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Fuel injection influence at engine start-up moment on diagnostic parameter blow – by phenomenon

Wpływ wtrysku paliwa w fazie rozruchu silnika na parametr diagnostyczny zjawiska przedmuchów gazów

ABSTRACT

The paper presents the diagnostic of exhaust gas scavenging crankcase combustion piston diesel engine SB-3.1 speed boot. In the measurements, the influence of fuel injected into the engine start-up phase of the value of the intensity of exhaust gas scavenging.

Keywords: *diagnostics, piston, rings, tightness, blow-by, engine starting*

STRESZCZENIE

W referacie przedstawiono diagnostykę przedmuchów gazów do skrzyni korbowej tłokowego silnika spalinowego o zapłonie samoczynnym SB-3.1 dla prędkości rozruchu. W pomiarach analizowano wpływ wtryskiwanego paliwa w fazie rozruchu silnika na wartość natężenia przedmuchów gazów.

Słowa kluczowe: *diagnostyka, tłok, pierścienie, szczelność, przedmuchy gazów, rozruch silnika*

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1. Introduction

In the initial period, the value of starting the engine crankshaft speed is most important for the boot process. Of course, an important parameter is also the starting time. High temperature engine running smoothly does not pose any major problems (we are talking about the so-called. Easy start). The situation changes starting at low temperatures (eg. During the harsh winter). During the start of the first phase of the starter motor drives the crankshaft with a complete lack of ignitions in the workspace engine cylinders [1-6]. Then, with increasing rotational speed of the shaft and longer start-up time when the temperature increases in the workspace, self fire first appear. At this time, the engine combustion chamber formed corresponding to the creation of conditions for self-ignition of the fuel. At start-up time is mainly affected by temperature in the combustion chamber, which depends on the ambient temperature, rotational speed of the engine crankshaft, the starting dose value, fuel atomization, the time required for evaporation and mixing of reaction before ignition, combustion chamber shape, the pressure and the size load losses caused by gas blow through the rings into the crankcase engine [11, 13]. The loss of cargo mainly affects the technical condition and parameters of the design and operation of the piston rings and cylinder (PRC) [2, 4, 12, 13].

Excessive consumption of the system results in an increase of exhaust gas scavenging into the crankcase, which in extreme cases can lead to failure to obtain start-up [5, 7, 8, 10]. It is also noted that particularly important effect fuel injection in the engine starting phase of the phenomenon of purge gas through the system PRC was at low temperatures.

2. Experimental procedure

Studies of exhaust gas scavenging crankcase engine performed for the SB-3.1, which is a prototype design one cylinder, four-stroke diesel engine with direct fuel injection into the open combustion chamber in the piston. The cylinder head SB-3.1 is a single cylinder engine section SW-680. Hence, for the construction of

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SB-3.1 engine parts used SW-680, among others: the piston rings (stroke 146 mm) cylinder liner (cylinder diameter 127 mm), the connecting rod to a bearing, valve, injector, and other.

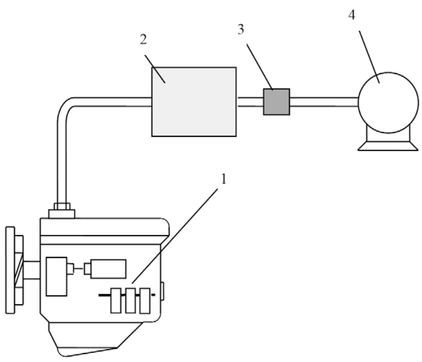

Fig. 1. Schematic of the research station:1-test engine, 2-expansion tank, 3-gas purification filter, 4-gas meter laboratory.
Rys. 1. Schemat stanowiska badawczego: 1–badany silnik, 2–zbiornik wyrównawczy, 3–filtr oczyszczania przedmuchiwanych gazów, 4–gazomierz laboratoryjny.

Prior to testing the engine was checked for condition. Activities associated with it consisted of an inspection of the strokes of the cylinder, piston rings status, check the compression ratio, valve clearance adjustment (adjusted valve clearance to 0.5 mm), adjust the injection timing (injection timing is set at 26 °C) before ZZ (repayment of external), determine the starting dose. Injection timing adjustment easier applied to the flywheel pitch angle. On the type of injector tester PRW-3 fuel injection pressure checked. The injector was efficient, because the injection pressure was 17 MPa and the quality of fuel atomization is correct. The engine was also equipped with apparatus for measuring the pressure and temperature of oil in the lubrication system.

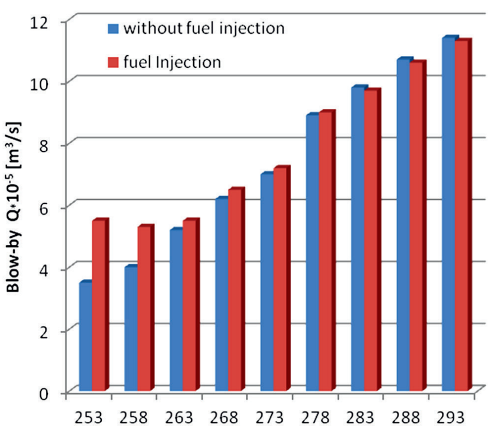

Fig. 2. Effect of fuel injection blow-by gases to the engine crankcase SB-3.1 depending on the ambient temperature.
Rys. 2. Wpływ wtrysku paliwa na przedmuchy gazów do skrzyni korbowej silnika SB-3.1 w zależności od temperatury otoczenia.

Shown in Fig. 1 was used for measuring the position of the measurement of exhaust gas scavenging into crankcase. This phenomenon results from a blow leaks occurring between the piston rings and cylinder sleeve (PRC system). A measuring instrument (4) is combined with the test engine crankcase (1) by means of a rubber hose inserted in place of the lubricating oil filler. While the engine is produced in the crankcase pressure, which causes the gas flow to the reservoir (2), a solid steel chips to eliminate pulsation and preliminary purification of exhaust gases from oil mist. Then the gases pass through a fine filter (3) and enter the laboratory meter (4). Measurement station permitted to rergister basic work parameters of engine, eg. temperature and pressure of lubricating oil, gas pressure in the crankcase, etc. The engine speed was measured by digital tachometer. In order to stabilize the temperature measurements, the engine was placed in a low-temperature chamber, which is located at the Department of Motor Vehicles Operation West Pomeranian University of Technology in Szczecin. Before performing the next test engine temperature was stabilized for at least 18 hours.

3. Test results

The test results of exhaust gas scavenging into the crankcase carried out on the engine SB-3.1 is shown in Fig. 2. The tests were carried out for temperatures of 253 K (-20 ° C) to 293 K (20 ° C) at 5 degrees. The starting time t as shown in Fig. 3 is the arithmetic mean of five measurements.

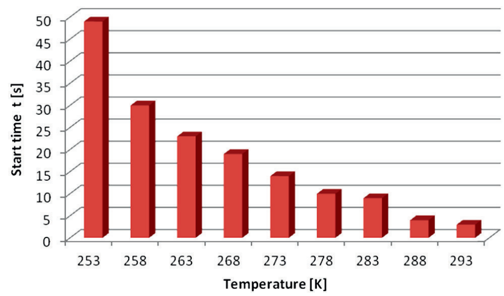

Fig. 3. Effect of temperature on motor starting time
Rys. 3. Wpływ temperatury otoczenia na czas rozruchu silnika

On issues related to the difficult start at low temperatures is affected, in addition to general technical condition of the engine, the temperature in the combustion chamber, which mainly depends on the ambient temperature, the speed of the crankshaft of the engine (at boot time decreased as a result of larger resistances start) and values load losses caused by gas blow through the rings into the crankcase.

Fig. 2 shows the time curve of exhaust gas scavenging the crankcase depending on the temperature and the fuel injection start. Worthy of note is the fact that the value of purge gas during start-up is significantly dependent on temperature start-up, despite the low rotational speed of the crankshaft. It can be seen that the higher the temperature, the purge is larger.

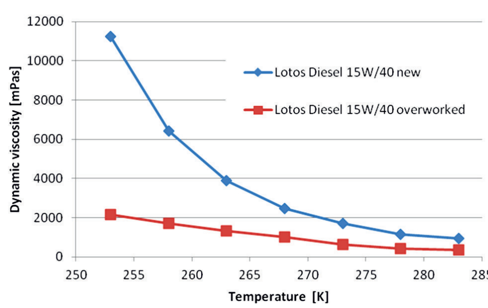

Fig. 4. Change the dynamic viscosity of the oil Lotos Diesel 15W / 40 new and overworked
Rys. 4. Zmiana lepkości dynamicznej oleju Lotos Diesel 15W/40 nowego i przepracowanego

Also has a significant impact fuel injection into the workspace. Changes in the amount of loss of working medium through the piston rings are dependent on the oil viscosity changes depending on the starting temperature, but also on the "dilution" caused by the injected fuel. In Fig. 4 it can be seen that the lower the temperature a few tens of degrees can cause a several fold increase in the viscosity of the oil, which affects the stability of the oil film and its better sealing properties. This in turn has a positive effect on the tightness of the workspace and smaller blow. In Fig. 2 it can be noted also a great influence on the fuel injection purge phenomenon, particularly at low temperature starting. Fuel injected at low temperatures for small start-up speed of the engine crankshaft will "wash" the oil film. This phenomenon increases the purge.

The tightness of the band PRC has a direct impact on the value of the load losses. It can be seen in Fig. 4 that, with the lowering of the ambient temperature increases the dynamic viscosity of the oil (especially in the initial start-up phase), which reduces the rotational speed of the engine during startup. The increase in viscosity of the oil reduces the amount of exhaust gas blow-by. This is a beneficial relationship for a cold engine start, as this facilitates the start. It should be noted that the measurements were performed for the actual conditions of the boot, and a slight change in the speed of the engine crankshaft was caused by a reduction in the starting temperature. Reduced temperature affected the increase in the viscosity of lubricating oil, but also a decrease in battery capacity and the deterioration process of creating a combustible mixture (reducing the pressure and temperature of the end of the compression stroke, worse fuel atomization due to a decrease in the speed of the injection pump). This prolongs the time required to obtain necessary starting the engine, as shown in Fig. 3.

It could be notice in presented researches that using blow – by phenomena to analyzing technical condition piston – cylinder linear system huge influence on starting up has injection fuel. In engine construction, where hydrogen is using as the fuel it could have mainly influence on blow – by value. It could make a mistake by reading diagnostic parameter (blow – by) and put wrong results of technical condition assessment in.

4. Summary

Made a big impact studies confirm the fuel injection in the initial start-up phase of the value of exhaust gas scavenging into the crankcase. You can unequivocally state that in the initial start-up period unburned fuel will wash the oil film from the cylinder liner, resulting in deterioration of the labyrinth sealing ring assembly on the plunger. This in turn reveals an increase in the value of blow-by crankcase gases. Clear demonstration of the impact of fuel injected to the thickness of the oil film between the ring and cylinder liner in the initial phase of starting the engine can be determined based on the measurements, eg. Oil film resistance using inductive meter, which was not investigated in this work.

During the measurements also noted that in the initial period of starting the engine, if it does not work for a certain period of time (approximately 3 weeks for Lotus mineral lubricating oil 15W / 40) immediately after starting the flow of exhaust gas scavenging repeatedly reaches a higher value than the average for a given ambient temperature. After a few or several cycles of the engine (depending on ambient temperature), the intensity decreased to purge the average value achieved on average. This means that in the initial start-up period, there was no oil film on the cylinder and takes away the PRC system worked without a layer of oil. Some researchers [2, 9] believe that in the initial period of operation of the engine on the cylinder strokes creates a still oil film. Only after some time, the oil film is achieved when there is mobility and hydrodynamic lubrication. In the subsequent period of operation of the engine can be seen the effect of vibration on the piston rings oil film, which loses its stability and there are large variations in the thickness. However, the lubrication system stabilizes PRC and despite further engine operation does not change its character.

Changes in the amount of loss of working medium through the piston rings are dependent on the oil viscosity changes depending on the starting temperature. Lowering the temperature by tens of degrees can cause a several fold increase in the viscosity of the oil, which affects the stability and quality of the oil film (better sealing properties of the oil film), and this has a positive effect on the tightness of the working space and a smaller value of lost load the workspace in the form blow-by gases into the crankcase.

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