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Scientific Articles

Analysis Of Caterpillar C15 Fuel Filter Modifications In The Laiwui Electricity Center

Analisis Modifikasi Filter Fuel Caterpillar C15 Di Pusat Listrik Laiwui

Muhammad Ridwan[1*], Iwan Gunawan[2], Said Hi Abbas[3**]

[1]PT. PLN (Persero) Ternate City Area, Maluku, Indonesia

[2]Department of Mechanical Engineering, Faculty of Engineering, Khairun University

**Corresponding author*: iwan99gun@unkhair.ac.id

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Abstract

Today the development of technology is very rapid both in the field of basic science and the modification of a tool and even modifications in the field of engines, both combustion engines and electric engines. Modifications are needed to improve the performance of a machine. Modifications that can be applied to diesel engines that use fuels such as MFO, diesel, and biosolar. Diesel oil is the result of distillation of petroleum which is used only as fuel for compression ignition engines used by injectors. Biodiesel or biosolar is a type of fuel made from vegetable oil. The main objective of developing biodiesel is to substitute fossil fuels to produce green, environmentally friendly energy. The research we conducted was on the Caterpilar C15 Engine at PLTD Laiwui, and used biodiesel fuel (B30). Data collection is carried out when the machine is operating normally. From the data, we process it by analyzing it so we can find the main problem. From the results of the analysis, we get the root of the problem, namely the engine often shuts down because the pressure drops in the fuel system, this is caused by a dirty filter. From the results of the analysis, the researchers made a plan to modify the fuel system on the Caterpilar C15 engine at PLTD Laiwui. The modification applied is to add a material filter before entering the machine. then a performance test was carried out for 1 week and the modified data was compared with the initial data before the modification.

Keywords: Catterpilar C15 engine, Diesel engine, biodiesel (B30)

Abstrak

Dewasa ini perkembangan teknologi sangan pesat baik di bidang ilmu dasar maupun modifikasi suatu alat bahkan modifikasi di bidang mesin baik mesin pembakaran maupun mesin listrik. Modifikasi sangat diperlukan untuk meningkatkan kinerja dari suatu mesin. Modifikasi yang bisa diterapkan seperti pada mesin Diesel yang menggunakan bahan bakar seperti MFO, Solar, Dan Biosolar. Minyak solar merupakan hasil destilasi minyak bumi yang digunakan hanya sebagai bahan bakar mesin Compresion Ignation digunakan injector. Biodiesel atau biosolar adalah jenis bahan bakar yang terbuat dari bahan minyak nabati. Tujuan pokok pengembangan biodiesel ini adalah untuk mensubstitusi bahan bakar fosil agar menghasilkan energi hijau ramah lingkungan. Penelitian yang kami lakukan adalah pada Mesin Caterpilar C15 di PLTD Laiwui, dan menggunakan bahan bakar biosolar (B30). Pangambilan data dilaksanakan waktu mesin beroprasi normal. Dari data kita olah dengan menganalisa sehingga dicari dapat permasalahan pokoknya. Dari hasil Analisa dan didapat akar permasalahannya yaitu mesin sering mati karena tekanannya turun pada sistem bahan bakar, ini diakibatkan karena filter yang kotor. Dari hasil analisa peneliti membuat rencana untuk memodifikasai sistem bahan bakar pada mesin Caterpilar C15 di PLTD Laiwui. Modifikasi yang diterapkan yaitu menambahkan saringan bahan bakar sebelum masuk ke mesin. Kemudian baru dilakukan uji kinerja selama 1 minggu dan data hasil modifikasi dibandingkan dengan data awal sebelum modifikasi.

Kata Kunci: Mesin Catterpilar C15, mesin Diesel, biosolar (B30)

1. Introduction

Fuel is one of the most important components in the internal combustion engine system. PLTD Laiwui uses diesel fuel which is supplied from the Pertamina Ternate Depot. The diesel fuel used is Biosolar type B-30. In the business process of distributing electricity to customers, PLN is required to maintain the quality and reliability of electricity. So that interference in the machine must be prevented as much as possible. There are many factors that cause an engine to trip, if it is not followed up or prevented, the production process at the plant can be disrupted and it will be detrimental to the company if things like this happen frequently.

There are several engines operating at PLTD Laiwui, namely Daf DKT 1160 AG, Cummins Dongfeng, and Caterpillar C15. In this case the Caterpillar C15 engine. Since PLN uses Biosolar B30, this engine is very protective, so trips often occur, especially at low fuel pressure (Low Differential Fuel Pressure and fuel pressure) and since using biosolar fuel (B30), the condition of the fuel filter is also often dirty and replaced quickly.

2. Methods

The stages of testing data collection steps are:

- Collecting data needed before modifying the addition of fuel to the CATERPILLAR C15 engine fuel installation system at the Laiwui Power Center.
- Analyzing trip disturbances for the CATERPILLAR C15 engine at the Laiwui Power Center
- Designing the fuel installation that will be made.
- Gather tools and materials. Then the process of making fuel installations that have been designed.
- The process of testing the results of modifications to the CATERPILLAR C15 engine fuel installation at the Laiwui Power Center.
- Analysis of trip disturbances after modifying the addition of fuel to the CATERPILLAR C15 engine fuel installation system at the Laiwui Power Center
- Then evaluate the results of modifications to the addition of fuel to the fuel installation system for the CATERPILLAR C15 engine at the Laiwui Power Center.

The following (Figure 1) is a picture of the research flowchart.

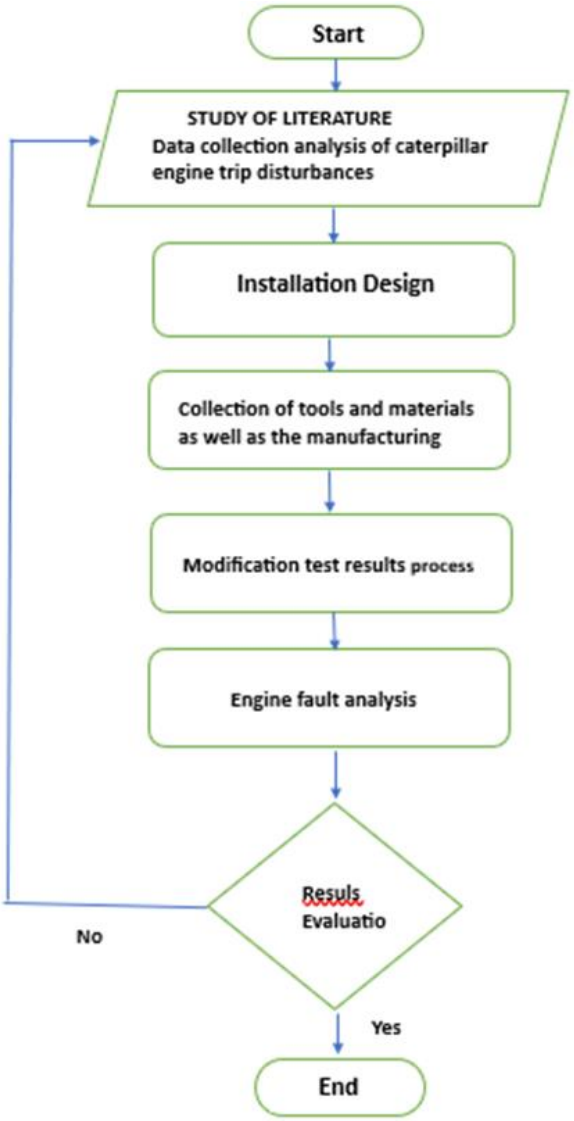

Figure 1. Research flowchart

Furthermore, after the research data was obtained, the researchers processed the data and analyzed it to determine the rate of heat transfer, effectiveness, and consumption of electrical energy from the radiator.

3. Results And Discussion

3.1. Laiwui PLTD fuel system before modification

Data before modification maintenance of scheduled fuel filter replacement during monthly maintenance (P3) or 500 engine hours.

Table 1. History of hours of disturbance of fuel filter differential pressure on Caterpillar C15 engines

Tanggal	JK Daily	Jam Kerja Komulatif				JSB	Umur Filter (Jam)
		Harian	Bulanan	Ganti Oli	JSMO		
				10,000	16,000		
14-Feb-20	18			18	329	329	0
9-Mar-20	9			145	703	703	374
26-Mar-20	22			482	1040	1040	337

*note = Red Table = Disturbances
Yellow Table = Fuel filter replacement maintenance

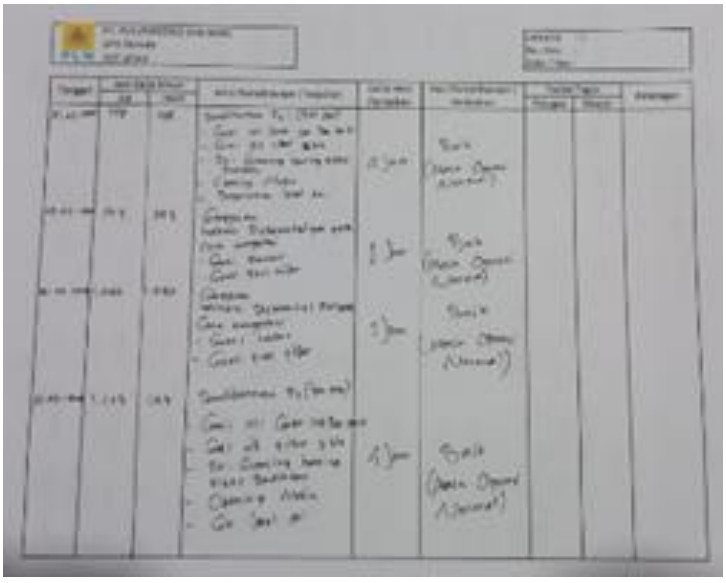

Figure 2. Standard fuel pressure and fuel filter differential pressure on the Caterpillar C15 engine

No.	Indikator Fuel Pressure	Range Fuel Pressure
1	High (Alarm High)	>520 kPa (75 psi)
2	Normal	345 kPa (50 psi) – 520 kPa (75 psi)
3	Low (Alarm Low)	< 345 kPa (50 psi) or *differential pressure* obtains 105 kPa (15 psi) from normal numbers

Based on the problems mentioned above and the impact of losses that can be caused, the authors try to do a diagnostic through the Root Cause Problem Solving method.

Table 2. Material stock for Caterpillar C15 engine fuel filters

No.	Nama Material / Spare Part	No. Spare Part	Saldo Awal		Keluar (TUG 9)	Banyaknya		Saldo Akhir
	CATERPILLAR C15		Vol	Sat		Vol	Sat	
1	Filter Element As Air	208-9065	**6**	BH	17-Mar-20	**2**	BH	**4**
2	Filter Element As Oil	1R-0756	**28**	BH				**28**
3	Filter Element As Fuel	1R-0726	**12**	BH	26-Mar-20	**8**	BH	**4**

(RCPS) to find the root cause of the reduced fuel pressure in the Caterpillar C15 PLTD Lawui engine, so that corrective steps can be taken. After carrying out a diagnostic using the RCPS method for decreasing fuel pressure in the Caterpillar C15 PLTD. Laiwui engine, several causes of this problem were obtained, namely,

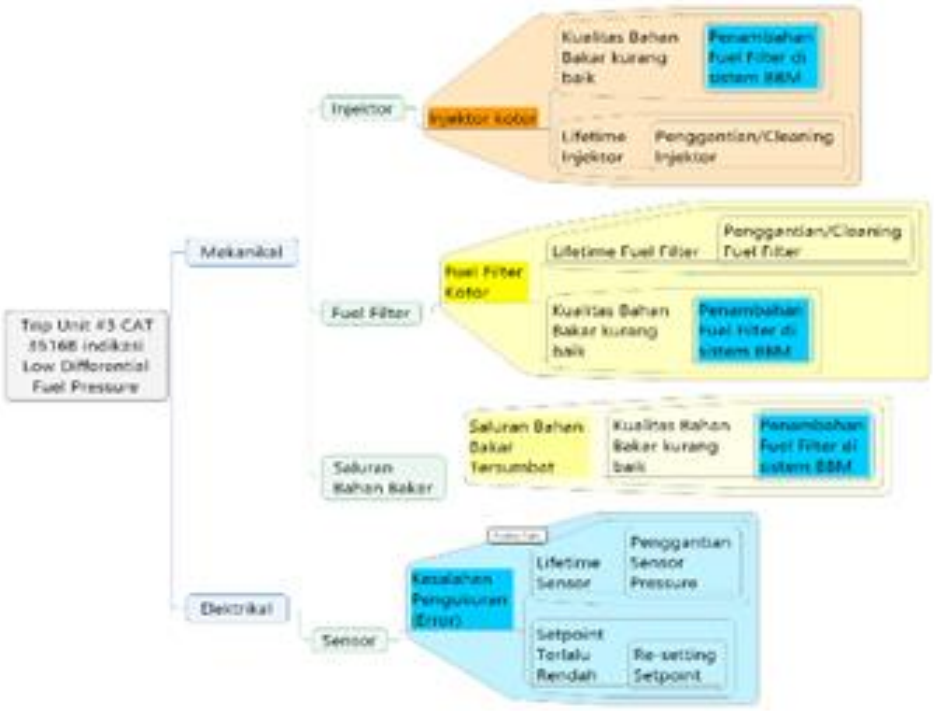

Figure 3. RCPS trip mesin indikasi fuel differential pressure low

a. Injector

At the time of the disturbance, the injector was in good condition, because the working hours of the machine were relatively new (JKM at the time of the disturbance: 703). In these conditions, the injector cannot be opened by the PLTD, because the engine is in good condition and is still under warranty.

b. Fuel Line

At the time of the disturbance, the condition of the fuel piping to the engine was not problematic/in good condition.

c. Fuel Filters

At the time of the disturbance, the condition of the fuel filter is not good, the fuel looks dirty, fuel filter age (oldest age) is 374 hours.

Figure 4. Fuel filter conditions when engine trip interference

At the time of the disturbance, the condition of the fuel filter is not good, the fuel looks dirty, the life of the fuel filter (the longest life) is 374 hours. As an initial diagnosis of the discussion, namely by carrying out observation and data collection activities through direct observation in the field and processing data into information to formulate problems. The initial method of formulating this problem used RCPS by taking the problem "There is a low differential fuel pressure alarm on the Caterpillar C15 engine". From these problems, improvement initiatives and a prioritization matrix were made so that strategic initiatives were obtained which became the main priority which included:

In order for this program to run consistently, a work plan has been prepared. Activities carried out must run according to a predetermined schedule.

Table 3. Chart of Improvement Initiatives

<table>
<tr><th colspan="4">BAGAN INISIATIF PERBAIKAN</th></tr>
<tr><td colspan="2">Judul Inisiatif : UPAYA MENJAGA KUALITAS BAHAN BAKAR MINYAK KE ENGINE DENGAN PENAMBAHAN FUEL FILTER PADA SISTEM INSTALASI BAHAN BAKAR DI PUSAT LISTRIK LANGGUR</td><td colspan="2">Unit / Bagian : PT PLN (PERSERO) WILAYAH MMU - SEKTOR PEMBANGKITAN MALUKU - PLTD LANGGUR</td></tr>
<tr><td colspan="4">Deskripsi : Fuel Filter adalah alat/komponen yang menyediakan, mengalirkan, dan menyaring kotoran dan air yang terdapat dalam bahan bakar yang nantinya tidak menyumbat aliran bahan bakar yang dapat menimbulkan berbagai masalah dalam sistem bahan bakar.</td></tr>
<tr><td colspan="2">Latar belakang :</td><td colspan="2">Item-item tindakan :</td></tr>
<tr><td>1</td><td>Pengoperasian Satuan Pembangkit Diesel (SPD) membutuhkan pemantauan, pengontrolan serta pemeliharaan pada sistem bahan bakar agar kualitas kinerja mesin selalu handal.</td><td>1</td><td>Pengambilan data dan studi literatur untuk perancangan fuel filter tambahan yang dipasang di pipa utama sistem bahan bakar pltd langgur.</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Terjadi alarm low differential fuel pressure pada mesin Caterpillar 3516B yang disebabkan oleh kualitas minyak yang kurang baik.</td><td>2</td><td>Perancangan dan pembuatan fuel filter tambahan yang dipasang di pipa utama sistem bahan bakar pltd langgur.</td></tr>
<tr><td>3</td><td>Pengujian fuel filter</td></tr>
<tr><td>4</td><td>Analisa dan evaluasi fuel filter</td></tr>
<tr><td colspan="2">KPI yang terkena dampak : EAF</td><td colspan="2">Kemudahan implementasi : Mudah</td></tr>
<tr><td colspan="2">Keuntungan / dampak positif : Sangat Berdampak</td><td colspan="2">Biaya implementasi : Rp 2.821.000,00</td></tr>
<tr><td colspan="2">Mentor : MANAGER SEKTOR</td><td colspan="2">Mentee : MANAGER PLTD</td></tr>
</table>

Table 4. Work plan for adding a fuel filter to the fuel installation system at the Laiwui power center

Initiative	PEMASANGAN FUEL FILTER PADA SISTEM PEMIPAAN BAHAN BAKAR PUSAT LISTRIK Laiwui	Atasan / Mentor	Manajer ULP	Overall Project Status	
		Inisiator / Talent	Spv. Pembagkit		

PROJECT PROGRESS TRACKING (TEAM LEADER)

		ACTIVITIES	TARGET	PIC	STATUS	Timeline (Weekly) MARET 1	MARET 2	MARET 3	MARET 4	APRIL 1	APRIL 2	APRIL 3	APRIL 4	MEI 1	MEI 2	MEI 3	MEI 4	Status
DEVELOPMENT	1	Pembentukan tim perancangan dan pembuatan fuel filter pada sistem bahan bakar pltd langgur	26 Maret 2020	Manajer ULP & Spv. Pembagkit	Plan													
					Actual													
	2	Pengambilan data dan study literatur	30 Maret 2020	Spv. Pembagkit & Tim	Plan													
					Actual													
	3	Pembuatan fuel filter	03 April 2020	Spv. Pembagkit & Tim	Plan													
					Actual													
DEPLOYMENT	4	Pemasangan fuel filter	06 April 2020	Spv. Pembagkit & Tim	Plan													
					Actual													
ACATIVITY	5	Pengujian fuel filter	17 April 2020	Spv. Pembagkit	Plan													
					Actual													
	6	Analisa dan evaluasi fuel filter	30 April 2020	Manajer ULP & Spv. Pembagkit	Plan													
					Actual													

1	Penggantian Komponen Injektor
2	Pengecekan dan Pembersihan Saluran Bahan Bakar secara menyeluruh
3	Pembuatan Fuel Filter disaluran bahan bakar utama
4	Pengecekan dan penggantian Fuel Filter
5	Re-setting setpoint

Figure 5. 5 Priority matrix chart

Existing Fuel System Conditions Existing fuel system conditions (before fuel filter installation) are as follows.

Figure 6. Condition of the existing fuel piping system

In the Figure 7, it shows that fuel flows directly from the rear monthly tanks (T50 KL and T15 KL) to the 5 KL storage tank then to the engine daily tanks. In the condition of the fuel tank being standby (unused), the oil will automatically settle for some time, so that the quality of the fuel will decrease. The sediment which is at the bottom of the tank will also flow in the fuel pipes, so that if conditions like this are maintained, it will potentially reduce the performance of the engines.

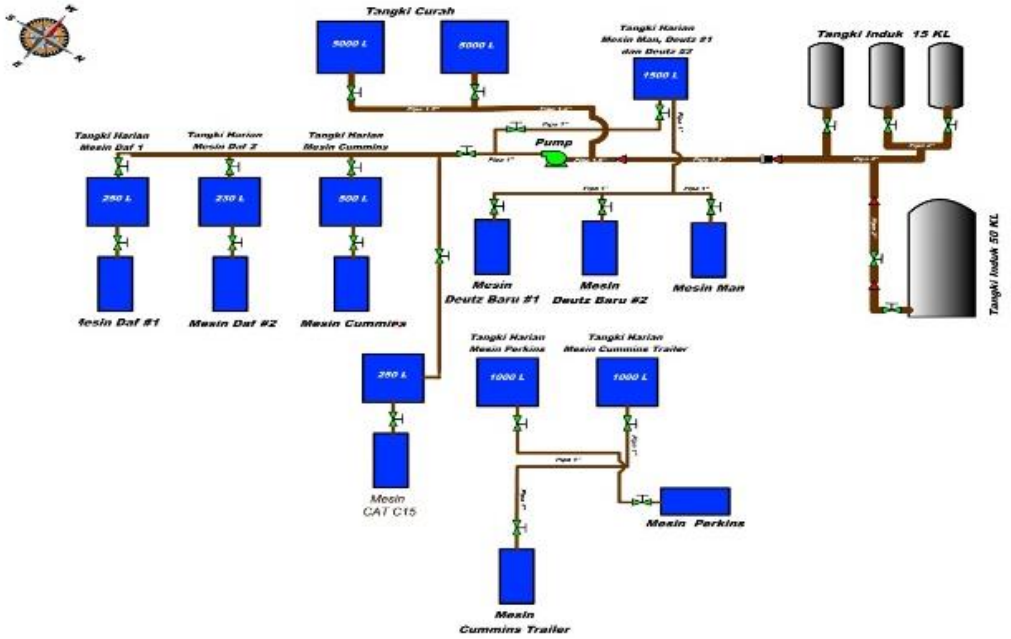

Figure 7. Layout of the Laiwui PLTD fuel system

3.2. Laiwui PLTD fuel system modification

Based on the fuel system layout and the problems at the Laiwui PLTD, it is necessary to make modifications to the fuel system at the Laiwui PLTD, namely by adding a fuel filter located between the monthly tank and the daily tank, so that the fuel entering the daily tank is clean and can reduce deposits. – fuel deposits.

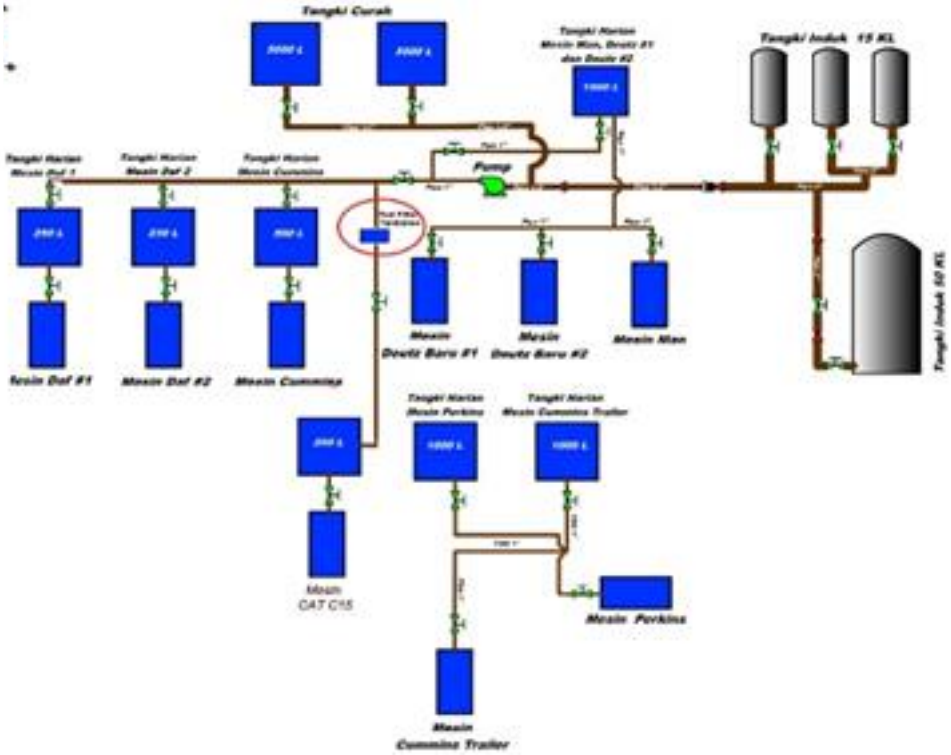

Figure 8. Layout of the Laiwui PLTD fuel system with additional fuel filters

This modification also aims to reduce the number of trip units caused by low fuel pressure and low differential fuel pressure, as well as reduce the use of stock fuel filter parts, especially in

the Caterpillar C15 engine and in general in all Laiwui PLTD engine units, which incidentally takes a long time in the procurement process and delivery.

The following is a flowchart of the working mechanism of the additional fuel filter in the Laiwui PLTD fuel system.

Figure 9. Flowchart of the work mechanism of the Laiwui PLTD fuel system with additional fuel filters

The following is a design for the additional fuel filter installation that is installed in the Laiwui PLTD.

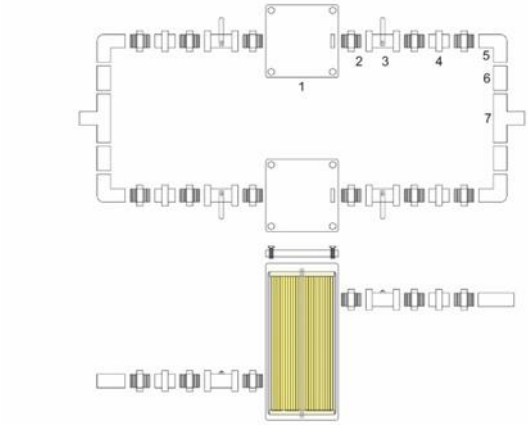

Figure 10. Additional fuel filter design in the Laiwui PLTD fuel system

Table 6. Material costs for Laiwui PLTD fuel filter modification

NO	NAMA MATERIAL	JUMLAH	SAT.	HARGA	TOTAL
1	Knee 2"	4	Pcs	Rp. 45.000,-	Rp. 180.000,-
2	Double Drat 2"	12	Bh	Rp. 55.000,-	Rp. 660.000,-
3	Watermur 2"	4	Pcs	Rp. 115.000,-	Rp. 460.000,-
4	Tee 2"	2	Pcs	Rp. 60.000,-	Rp. 120.000,-
5	Knee ½	2	Pcs	Rp. 8.000,-	Rp. 16.000,-
6	Dop ½	2	Pcs	Rp. 10.000,-	Rp. 20.000,-
7	Semen	1	Krng	Rp. 45.000,-	Rp. 45.000,-
8	Stop Kran 2"	4	Pcs	Rp. 325.000,-	Rp. 1.300.000,-
9	Double Drat ½	2	Pcs	Rp. 10.000,-	Rp. 20.000,-
TOTAL BIAYA PEMBUATAN 1 ITEM				**Rp. 2.821.000,-**	

Broadly speaking, the process of making additional fuel filters in the Laiwui PLTD fuel system includes,

a. Fuel Filter Installation and Assembly Design

First design and prepare the completeness of materials / materials and equipment to be used. After that, the fuel filter assembly process is carried out, including cutting and grinding the fuel filter casing made of pipes, as well as adding other piping components. Here is the documentation of the work.

b. Fuel Filter Testing

After the fuel filter is assembled according to the design, we do a leak test for 2 days. Here's the test documentation.

Figure 11. Fuel filter testing process

c. Additional Fuel Filter Installation in the Fuel System

After the fuel filter had no leaks and passed the test, we installed the fuel filter in the main fuel system installation, which is located between the monthly tank and the daily tank. After the installation of the fuel filter into the main fuel system pipe for PLTD Laiwui has been completed, we conducted a fuel filter test that affected the life of the Caterpillar C15 engine fuel filter which previously recorded 374 working hours, the engine experienced a low differential fuel pressure problem.

Table 7. Comparison of Caterpillar C15 engine fuel filter age before and after additional fuel filter installation

Tanggal	Jam Kerja Komulatif				JSB	Umur Filter (Jam)	KETERANGAN
	Harian	Bulanan	Ganti Oli	JSMO			
			500	16,000			
Sebelum Pemasangan Fuel Filter Tambahan							
14-Feb-20			18	329	329	0	Penggantian pertama oleh pihak Trakindo
9-Mar-20			145	703	703	374	Gangguan
26-Mar-20			482	1040	1040	337	Gangguan
Setelah Pemasangan Fuel Filter Tambahan							
17-Apr-20			7	1444	1444	404	Pengujian 1
1-May-20			317	1754	1754	310	Pengujian 2
30-May-20			568	2322	2322	568	Pengujian 3

Based on the test results in the table above, it can be seen that the additional age/life of the Caterpillar C15 Engine fuel filter has increased, and in the picture it can be seen that the fuel pressure is in safe condition and still above the set point

Benefits of modification of the addition of Fuel Filter Extends the lifetime of the fuel filter until the planned maintenance time (P3 maintenance every 500 hours).

4. Conclusion

Based on the test results above, the age of the fuel filter is much increased from the previous condition, this is because the deposits contained in the fuel will be filtered in the additional fuel filter. Saves the use of fuel filter material in each machine. Based on the test results above, the longer the service life of the fuel filter, the less fuel filter replacement for each machine so that the fuel filter stock for each machine is maintained, because the stock is very limited. Monthly, the Caterpillar C15 engine requires 5 fuel filters to be replaced once, 2 times more efficient than before (from JKM data and trouble reports, 2 times a month are replaced, because they are caused by trips, not maintenance replacements). The maintenance team can plan a timely replacement of the fuel filter and the logistics team does not request additional stock from the Maluku Generation Sector ophar team from the planned stock at the beginning of the semester, so that there are no additional costs incurred for adding fuel filter material. Avoid tripping the unit which causes a low differential fuel pressure alarm, because fuel deposits can be filtered in the additional fuel filter. Thus, the quality of the fuel that goes into the engine improves.

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