-down movement, and supports fuel spraying accuracy.
- d. *Spring*: functions to restore the *spindle/valve* and regulate the fuel injection pressure.
- e. *Cut-off*: stops the flow of fuel to the *nozzle* quickly and precisely after spraying is complete, preventing fuel leakage, and ensuring combustion efficiency.
- f. *Housing*: protects the injector's internal components (*such as nozzles, spindles, and springs*), provides a sturdy structure, and ensures the safe

installation of the injector to the machine

- g. The injector body houses and protects the internal components of the injector.

3. How the injector works

The fogging process begins when the high-pressure fuel from the injection pump flows through the internal line to the needle valve *nozzle*. When that fuel pressure exceeds the pressure force threshold of the regulating spring, the needle valve will be lifted from its seat. The lifting of this needle opens a hole *nozzle*, so that the fuel is sprayed in the form of a fine mist into the combustion chamber of the cylinder. Conversely, as soon as the pump stops supplying pressure, the spraying process will stop and the spring force will push back the needle valve to close the hole *nozzle* with tightness.

The amount of injector opening pressure can be adjusted by adjusting the spring tightness level via the adjusting bolt on the injector housing. To maintain the responsiveness of the system, the cavities in the body *nozzle (nozzle body)* must always be in a fully charged condition by fuel. After the spraying cycle ends, the remaining fuel that functions as an internal component lubricant and is not fogged will be reflowed. This residual fuel passes through the return channel (*return line*) to the overflow tank (*overflow tank*) to be circulated back into the system.

4. Data analysis

The data on the injector performance in table 4.1 normal injector conditions, 4.2 abnormal injector conditions, 4.4 injector conditions that have been improved, in the manual book normal

Exhaust gas temperature of the main engine 325°C - 370°C in connection with the title raised as a comparison material taken through research while conducting marine practice on mt ships. Edricko 8 is as follows:

Table 4. 1 normal exhaust gas conditions

About cyl	Rpm	Rack	Lo m/e		Jacket temp	Exh gas temp
			In	Out		
1	190	6,5	50	46	50	300
2	190	6,5	50	46	55	300
3	190	6,5	50	46	55	310
4	190	6,5	51	46	55	300
5	190	6,5	51	46	55	300
6	190	6,5	50	46	55	315

Source: mt ship. Edricko 8

figure 4. 4 running hour f.i.v

VESSEL		MT EDRIKO 8		MONTH OF		MARET		PT. BITUMEN MARASENDE												VESSEL		MT EDRIKO 8									
IMO.NO		9034224		YEAR		2025														IMO.NO		9034224									
Planning Maintenance and hours record of MAIN ENGINE (TYPE)(HP)(RPM)																															
Date	Daily	TOTAL R/H	CRANKSH BEARING						MAIN BEARING						INLET VALVES						Date	Daily	TOTAL R/H								
			20000-30000						24000-30000						3000-8000									Std.RH							
BMH			1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3		4	5	6	1			
0	13650	52.4	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	7	0	13649	84.4							
1	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	8	0	13649	84.4							
2	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	9	0	13649	84.4							
3	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	10	0	13649	84.4							
4	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	11	0	13649	84.4							
5	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	12	0	13649	84.4							
6	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	13	3.2	13653	87.6							
7	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	14	0	13649	84.4							
8	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	15	0	13649	84.4							
9	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	16	0	13649	84.4							
10	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	17	0	13649	84.4							
11	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	18	0	13649	84.4							
12	0	13650	52.4	52.4	52.4	52.4	52.4	13737	13737	13739	13737	13737	13737	13737	84.4	84.4	84.4	84.4	2.3	84.4	19	0	13649	84.4							
13	3.2	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	20	0	13652	87.6							
14	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	21	0	13652	87.6							
15	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	22	0	13652	87.6							
16	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	23	0	13652	87.6							
17	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	24	0	13652	87.6							
18	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	25	0	13652	87.6							
19	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	26	0	13652	87.6							
20	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	27	0	13652	87.6							
21	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	28	0	13652	87.6							
22	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	29	0	13652	87.6							
23	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	30	0	13652	87.6							
24	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	31	0	13652	87.6							
25	0	13653	55.6	55.6	55.6	55.6	55.6	13740	13742	13740	13740	13740	13740	13740	87.6	87.6	87.6	87.6	5.5	87.6	32	0	13652	87.6							
26	2.4	13655	58	58	58	58	58	13743	13744	13743	13743	13743	13743	90	90	90	90	2.4	7.9	90	27	0	13655	90							
27	0	13655	58	58	58	58	58	13743	13744	13743	13743	13743	13743	90	90	90	90	2.4	7.9	90	28	0	13655	90							
28	0	13655	58	58	58	58	58	13743	13744	13743	13743	13743	13743	90	90	90	90	2.4	7.9	90	29	0	13655	90							
29	0	13655	58	58	58	58	58	13743	13744	13743	13743	13743	13743	90	90	90	90	2.4	7.9	90	30	0	13655	90							
30	0	13655	58	58	58	58	58	13743	13744	13743	13743	13743	13743	90	90	90	90	2.4	7.9	90	31	0	13655	90							
31	0	13655	58	58	58	58	58	13743	13744	13743	13743	13743	13743	90	90	90	90	2.4	7.9	90	32	0	13655	90							
Total	5.6																				Total	5.6									

Source: running hour main engine mt ship. Edricko 8

Table 4. 2 abnormal exhaust gas conditions

Ab out cyl	Rpm	Rac k	Lo m/e		Jack et tem p	Exh gas tem p
			In	Out		
1	190	6,5	50	46	50	240
2	190	6,5	50	46	55	410
3	190	6,5	50	46	55	320
4	190	6,5	51	46	55	300
5	190	6,5	51	46	55	400
6	190	6,5	51	46	55	250

Source: mt ship. Edricko 8

Table 4. 3 test the injector pressure after repair

No injector	Pressure atomization	Conditions	Conclusion
1	240 bar	Normal	Wearable
2	250 bar	Normal	Wearable
3	240 bar	Normal	Wearable
4	250 bar	Normal	Wearable
5	250 bar	Normal	Wearable
6	250 bar	Normal	Wearable

Description:the injector has been repaired and the pressure reaches 250 bar resulting in perfect fuel fogging and no fuel dripping on the *nozzle*.

3.2. Application of the Ultrasound Method

The ultrasound (urgency, seriousness, growth) method is a method of analysis used to determine the priority of problems based on three main aspects, namely: urgency, seriousness, and growth.

a. Urgency describes the level of urgency of a problem to be truly corrected.

The more urgent a problem is, the higher the level of urgency.

- b. Seriousness calculates how much of a negative risk it can pose if the problem is not addressed.
- c. Growth shows the potential for a problem to develop bigger and more complex if not handled properly. Each problem will be given a score using a scale of 1-5 based on these three aspects. A problem with the highest total score is a problem that is a top priority in a study.

Table 4. 4 scale

1	Very small
2	Small
3	Medium
4	Large
5	Very large

3.3 . Problem Priority Questionnaire Using the Ultrasound Method

The following are the results of the priority questionnaire on the problem of declining injector work on the combustion process of diesel engines on board mt ships. Edricko 8 out of 10 respondents

Table 4. 5 total questionnaire results

Yes	Causative factors	Ultrasound			Total	Priorities
		U	S	G		
1	Nozzle hole blockage due to dirty fuel	40	40	35	115	1
2	Wear on injector components (springs and nozzle needles)	36	36	33	105	2
3	Water contamination in the fuel system	20	15	20	55	3
4	Failure to perform regular injector pressure testing	40	10	10	60	5
5	Lack of periodic treatment of the injector	10	10	11	31	4
6	Parts are not original	12	10	9	31	5
7	Adjusting nozzle changes due to engine vibration	9	9	10	28	7

Likert scale ultrasound method7

Table 4. 6 ultrasound

U (urgency) The urgency of the problem	S (seriousness) The seriousness of the problem	G (growth) Growing problems
1 : very unurgent	1 : very serious	1: very undeveloped
2 : not urgent	2 : not serious	2: not developing
3 : urgent enough	3 : quite serious	3: grow fast enough
4 : urgent	4 : seriously	4: grow fast
5 : very urgent	5 : very serious	5: very fast growing

Based on the results of the analysis using the ultrasound method, it is known that of the 7 factors that cause the decrease in injector work on the combustion process of the diesel engine on board, there are 2 factors that have the most significant impact, namely:

1. Nozzle hole clogging due to total dirty fuel : 115
2. Wear on injector components (springs and nozzle needles) total : 105

Both factors have a high level of urgency and seriousness, as they directly affect the air compression process. If not treated immediately, this damage can cause interfering with fogging , incomplete combustion, unstable exhaust gas temperature, and causing overheating or underheating in certain cylinders.

Therefore, the top priority of maintenance and inspection should be focused on the inspection and maintenance of the injectors, so that the ship's pneumatic system remains reliable and supports the safety and smooth operation of the vessel.

4. CONCLUSION

Based on the results of observations, injector pressure testing, exhaust gas temperature analysis, and ultrasound methods that have been carried out on board the Mt. Edricko 8 ship, it can be concluded as follows:

- A. The decrease in injector work greatly affects the efficiency of the diesel engine combustion process. Injectors with substandard fogging pressure (270-280 kg/cm²) cause poor fuel atomization, resulting in incomplete combustion and a

drastic increase in exhaust gas temperature.

- B. The main factors that cause decreased injector performance are, nozzle hole clogging due to dirty fuel, wear and tear on injector components. These two factors were obtained as the highest priority from the results of the analysis of the ultrasound method with the highest total score compared to other factors.
- C. After maintenance, such as cleaning and resetting the injector, as well as replacing worn components, the injector pressure returns to normal (360-371 kg/cm²), and the exhaust gas temperature is stable again in the range of 340-350°C. This shows that regular maintenance and checks are very important in maintaining the performance of diesel engines.
- D. Irregularities in injector pressure testing and fuel system maintenance are factors that cause recurring problems. This can be prevented with more disciplined treatment management.

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