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STUDY ON THE ENGINE OIL’ S WEAR BASED ON THE FLASH POINT

Tolga Yusnyu
Department of Thermotechnics, Hydraulics and Ecology,
“Angel Kanchev” Univesity of Ruse
Phone: 0895662690
E-mail: tolga_95@yahoo.com

Assoc. Prof. Simeon Iliev, PhD
Department of Engines and Vehicles,
“Angel Kanchev” Univesity of Ruse
Phone: 082-888 331
E-mail: spi@uni-ruse.bg

Abstract: *Increasing energy performance of internal combustion engines is largely influence by frictional forces that arise between moving parts. Thus, in this respect, the nature and quality of the engine oil used is an important factor. Equally important is the effect of various engine injection strategies upon the oil quality. In other words, it is of utmost importance to maintain the quality of engine oil during engine’s operation. Oil dilution is one of the most common causes that lead to its wear, creating lubrication problems. Moreover, at low temperatures operating conditions, the oil dilution with diesel fuel produces wax. When starting the engine, this may lead to lubrication deficiencies and even oil starvation with negative consequences on the engine mechanism parts wear (piston, rings and cylinders) but also crankcase bearings wear. Engine oil dilution with diesel fuel have several causes: wear of rings and/or injectors, late post-injection strategy for the sake of particulate filter regeneration, etc. For measuring the flash point, it is used Eraflash device, manufactured by Eralytics, Austria.*

Keywords: *Engine oil, Oil quality, Lubrication, Oil dilution.*

INTRODUCTION

The trend of increasing energy conservation and the reduction of greenhouse gases means improvement in fuel consumption of automotive engines. Even if, for modern engines, the useful work loss due to internal engine friction is relatively small, the reduction of all energy losses, including friction, remains as a valuable contribution to overall efficiency improvement. Improvement of fuel economy has been one of the most important challenges for the automotive industry. A small gain in fuel consumption reduction, even by 1% over existing levels, is an important achievement.

Currently, lubrication is a key methodology to reduce energy consumption and emission, which is very important to create a sustainable society. In this regard, to reduce friction and wear, new technologies, novel lubrication oils and additives are being develop. To improve the energy efficiency of engines, even increasing capacity lubricating fuels is a topic for researchers.

One disadvantage of diesel compared with gasoline engines is that they generate greater problems regarding emissions. In respect to this, new specific depolluting strategies are required. According with new emission regulations, additional equipment for diesel after-treatment such as catalytic convertor, particulate filter (PF), exhaust gas recirculation, NOx after treatment etc. is need to be add. Using a PF has become somewhat standard with Euro 4 norms, which halved the mass of particulate emissions compared with Euro 3. For this reason, many Euro 4 diesel cars are equipped with PF and starting with Euro 5, all diesel powered cars have PF. Non-combustible ash can be deposited on channel walls through the full length of a diesel particulate filter (DPF). This type of ash can affect the exhaust condition and heat transfer process during the periodical soot regeneration of DPF.

The contamination of oil with fuel (diesel) has the effect of lowering the viscosity implying poor lubrication of moving parts. For instance, it may cause oil washing on the surface of the cylinder, and thus accelerates the wear of the piston and the cylinder. It also lowers the temperature of the oil flammability (flash point) which can produce its auto-ignition. Severe dilution reduces the concentration of additives in diesel oil and, as such, it reduces their effectiveness. At the same time worsening the lubricating conditions (the sealing in the rings area), appears a circulation of gas within the cylinder to the oil sump and to the combustion zone (increasing oil consumption). Oil dilution with diesel, operating in low temperatures conditions may cause waxing. This can lead, at starting moment, to low oil pressure and starvation.

FLASH POINT AND DILUTION

In order to determine the oil flash point and dilution degree Eraflash apparatus produced by Eralytics, Austria was use. Eraflash measurement is directly under the latest and safest standards ASTM D6450 & D7094), which are in excellent correlation with ASTM D93 Pensky - Martens ASTM D56 TAG methods. It uses the Continuous Closed Cup method for finding the Flash Point (CCCFP).

EQUIPMENT DESCRIPTION

The Fig. 1 shows the Eralytics analyser. It consists of display on which we put in the temperatures and follow the process. A measuring chamber where we put the sample cup and a chamber door.

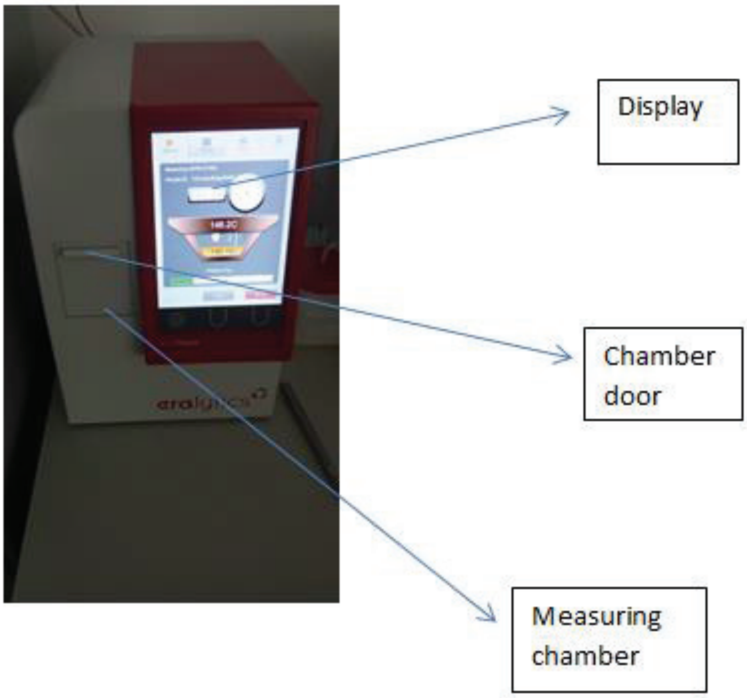

Fig. 1. Eralytics analyser

METHOD DESCRIPTION

The standard method which was used (ASTM D7094) is an extremely versatile flash point method that can be used for the accurate flash point measurement of almost every sample: gasoline, diesel, fresh oil, used oil, asphalt, tar, bitumen, hydrocarbon solvents, different types of paint and varnish and many other types of solids and liquids. This standard method ASTM D7094 can be used even to determine the influence to the flash point of highly flammable fractions in samples like gasoline in diesel or diesel in oil or gas in oil. The repeatability and reproducibility data from

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ASTM D7094 is better than with another standard method, like ASTM D93. When the start temperature is reach, the sample cup is lift. After the sample cup is lifte, the measurement is initiate. The electric arc ignites in the preprogramed interval steps. For this case, the interval is 1 second. Depending on the selected method (ASTM D7094) and the current temperature, fresh air is automatically introduce into the measurement cup to keep up a sufficient oxygen level. When the pressure after ignition, in the measurement chamber, is 20kPa or higher, the flash point was detect.

EXPERIMENTAL SETTINGS

Sample cup for ASTM D7094 is for volume of 2 ml sample. In order to keep a homogeneous sample, it was necessary to put a stirring magnet into the sample cup as it can see in Fig. 3.

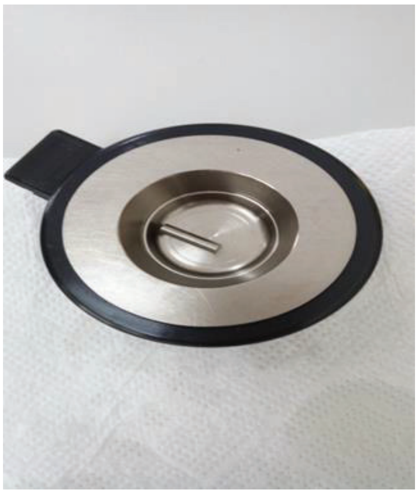

Fig. 2. Sample cup with stirring that keeps a homogeneous sample

For standard flash point measurements, the following parameters have to be set: The Measuring Range (“T range”) parameter appears and is valid only when the expected flashpoint is selected for calculating the measurement range. Then, the measurement range (“T initial” and “T final”) is automatically calculated according to the “T range” parameter. “T initial" is automatically set according to the definition of the selected standard method and “T final” = “T initial” + “T range”. In our case, we don’t know the expected flashpoint, so the initial temperature “T initial” and final temperature “T final” were chosen (Fig. 4). The temperature of the cup must be below the start temperature.

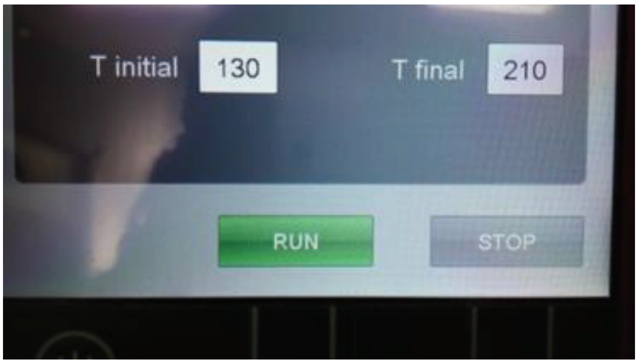

Fig. 3. Measuring range for putting in the starting temperature and the final temperature for the experiment

The Ignition Frequency ("Step") parameter defines the temperature interval between two ignitions of the arc. It is defined by the standard method (1 second as we mentioned above).

Ignition Energy ("Ignition"). The ignition length of the arc is also fixed by the standard methods. In this paper, we determine oil dilution within diesel fuel. Thus, it was necessary to measure reference fuel dilutions and draw the dilution curve.

RESULTS

In Tabl. 1 the samples and the particularities of the cars are presented, respectively the engines which used this oils.

Table 1. Samples presentation with used oils, cars from which they are taken, the kilometres that are covered and the period of use

Sample	Car model	Year of car production	Kilometers total performed	Kilometers covered with oil	Period of oil use [month]	Mark and type of used oil	Pollution norm (EURO)	5th injector YES/NO
1	Audi A4	2007	175 372	16 000	12	Castrol Edge 5W30	5	No
2	Tiguan	2008	116 955	20 000	18	Castrol Edge 5W30	5	No
3	Touran	2008	306 721	22 000	22	Castrol Edge 5W30	4	No
4	BMW 520	2011	201 540	35 000	26	Original BMW 5W30	5	No
6	VW Passat	2010	171 659	16 000	13	Castrol Edge 5W30	5	No

The Fig. 4 presents the decreasing temperature of the flash point according to the quantity of diesel.

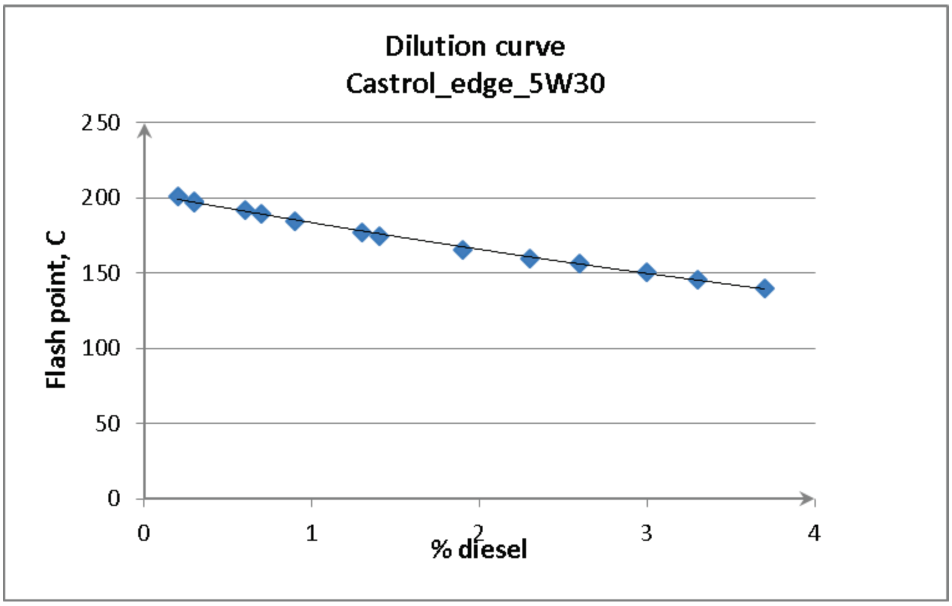

Fig. 4 Dilution curve – Castrol Edge 5W30

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In order to determinate the oil dilution with diesel fuel is necessary to measure the flash point. The first step for dilution determination is to realize the dilution curve for each type of oil.

Table 2. Experiment with unused oil – Castrol Edge 5W30, which includes amount of diesel in the oil, the flash point for every experiment and dilution

Nr. Proba	Oil [µl]	Diesel [µl]	Total [µl]	F.P. [°C]	Dilution [%]
1	5000	0	5000	208,7	0
2	5000	10	5010	198,9	0,20
3	5000	20	5020	193,8	0,40
4	5000	30	5030	190,8	0,60
5	5000	40	5040	185,8	0,79
6	5000	50	5050	180,8	0,99
7	5000	70	5070	173,8	1,38
8	5000	90	5090	167,6	1,77
9	5000	110	5110	160,6	2,15
10	5000	130	5130	156,6	2,53
11	5000	150	5150	151,6	2,91
12	5000	170	5170	145,6	3,29
13	5000	190	5190	140,6	3,66

The Fig. 5 shows that the best condition are reached by cars that cover between 100 000 km and 220 000 km.

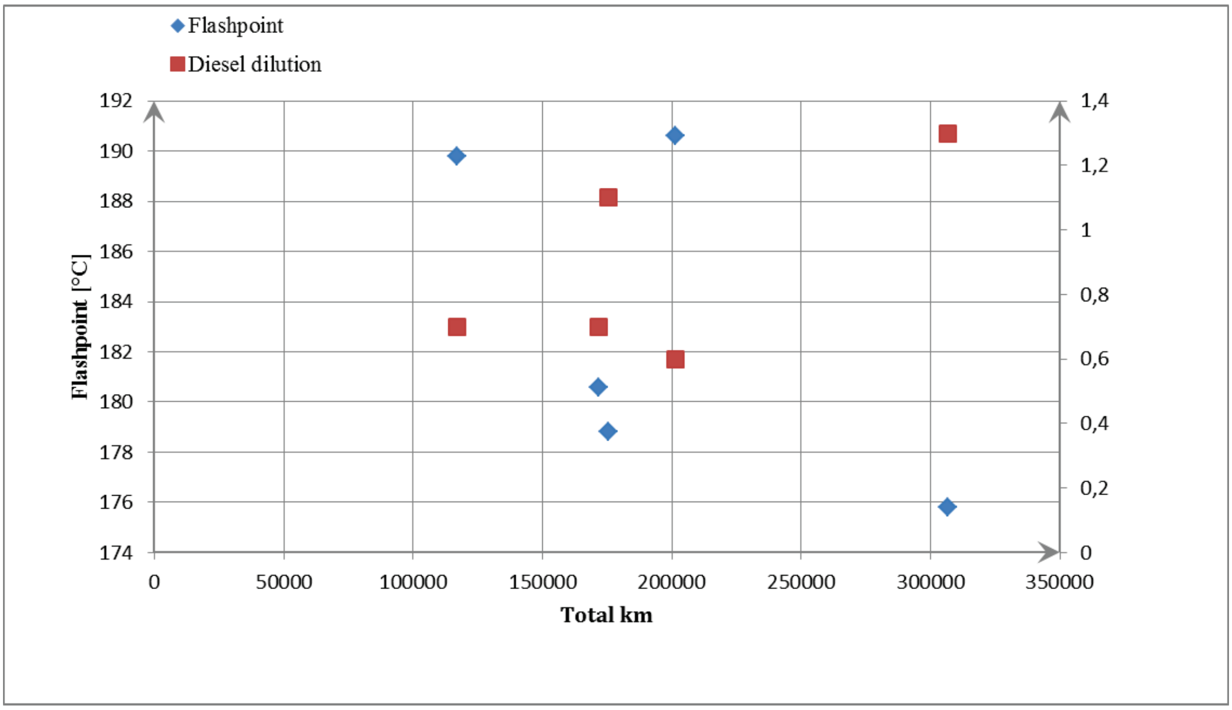

Fig. 5. Link between total kilometres performed by the car and flash point/ diesel dilution

The Fig. 6 shows that the flash point increases and the dilution decreases.

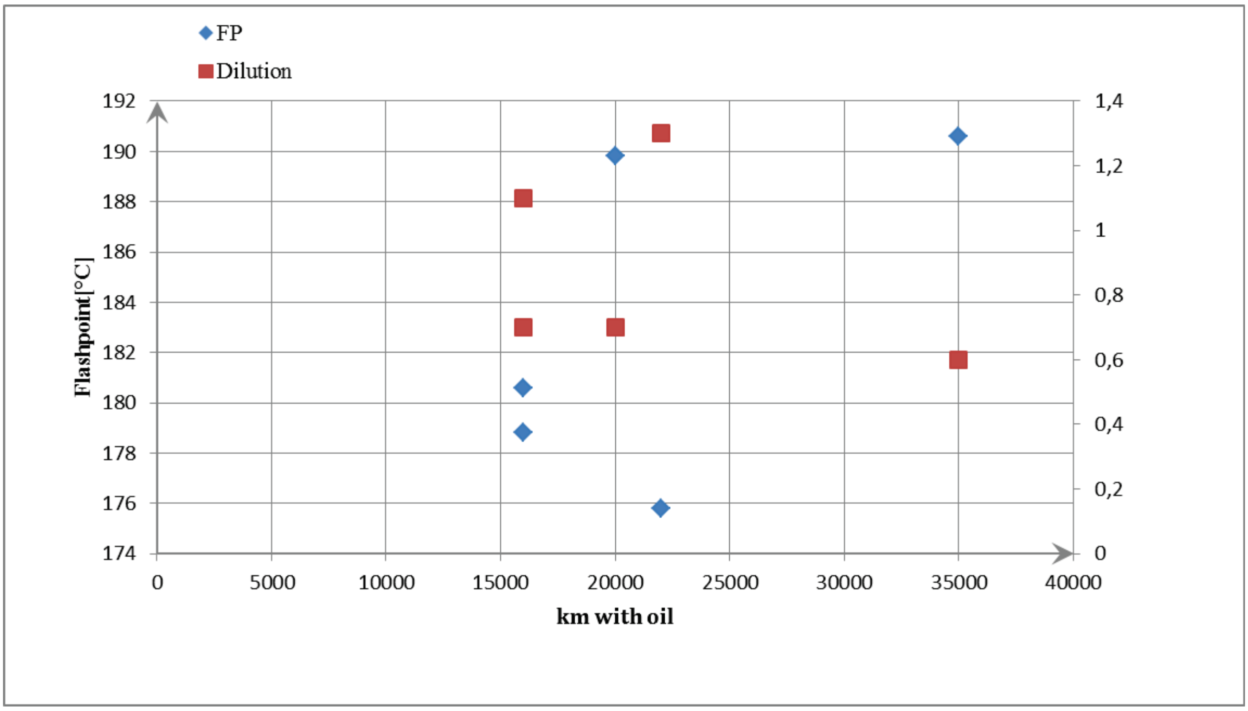

Fig. 6. Relation between the flash point, the dilution and kilometres covered with the oil

CONCLUSIONS

For the same number of kilometers covered with the same oil, duration of use is very important in terms of parameters variation studied. The study shows that a short time using causes less level of oil dilution. For a future study it is important to perform a comparison on the matter of the degree of variation of viscosity and oil dilution, between engines with PF and engines featuring the fifth injector.

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