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Original Research Article

Investigation of the Effect of Using Biodiesel Diesel Engine Fuel System Injectors

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ABSTRACT

In this study, currently used as a fuel in diesel engines instead of diesel fuel, biodiesel from renewable energy sources is used, the mass loss due to wear of diesel engines, injectors, injector opening pressure of diameter shrinkage and as a result, the fuel density and changes in the system flows is investigated Research, a diesel engine, electric motor, for a period of 1000 hours with the motion given to biodiesel, the fuel system was built cycle.

At the end of this study, caused by wear, 0,08333 to 0,13893% reduction in diameter of the injector needle, syringe needle bodies decreased from 0,00810 to 0,01494%, 0,00848 to 0,02084% loss in mass bodies injector nozzle, injector opening reduction of 3-5bars pressure and fuel flow volume 0,46 mL/h was observed to be reduced.

KEY WORDS: Biodiesel, diesel engine, injector wear and tear.

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1. INTRODUCTION

People have always tried to improve engine performance and engine life since the invention of the engine,. Developments in the field of electronics, computer and machinery have also shown its effects in engines as a result high power and speed have been obtained. Another remarkable point in engine work is the reduction of fuel consumption and exhaust emissions [1].

In spite of the fact that fuel consumption and exhaust emissions have been minimized, in parallel with population growth in the developing world, the number of vehicles is increasing as well. As a result, energy consumption and exhaust emission is increasing rapidly.

The main energy source of motor vehicle industry today is the petroleum products. Negative effects of oil resources will cause the use of alternative fuels [2].

Currently, close to 90% of the energy consumed in the world of fossil-based sources are provided from fossil fuels

It is compulsory to take measures and have new researches as fossil fuels lack appropriate emission values for the future.

For all these reasons, people in recent years are forced to work in the field of energy and emissions, and research for alternative sources.

Vegetables or animal products or waste has a structure consisting of carbon-hydrogen-oxygen components.

These products can be converted into hydrocarbon, alcohol, natural gas, and ammonia and used as engine fuel [3].

Today, the most common liquid of bio fuels are bio ethanol and biodiesel [4].

2. REVIEW OF THE LITERATURE

Ministry of Environment and Forestry gives definition that it's a fuel released as a result of the reaction product from oils of all sorts of biological origin by the help of alcohol [5].

Taşyürek in his work of 2005 says; methanol fuel remaining in the fuel pumps because obstruction may affect elastomers and can lead to poor combustion, properties of the fuel injector high-level production catalysts indicated that accumulation can lead to obstruction or filter blockage. If the fuel waits or improperly produced its acid numbers may change. Higher than 10% of the acidic properties of those wastes shorten the life of fuel system, fuel pumps and filters [4].

Ögüt et al. In their presentations of 2006: while using biodiesel, diesel fuel filter sediment and sludge caused problems such as blockage of the injector mentioned [6].

The TS 7054 standard (1989), road vehicles used in diesel engines, fuel injectors can spray 300mm3/stroke for yields, The TS 7053 specified test devices, complying with pre-determined values, with spring-board nozzle valve, the fuel injectors are trying the rules on [7].

Kimberly and al in their studies in 2005 compared especially the wears of injector nozzles from petroleum-derived diesel fuels, oxidised alternative fuels, deoxidised (B20) alternative fuels. The wearing in the material occurs more in comparison with high-sulphur diesel fuels while oxidized low alternative fuels cause particle emissions. The highness of sulphur in diesel fuels increases the wearing. These wearing characteristics were tested especially on B20, $B20O_x$, $B20O_{x2}$ (oxidized biodiesel) Cameron-splint types of machines. As a result, the wear in B20 is less whereas more in the oxidized B20 [8].

Goodrum and Geller pointed out in their study of 2004 that the sulphur in diesel fuels reduces the rate of lubricity and as a result of such big problem it caused wearing and some damages mainly to fuel injection system. They also added that biodiesel has a high rate of lubricity, and if mixed in diesel fuels in small amounts it will double the lubricity feature [9].

Keskin et al. in their research of 2007, came to the conclusion that a mixture of 90% of tall biodiesel with diesel fuel can be used as an alternative fuel in diesel engines without going to any modification [10].

In the literature combustion in diesel engine is in the way that fuel is injected with

high pressure into the compressed hot air. The assembling system of components is called fuel system [11,12,13,14].

3. MATERIALS AND METHODS

In this study, the brand Peugeot J9 minibus engine fuel system components, Delphi 657713 injector (nozzle and needle) and B100 biodiesel was used.

The engine is powered through crankshaft pulley by an electric motor.

The required calculations of pulley ratio were made and the diesel engine's operating speed is 1500 rpm / min.

In this experimental setup (Figure 3.1.); biodiesel in the fuel tank after being sucked and filtered is sent to injectors in high pressure and the fuel sprayed by injectors came back to the fuel tank again because of level difference.

System has been visually inspected for any leaks.

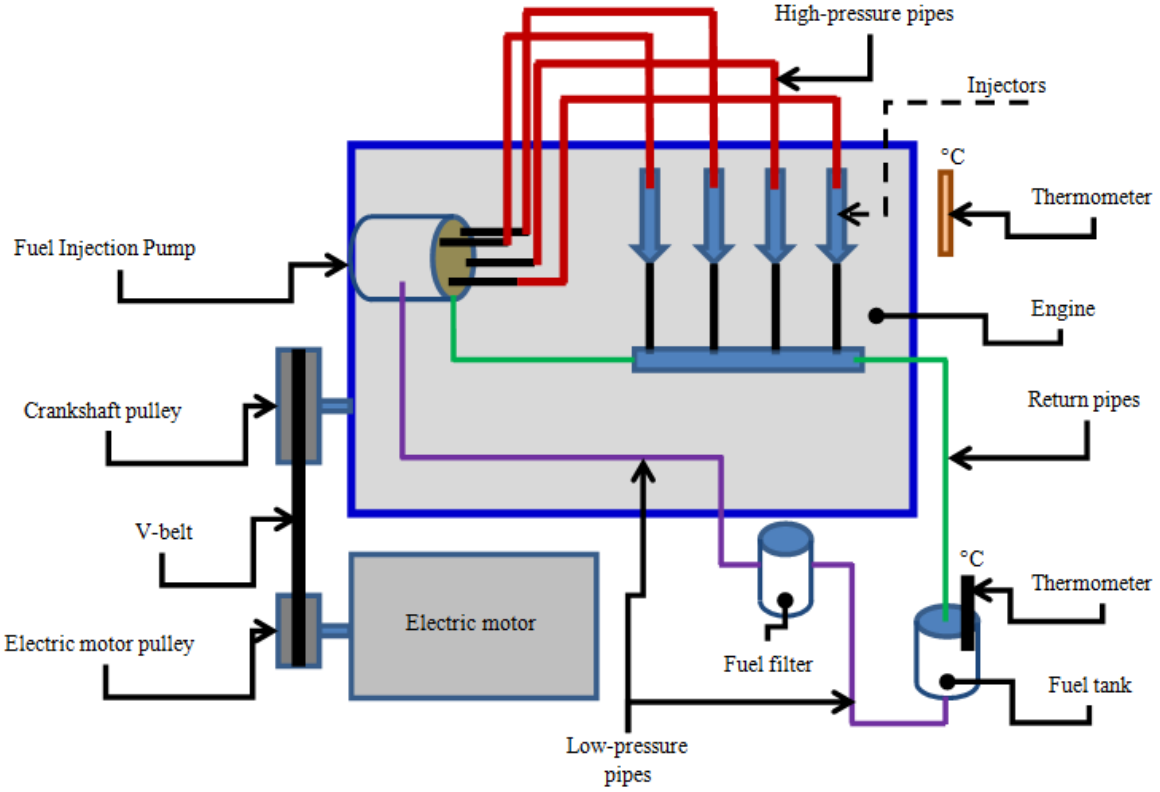

Figure 3.1.Schematic representation of the experimental apparatus

Injector nozzle and the needle were replaced with new ones. To avoid confusion, the numbers are given in the injector bodies.

The injectors are controlled and set up to 130 bar pressure [15].

The experimental period, the average injector service life of a vehicle is 75000km and its speed is 75 km/h, assuming (75000km) / (75km/h) = 1000h identified as working time.

Biodiesel is filled in the test assembly tank and experiment started.

In this study, the injector is used as in the photo of Figure 3.2 and the following controls and measurements were made.

- Pintle diameter; Helios brand, with 0,001 mm precision digital micrometer at room temperature (20°C) was measured at the end of each 50 hours of operation.
- The mass of the injector needle and nozzle, Sartorius BP221S brand 0,1 mg (0.0001g) sensitivity is measured with a balance at the end of each 50 hours of operation.
- Temperature of the fuel used in the system; a thermometer is placed in the fuel tank and temperature is measured every 50 hours of operation.
- Ambient temperature of the test is carried out with a thermometer attached to the test assembly and thermometer was

measured at the beginning of every 50 hours of operation.

- Flow rate of the system, filling time of a container of one litre capacity is calculated by measuring with a stopwatch. It was measured three times, once at the beginning, then at the end of 500 hours of working and finally at the end of the experiment.
- Controls of injectors; they were controlled with Bosch Injector Test and Calibration Device made of chrome (TS 7054). Controls were repeated every 50-hour periods.
- Microscopic images of the injector needles; Microscopic images were taken with EMS 420E brand microscope (10x-40x) and Sony DSC W30 digital camera. Filming was made in the same period of the injector controls.

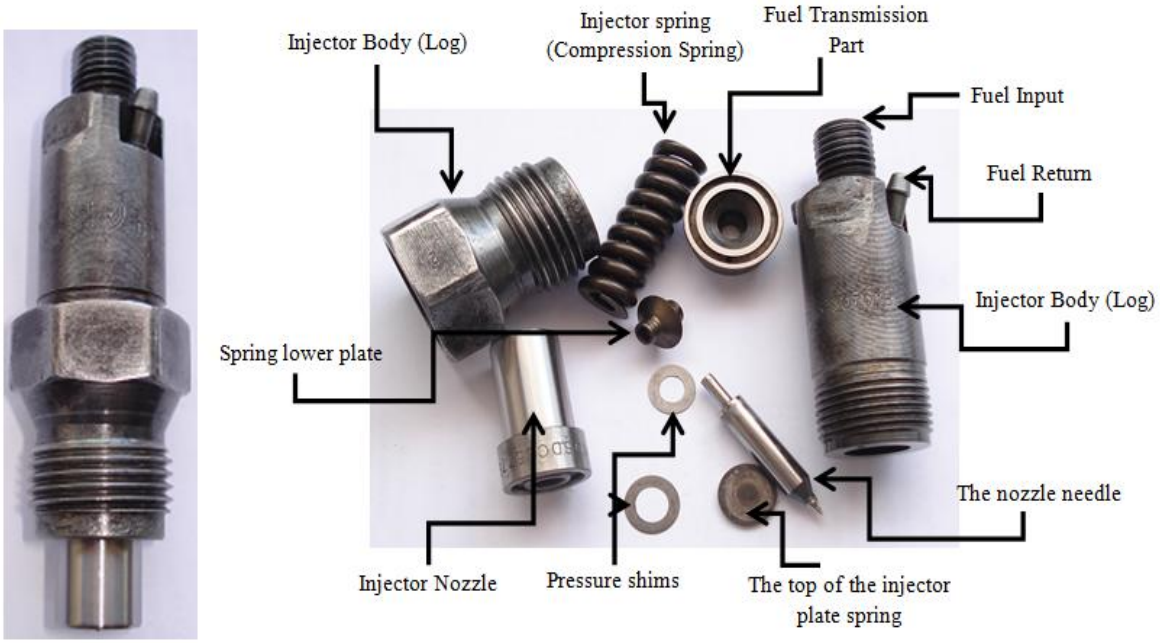

Figure 3.2.Injector and injector parts of the photo [1]

4. RESEARCH RESULTS

Those are the changes as a result of wearing in injectors at the end of 1000 hours of cycling with B100 biodiesel in diesel engine.

4.1. Pintle-Wide Change

Starting the experiment, the injector needle diameters are measured as following; 1st pintle diameter 5.998 mm, 2nd pintle diameter 5.999 mm, 3rd an injector needle diameter of 6 mm and 4th an injector needle diameter 6 mm. Injector needle diameters measured at the end of the first 50 hours of operation have not changed. The wearing in the diameters of the needle started after 100 hours of working and continued until the end. Changes in diameter of the injector needle are given in Figure 4.1. Injector needle diameters, 1st 0.13893% reduction in syringe, 2nd 0.13335% reduction in syringe, 3rd 0.09445% reduction in syringe and 4th was 0.08333% reduction in syringe.

4.2. Injector Nozzle and Needle the Mass Change

Before you start working injectors, a new nozzle and needle from the syringe weighed. Injection needle and nozzle were weighed every 50 hour period, calculated mass losses. Run-time graph of the mass-loss pintle in Figure 4.2 and on the injector nozzle mass loss-run-time graph in Figure 4.3 is given.

Graphics, as shown in Figure 4.2, the mass loss after 100 hours of operation has started, and, including progressive loss of mass during working hours increased particular in the injector needles numbered I and II. The maximum loss of mass in the

needle mass is on number I the injector needle with a loss of 0.01494%, and the least loss of mass is on the 4th pintle injector with a loss of 0.00810%.

The maximum loss of mass among the injector nozzles is in the number one injector nozzle with a loss of 0.02084% and minimum loss of mass is in the number II with a loss of 0.00848%.

When injector needles and injector nozzles were evaluated together, the highest weight loss is in No I with 0.01988%, and at least in II No. syringe injector with 0.00922%.

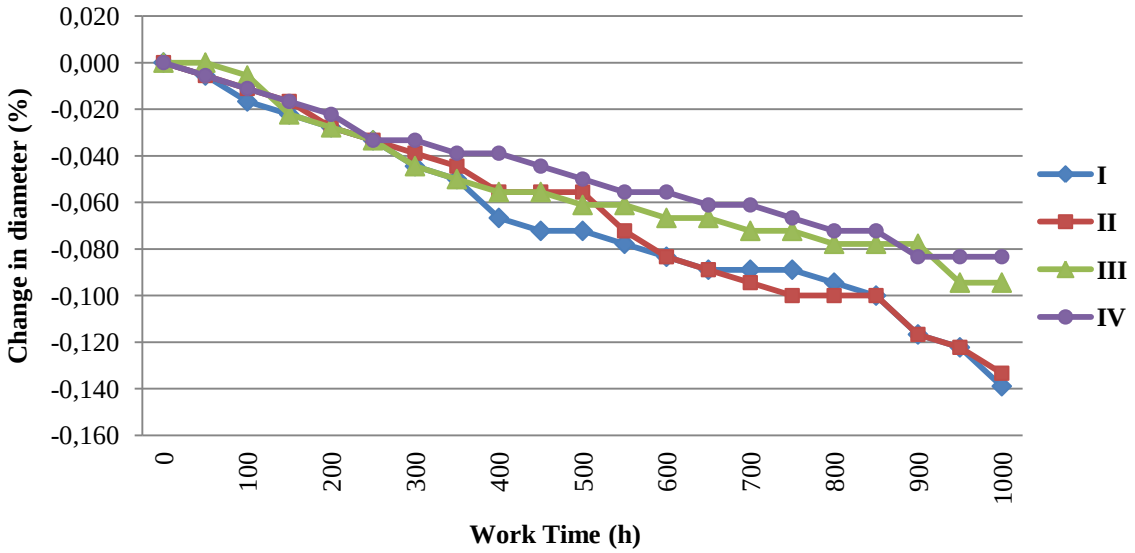

Figure 4.1. Pintle-Wide Change-Runtime Chart

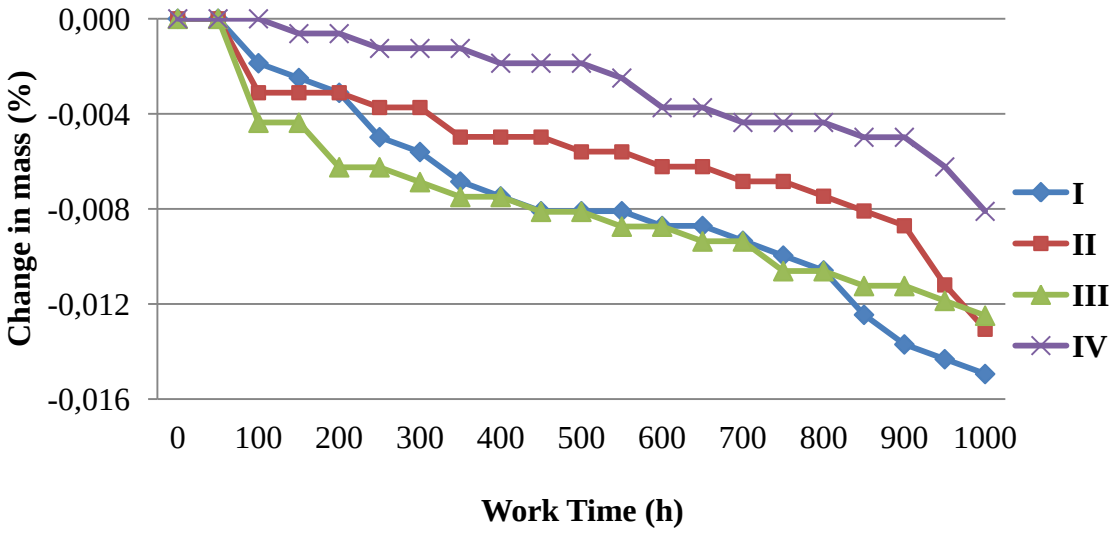

Figure 4.2. Mass Needle Exchange-Runtime Chart

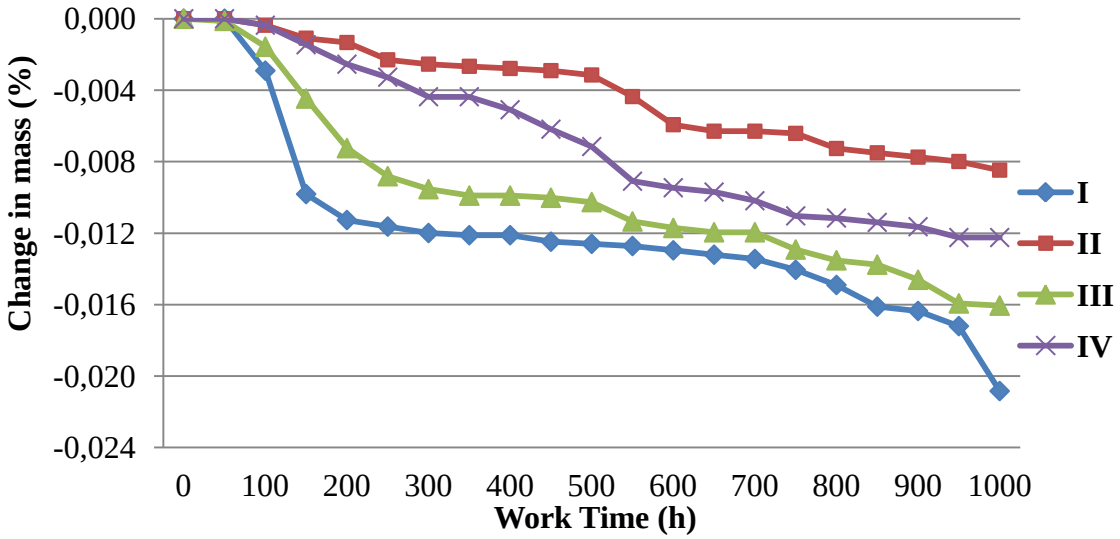

Figure 4.3.Injector Nozzle Mass Change-Runtime Chart

4.3. Experiment where the test environment and Fuel Temperature Change

Fuel temperature used in the test media and the test is carried out at the beginning of the period of 50 hours, 1 hour after the start period and the end period are measured. This 50-hour period, at the beginning of the measurements, the test is carried environment and fuel temperatures were very close to each other (0-2°C).

After the system is running, the fuel temperature begins to rise and the test is carried out approximately 1 hour after the temperature difference between the ambient temperature increase of (7-13°C) were preserved. The graph given here shows the performance of the tests ambient temperature and fuel temperature figure 4.4. The test is carried out in 10°C to ambient temperature, 10°C fuel temperature, respectively. The ambient temperature in which the test is carried out measured maximum as 23 °C and fuel temperature 34°C.

The maximum difference between the fuel temperature and ambient temperature of testing is 12°C.

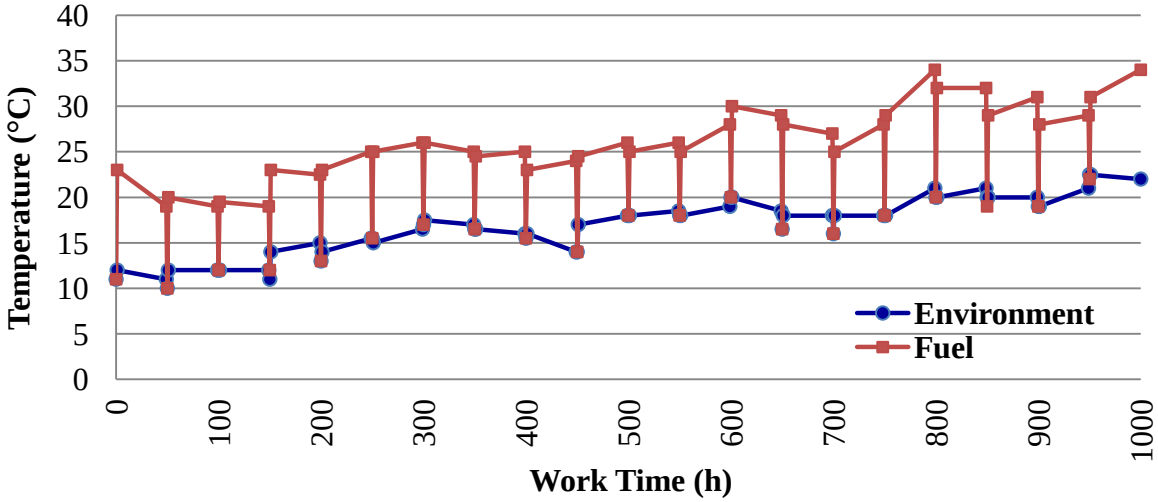

Figure 4.4.Try the Institution Environment and Fuel Temperature-Run-time Chart

4.4. The change in the system flows

Flow rate of the system is measured three times, initially 4,93 mL/h and at the end of 500 hours duration 4,74 mL/s and at the end of 1000 hours duration 4,47 mL/s. The reason for the decrease in flow rate is supposed to be fuel filter contamination.

4.5. The change in the injector opening pressure

Injector nozzles and injector needles renewed before starting the experiment, the injector opening pressure is set to 130bars [15].

It was noticed in controls that until the end of 600 hours of working, no change was notified in injectors' pressures, at the end of 600 hours of working time, 1 bar decrease was notified in 2nd and 3rd injectors and in the further working hours the decrease was notified in other injectors' pressures as well.

Injector opening pressure-run-time graph is given in Figure 4.5. It was noticed that at the end of 1000 hours of operation, a decrease of 5 bars in the 1st and 3rd injectors' opening pressure, 3 bar decrease in 2nd and 4th injectors' opening pressure was observe.

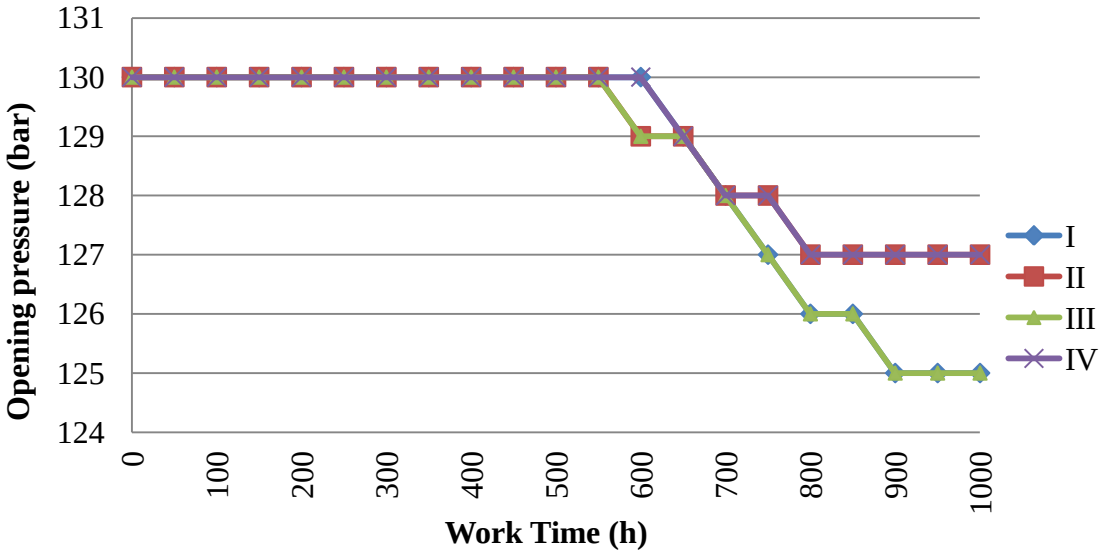

Figure 4.5.Injector nozzle opening pressure - time graph

4.6. Microscopic images of the injector needle

Injector needles under a EMS 420E (10x-40x) brand microscope examinations: as a start, at the end of 400 hours, 800 hours and 1000 hours of operation these photos below were taken with the Sony camera DSC W30.

In injector needles, traces of wear started to be seen at the end of 400 hours of operation (Figure 4.7).

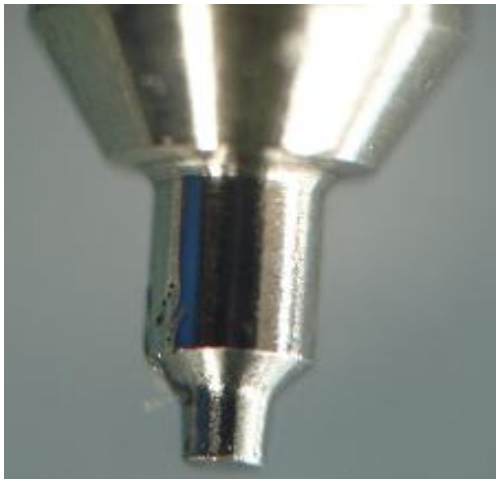

Figure 4.6. Worked in photo injector needle

Figure 4.7. Photo injector needle at the end of 400 hours of work

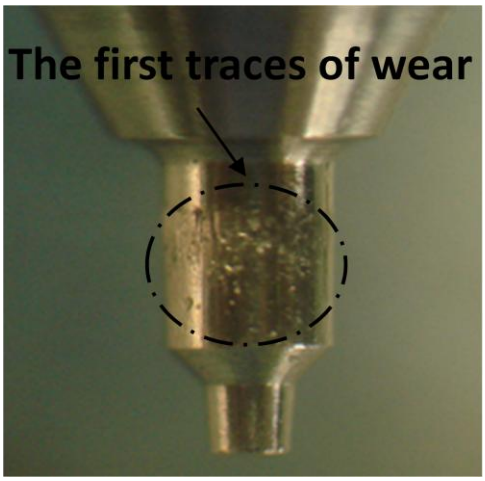

Figure 4.8. Photo at the end of 800 hours of work

Figure 4.9. Photo injector needle at the end of 1000 hours of operation

5. EXPERIMENTAL RESULTS AND DISCUSSION

In the study, after100 hours of operation, a decrease in diameter of needles, a start of loss of mass in needle and nozzle bodies of injectors used for biodiesel was observed and as for the injectors' operating pressures; the start of decrease was observed after 600 hours of operation.

In 1000 hours of bio-diesel the study, the injector needle decreases in diameter (0,08333% - 0,13893%), the injector opening pressure reductions (3-5bars), breast masses mass loss (%0,00848 – 0,02084%) and needles loss of mass bodies (0,0081% - 0,0149%) is measured.

These losses at the end of the experiment are not hindrances for injectors to fulfil their task. Road vehicles do not receive fuel from the same station. There are oil companies operating in Turkey and in the world and a lot of their dealers. There are even quality differences in their products among these firms available.

Considering the average life of a diesel engine, the fuels taken from different places will be difficult to determine in the long-term effect of the fuel to the engine.

For the reasons described above, it is very hard to say how many miles which injector or how many hours which injector goes?

Research carried out about biodiesel, shows that biodiesel compared to diesel oil have many advantages such as environmental, emissions, lubricity, a variety of production resources [16][17].

In today's diesel engines and we need a good performance and combustion in various operating conditions. Biodiesel can be used in existing diesel engines without the need for a large-scale modification of alternative fuel for diesel engines [10].

The life of a diesel engine's efficiency varies between 350 000-100 0000 km [18].

In such a long and variable work-life research, it is very difficult to say about the net advantage or disadvantage of biodiesel without thoroughly using biodiesel.

For the reason that biodiesel is continual and avoidance of it unknown effects to engine in its long run, we had better use as the European Union (EU)'s recommended (5.75% - 10%) values diesel [19].

In this study, the engine didn't have combustion. Fuel only had a cycle through the fuel system. Although this study gives us some information about the change of diameter, loss of mass in injectors and decrease of injector opening pressure and fuel flow, some studies can be held as following.

Two diesel engines should be bought with the same brand and features.

All parts of the fuel system should be replaced with new ones manufactured by the same company in the same country. Engines should be operated in the same or similar

working conditions. While using diesel oil in one engine, biodiesel must be used in the other. By measuring characteristics of both the engines, more precise in comparison can be achieved on this topic.

In this study, "Fatty Acid Methyl Ester (FAME) Investigation of the Effect of Using Diesel Engine Fuel System Materials that are" prepared making use of his master's thesis [1].

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