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(54) **Method and system for dectecting the dilution of the lubricant by the fuel**

(57) Method for detecting the dilution of the lubricant of an internal-combustion engine having a crankcase and a series of combustion chambers delimitated by a cylinder open in its lower part toward said crankcase and a movable piston in said cylinder, comprising the measurement of hydrocarbons (HC) in gases withdrawn from the crankcase of said engine by means of a provided sensor (6). System having the function to apply said method and vehicle equipped with said system.

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Description

FIELD OF THE INVENTION

[0001] This invention relates to a method for detecting the dilution of the lubricant by the fuel in an internal-combustion engine, in particular an engine provided with combustion chambers, delimitated between cylinders and pistons, and with a crankcase, in communication with said cylinders, in which a stock of lubricating oil is stored, more in particular a diesel engine for a vehicle.

DESCRIPTION OF THE PRIOR ART

[0002] The traditional internal-combustion engines, as those for vehicles, are equipped with several combustion chambers delimited between cylinders and pistons. In their lower part the cylinders are open toward a crankcase in which various mechanical parts are present, such as the connecting rod and the crankshaft. The pistons separate the combustion chamber from the crankcase. The lubricant circulates within the crankcase and collects in a provided sump at the bottom, from where it is sucked by a provided pump and sent to the provided pipes in order to lubricate the different components.

[0003] It is inevitable that some matter filters from the combustion chambers toward the crankcase along the walls of the cylinders, favoured also by the difference of pressure caused by the functioning of the engine. This regards both gaseous matter, such as air and products of partial or total combustion, and fuel.

[0004] For this reason the crankcase is usually provided with a breather system, which may comprise a valve. Separation systems, such as filters of different types, of the oil entrained by the blow-by gases are usually included. In order to avoid pollution, the blow-by gases may be recirculated in the intake line of the engine and assure the combustion of possible unburnt or evaporated fuel or of residues of lubricating oil.

[0005] A particularly felt problem is the dilution of the lubricating oil by the fuel. The breather contributes to solve the problem, given the higher volatility of the fuel. However, the percentage of fuel that is present in the lubricating oil may reach considerable values, even around 5%, above all in diesel engines. Some of the factors that cause this phenomenon are the high pressure in the combustion chambers and the lower volatility of the fuel. Moreover, new and widespread injection techniques complicate the problem. It is the case of the fuel fractionation that improves the quality of the exhaust gases, or of the fuel injection after the combustion stage, in order to have some fuel in the exhaust gases that is used to heat the exhaust gases or to create a reducing mixture for gas treating devices on the exhaust line. It is evident that faults of different type or a reduced tightness between the cylinder and the piston, brought by wear or by other causes, may increase the dilution up to intolerable levels. The dilution of the lubricating oil considerably worsen its physical and chemical properties and causes wear and corrosion problems to the various components of the engine. Moreover, if the dilution reaches abnormally high values, inflammable gaseous mixtures may develop from the crankcase to the whole breather line. This causes many dangers, such as the possibility that the gases recirculated to the engine provoke the ignition in the cylinders and the starting of the engine without fuel supply.

[0006] For this reason, the composition of the lubricant has to be monitored in order to understand when it is necessary to change it, and in order to detect faults or malfunctions of the engine that cause an excessive dilution of lubricant. It is clear that a periodic oil change may be insufficient, especially in case of malfunction.

[0007] A known method is based on the measuring of the level of the lubricant. In this method, however, it is necessary to compare earlier and more recent data. Therefore this method is not suitable for immediate detecting systems, in particular on-board systems, and even the workshop tests take a lot of time.

[0008] Other systems, such as the use of viscosity sensors or the measuring of the delivery head of the lubricant, proved to be inaccurate, especially if the fuel was present in relevant but not high concentration. Moreover, the results depend on many other factors, such as the working conditions of the engine.

[0009] Therefore, the evaluation of the dilution of the lubricant is still awkward and expensive, its immediate detection is difficult or impossible with on-board systems, in case of vehicles, and even the detection during the workshop tests is problematic. It would be preferable a reliable and rapid detection system which might be applied to the engine during the routine or extraordinary maintenance. It would also be preferable a system that detects easily even a small quantity of fuel. Moreover, it would be preferable an integrated detection system, being able to work during the ordinary functioning of the engine. In case of vehicles, this means that it would be preferable an on-board detection system.

SUMMARY OF THE INVENTION

[0010] The problems mentioned above have been solved according to this invention by a method for detecting the dilution of the lubricant of an internal-combustion engine comprising the measurement of the hydrocarbons (HC) in gases withdrawn from the crankcase of said engine by means of a provided sensor.

[0011] According to a preferred embodiment of the invention, the gases are withdrawn from a breather line of said

crankcase. According to an embodiment of the invention, if the breather line is connected to an air intake line of the engine, the detection takes place on said breather line or on the gases withdrawn from said line before the connection with the intake line. It is possible that the detection takes place on gases present or withdrawn from a position upstream or downstream of a separation system of the lubricant from the blow-by gas. According to an alternative embodiment, the detection takes place on the intake line or on gases withdrawn from the intake line after the introduction of the blow-by gas. It is also possible to make the measurement directly in the crankcase, by means of a duly placed sensor.

[0012] The invention relates also to a detection system with the function to realize the method described above and an engine equipped with said system.

[0013] This invention refers in particular to what mentioned in the claims attached hereto.

LIST OF THE FIGURES

[0014] This invention will be explained by means of a detailed description of a preferred, but non-exclusive, embodiments shown with the help of the drawings that are attached hereto, which are merely illustrative and not-limitative, in which:

figure 1 shows the diagram of an engine provided with breather line from the crankcase, connected to the air intake line according to this invention.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

[0015] Figure 1 represents an engine in outline, such as a diesel engine for vehicles, which is suitable for the application of the method according to this invention. The method according to this invention may also be applied to other types of internal-combustion engines, even though diesel engines are its preferred application field, for the reasons mentioned above.

[0016] The engine 1 has an air intake line 2 and a breather line 3 of the crankcase. The breather line may connect, as usual, the crankcase with the intake line, for example at a point upstream of the high-boost turbocharger 4, if present. The breather line may include, as usual, different types of devices 5, such as separation devices, that may consist of different types of filters, inertial separator or others, in order to separate the oil entrained by the gaseous stream and to reintroduce it into the crankcase.

[0017] According to this invention, a duly calibrated sensor 6 for the detection of hydrocarbons (HC sensor) is used to measure the quantity of hydrocarbons present in the blow-by gases of the crankcase.

[0018] According to an embodiment of the invention, the gas may be withdrawn at an appropriate point and sent to an appropriate measuring device comprising the sensor. According to another embodiment of the invention, the sensor may be placed in an appropriate point of the engine, for example in the breather line (point A or A'), upstream or downstream of a separation device 5 of the lubricant drops, or in the intake line, downstream of the introduction point (point B). This measurements may also be carried out by external devices during the routine maintenance.

[0019] Alternatively, the sensor may be placed in an appropriate point of the engine, in order to obtain an on-board detection system.

[0020] The sensor may be of the appropriate type, different type of sensors are used, for example, for the evaluation of the presence of hydrocarbons in the exhaust gases. Other sensors are of the type used for the detection of gaseous hydrocarbons, for example in alarm systems. Also the physical principle of the sensor may be of any of the appropriate known type, for example sensors based on the capacity of the gas to remove heat, such as those based on the MMOS (mixed metal oxide semiconductor). The sensor, of course, has to be able to bear the conditions of the blow-by gases (temperature, presence of nebulized oil and other pollutants, such as soot). The person skilled in the art is able to determine which type of sensor is the most appropriate and to carry out an adequate calibration.

[0021] It has been measured that the method according to this invention allows an immediate and reliable evaluation of the dilution of the lubricant by the fuel. The reliability of the method is higher than the known methods, even in case of low dilution values, when other methods have proved to be totally inadequate.

[0022] This can be noticed by observing the attached table 1, where the results of tests carried out on a diesel engine for industrial vehicles are compared. The measurements have been carried out with an HC sensor first at the beginning of the test, then at the time indicated and finally when the dilution had lowered because of the evaporation of the fuel. The data obtained by this method are compared with those obtained with other methods. The test was carried out at different dilution conditions of the lubricating oil and at different operating conditions of the engine (these conditions where compared each time with the condition of non diluted oil). The oil consumption and the evaporated fuel were measured in the different conditions. The entrainment of the oil by the blow-by gases was measured by weighting a provided filter after the test, and averaging the value for the whole duration of the test. In addition, other parameters that are indicative of the lubricant quality were measured, such as viscosity, detected with a provided sensor, and oil pressure, at the beginning of the test.

[0023] The HC presence has been detected by means of a sensor both at the beginning of the test, and at the time indicated for the various tests, when the amount of fuel in the oil was lower as a result of the evaporation. The considerable sensibility of the detection in every operative condition of the engine is evident, even with low dilution values. The sensor was placed on the breather line of the crankcase, in an appropriate position.

[0024] This invention also relates to an engine, preferably a diesel engine and in particular a diesel engine for vehicles, equipped with a sensor for the detection of hydrocarbons in the blow-by gases of the crankcase, and to a vehicle, in particular an industrial vehicle equipped with said engine.

[0025] According to a preferred embodiment of the invention, the sensor sends the data to a control unit of the vehicle, that has the function to process and possibly to compare the data with a reference value. The processed data may be displayed by means of provided indicators, both for the alarm activation and the regeneration systems, if present. If the detection is carried out by an external system, said system may be equipped with a control unit with the function to receive the data from the HC sensor, and possibly from other sensors, and to process them in order to evaluate the dilution of the lubricant, according to predetermined methods. The invention also relates to a computer software, as such control unit with the function to carry out the evaluation described above can be considered .

[0026] The considerable sensibility of the method allows an analysis of the temporal variation of the dilution, even with low values, therefore providing a further possibility to distinguish anomalous functioning and alteration of the ordinary functioning of the engine.

[0027] Obviously, according to the type of sensor, it is necessary to take into consideration the conditions of the measured gas, in particular the flow rate and the temperature.

[0028] Both in the on-board detection system and in the workshop test it is possible, therefore, to correct or to process the data collected by the sensor using the data collected by other types of sensor, or it si possible to carry out the measurement only when the conditions are within the values allowing to obtain a significant result. Of course, in this case it is easier to carry out the test under predetermined operative conditions of the engine.

Table 1

Engine speed (min^{-1})	2100		2100		2100		1200	
Delivered power (kW)	290		290		145		180	
Oil temperature (°C)	110		107		99		99	
Overall quantity of pure oil (l)	22	19	22	21,5	22	21,5	22	21,5
Overall quantity of fuel (l)	0	3	0	0,5	0	0,5	0	0,5
Overall consumption (g/h)		160		30		26		23
Consumed oil (g/h)		20		16		14		9
Evaporated fuel (g/h)		140		14		12		14
HC in the blow-by gases of the crankcase (ppm)	beginning of the test		beginning of the test		beginning of the test		beginning of the test	
	214	10941	291	5075	286	2407	352	2036
HC in the blow-by gases of the crankcase (ppm)	After 2 h		After 5 h		After 5 h		After 5 h	
	213	5116	276	1075	190	539	77	458
Viscosity (V) at the beginning of the test	3,94	3,58	3,91	3,92	4,51	4,40	4,38	4,29
Oil pressure (bar) at the beginning of the test	4,74	4,65	4,80	4,80	4,85	4,85	4,20	4,17
Oil entrainment (g/h) at the beginning of the test	1,5	10,5	0,7	1,0	0,5	0,5	0,3	0,8

Claims

1. Method for detecting the dilution of the lubricant of an internal-combustion engine (1) having a crankcase, a series of combustion chambers delimitated by a cylinder open in its lower part toward said crankcase and a piston movable in said cylinder, comprising the measurement of hydrocarbons (HC), in gases withdrawn from the crankcase of said engine, by means of an appropriate sensor (HC sensor) (6).

2. Method according to claim 1, wherein the measurement is carried out on gases withdrawn from or present in a breather line (3) for the crankcase gases, upstream of a possible introduction point of said gases in an intake line of said engine.

3. Method according to claim 1, wherein the measurement is carried out on gases taken from or present in an intake line (2) of said engine, downstream of a possible introduction point of the blow-by gas of the crankcase by means of an appropriate breather line.

4. Method according to claim 2, wherein the measurement is carried out on gases withdrawn from or present upstream a separation device (5) of the drops of lubricant.

5. Method according to claim 2, wherein the measurement is carried out on gases withdrawn from or present downstream a separation device (5) of the drops of lubricant.

6. Method according to any of the previous claim, for detecting the dilution of the lubricant of an engine of a vehicle, carried out by means of an on-board system, comprising said sensor.

7. Method according to claim 6, comprising sending the data collected by the sensor to a control unit having the function to process the data.

8. Method according to any of the claims from 1 to 5, wherein the measurement is carried out by means of a system that is not integrated in the engine, system comprising a HC sensor having the function to be introduced into the crankcase, into a breather line or into an intake line of said engine, or comprising the withdrawal of the gas from one of said points and the measurement by means of said sensors on said withdrawn gas.

9. System for detecting the dilution of the lubricant of an internal-combustion engine (1) having a crankcase and a series of combustion chambers delimitated by a cylinder open in its lower part toward said crankcase and a piston movable in said cylinder, comprising a HC sensor having the function to measure on the gases withdrawn from of present in the crankcase of the engine, in a breather line from said crankcase of in a intake line of said engine downstream an intake point of the blow-by gases in said crankcase.

10. System according to claim 9, comprising a control unit having the function to process the data collected by said sensor.

11. Vehicle equipped with a system according to claim 9 or 10.

12. Computer software suitable to process the data collected by a HC sensor and to evaluate the dilution of the lubricant by the fuel in an internal-combustion engine on the basis of said data.

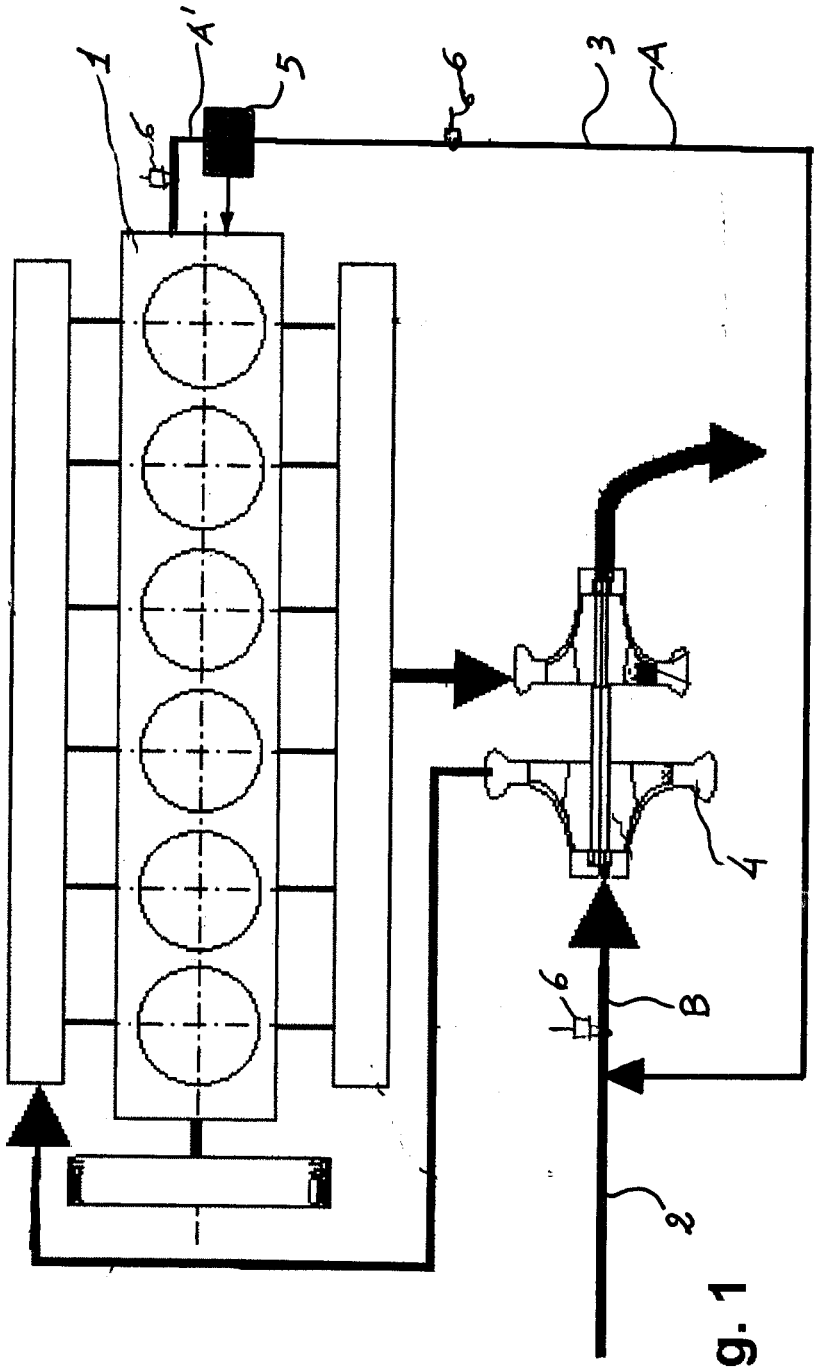

Fig. 1

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 12 2384

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F02D
F01M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	5 June 2008	Mouton, Jean

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 07 12 2384

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