the empirical data to be used for supervising the injectors, and for the same reason uncertainty in this matter occurs.

From EP 1 426 571 is also known local injectors that are based on using a needle valve with a valve body in the form of a needle and a corresponding valve seat. If the needle is inclined relative to the seat or not aligned with the seat, a leak occurs. The needle is therefore to be guided so that the needle is not displaced radially relative to the valve seat. This is typically achieved by having fine tolerances and fit of needle and valve boring (needle guide) in which the needle is positioned. There are drawbacks by this design as the injectors typically have a considerable length since they extend through a relatively thick cylinder wall and lining. The valve seat is to be as close as possible to the nozzle aperture in order to reduce the dead volume to be moved/accelerated before the valve begins to deliver the oil. This means that the relatively fine tolerances on the boring of the nozzle in which the needle is positioned and the needle are to be provided with great length in order to ensure that the needle is centred correctly in the seat. This fine tolerance and fit between the needle guide and the needle means that the valve is sensitive to dirt in piping and lubricating oil as it can get stuck in the very narrow gap appearing between the needle and the needle guide, meaning that relatively great demands are made to the purity of the oil supplied to the injector. This may cause the needle to be displaced off-centre relative to the seat or the needle movement to be blocked. In both cases there is a reduction of the valve function. This means that great demands are put on purity of the oil supplied to the injector.

From EP 1 582 706 a system is known which corresponds to the system and method mentioned by way of introduction. This document does not disclose that the dosing system includes a flow measuring unit. Accordingly, the document neither discloses how such flow measuring unit shall be arranged in relation to the injectors and/or to the cylinders. The document neither discloses how the flow measuring units are connected with the control unit. The document neither discloses how a regulation shall be effected based on the signals received by the control unit.

JP 2271019 discloses a lubrication device for injection of lubricant into an air/fuel mixture in the air intake in order to mix the lubricant with the air/fuel mixture before

Object of the Invention

It is the purpose of the present invention to indicate a lubricating system and a method for dosing lubricating oil where the drawbacks of the prior art systems are avoided.

Moreover, the object of the invention is to indicate an injector that contributes to avoid drawbacks of the prior art systems and which will be more robust/reliable and simple in operation.

Description of the Invention

The objective is achieved with a system and method as described in the independent claims.

In order to overcome the drawback of dependence on flow and viscosity in the supply lines, the system according to the invention is peculiar in that the dosing system includes a flow measuring unit for each injector and/or for each cylinder, that the flow measuring units are connected with the control unit for use in a closed loop regulation, that signal lines are connected to the control unit for delivering load/index signals directly to the control unit for controlling, timing and dosing of one or more injectors per cylinder, depending on reference signals form the engine and that each injector is made as a unit, that the opening/closing valve is an electromechanical valve integrated in the injector for dosing the lubricating oil, where the electromechanical opening/closing valve includes a spring-biased valve stem.

The method according to the invention is peculiar by the step of a local flow measurement for each injector and/or a cylinder central flow measurement of the actually dosed amount of oil per cylinder, transmitting result of flow measurement to the control unit, comparing the flow measurement of the actually dosed amount of oil with an expected/planned amount of oil, and by the step of delivering load/index signals directly to the control unit for controlling timing and dosing of one or more injectors per cylinder, depending on reference signals from the engine and by the step of the control unit transmitting a control signal to the opening/closing unit for regulating timing and amount of oil to the required extent and that dosing of lubricating oil is performed by activating an opening/closing valve in the form of an electromechanical valve integrated in the injector for dosing the lubricating oil, for moving the valve stem of the opening/closing valve by injection of the lubricating oil.

wall in the valve guide of the opening/closing valve there is a gap with a width exceeding 10 μm.

The dosing system is peculiar in that each injector is made as a unit, that the opening/closing valve is an electromechanical valve integrated in the injector for dosing the lubricating oil, where the electromechanical opening/closing valve includes a spring-biased valve stem.

According to a further embodiment of the invention, the dosing system is peculiar in that it includes flow measuring units with the same operation range for each injector and for each cylinder, and that the control unit is connected with all the flow measuring units and adapted for receiving signal from the flow measuring units at the injectors at relatively large flow rates and for receiving signal from the cylinder central flow measuring units at relatively small flow rates.

According to a further embodiment of the invention, the dosing system is peculiar in that it includes flow measuring units with different operation range for each injector and for each cylinder, that the control unit is connected with all the flow measuring units, that the flow measurement units with the lowest operating range are the local flow measuring units which are connected with the injectors, and that the flow measuring units with the highest operating ranges are the cylinder central flow measuring units.

According to a further embodiment of the invention, the dosing system is peculiar in that it only includes one cylinder central flow measuring unit which is combined with at least one local flow measuring unit connected with an injector.

According to a further embodiment of the invention, the dosing system is peculiar in that it includes a combination of a cylinder local flow measuring unit and an injector local flowswitch.

According to a further embodiment of the invention, the method is peculiar in that the injector local flow measurement is performed in combination with a central flow measurement per cylinder. In this way is achieved a more exact measurement wherein by relatively large flows the measurements from the local flowmeters on the individual injectors can be used and by the lesser flows (e.g. at low engine speeds and by small dosing amounts) the cylinder central flowmeters are used. The reason for this is that it is necessary that the dosing amount per injector is to "cover" a relatively large area.
An alternative embodiment will be that instead of using the same flowmeters (with same capacity), one may use different flow measuring units with different flow ranges, where the flow measurement unit with the least flow range is situated locally on the individual injector and the flowmeter with the greatest flow range is situated centrally of the cylinder. This method provides that the flow measuring system can more easily provide more precise flow measurements over the whole flow range.

An alternative embodiment will be to combine a central flowmeter with minimum one flowmeter mounted on one of the injectors. In that way is provided a measuring system which can handle large as well as small flows and a cheaper and more maintenance-free setup where the number of flowmeters is limited.

According to a further embodiment of the invention, the method is peculiar in that the supply pressure in the supply line is monitored.

According to a further embodiment of the invention, the method is peculiar in that the supply pressure in the supply line is used as parameter for controlling the dosing amount.

The method is peculiar in that
dosing of lubricating oil is performed by activating an opening/closing valve in the form of an electromechanical valve integrated in the injector for dosing the lubricating oil, for moving the valve stem of the opening/closing valve by injection of the lubricating oil.

Further the injector is peculiar in that the injector includes a filter and that the gap of the opening/closing valve at least has the same width corresponding to half of the mesh width of the filter.

Further the injector is peculiar in that it includes an electromechanical actuator, preferably in the form of a solenoid valve or a piezo-electric element.

Further the injector is peculiar in that it has an outlet for connection with a return line for draining off excess oil or for performing pressure measurements.

Further the injector is peculiar in that the injector includes a flow sight glass or a flowswitch for visually or electronically indicating an actual flow.

Further the injector is peculiar in that it is adapted to operate at a supply pressure between 30 and 100 bar.

Further the injector is peculiar in that it is adapted to operate with compact jet(s).

Further the injector is peculiar in that it is adapted to operate with atomised spray(s).

Further the injector is peculiar in that the gap width between the stem of the valve body and a boring in which the stem is received is at least half the size of the cross-sectional dimension of a nozzle aperture.

For each injector or for all injectors associated with a cylinder, a pulsating flow is to be measured concurrently.

In case of failing injectors, the other injectors can automatically supplement/replace one or more failing injectors based on the control in the control unit and the closed loop regulation.

It is preferred to have the opening/closing function of the dosing unit integrated in the injector while at the same time the control is designed so that based on actual

continuous calculation with continuously overlapping periods. Based on empirical experiments, for a given flow measurement unit the correlation between a given flow interval and the number of pulses is to be established which is to be integrated in the local control box.

For a cylinder is used between four and ten injectors, depending on engine size and type.

The dosing system operates via a pressurised supply line with lubricating oil. The lubricating oil is kept at a constant pressure, and with regard to minimising disturbances/variations in the pressurised supply line to the individual cylinders/injectors, there may be a need for disposing accumulators per injector and/or centrally per cylinder.

Alternatively, for using accumulators in the system, one could use supply pipes with greater clearance such that the pipes become accumulators by themselves.

Timing of dosing the lubricating oil is either controlled locally or centrally. The activation time is continuously adapted, depending on the reference signals of the engine.

In order to monitor the function of injectors, various solutions can be used:
Primarily, concurrent flow measurements are used where the actually dosed amount is compared with the expected flow. This flow measurement can either be performed locally per injector or centrally per cylinder such that the actually dosed amounts can be used for a closed loop regulation.

In case of deviations, these are processed/handled by the local or the central control box, respectively. For example, the control is to be capable of identifying any problems with one or more injectors.

Fig. 2.1 shows further embodiment of a system according to the invention;

Fig. 2.2 shows a detail of the system shown in Fig. 2;

Fig. 3 shows further embodiment of a system according to the invention;

Fig. 4.1 and 4.2 show detailed views of an injector for use in the system according to the invention; and

Fig. 5 shows an alternative embodiment of an injector for use in the system according to the invention.

Detailed Description of the Invention

Figure 1 shows a complete lubricating system for N cylinders 1. Each cylinder is equipped with a number of X injectors 2 which are connected to a common lubricating oil supply line 31 having a constant supply pressure, e.g. in the magnitude 30 - 100 bars. The supply pressure is delivered by a hydraulic pump unit 10 which is supplied from the day tank 1000.

The pump station 10 includes two pumps 11, two filters 12 and two check valves 13 preventing the lubricating oil from running back through a still-standing pump 11. The pump station also includes two shut-off valves 14 that are inserted in the supply line 34 so that the filters 12 can be cleaned during operation. The two pumps 11 are stand-by for each other and start up automatically in case of a drop in oil pressure.

At the end of the supply lines 31 there is provided a pressure valve 20 or a stepless electronically controllable pressure valve 115 (the figure shows the latter in principle). Typically, the pressure in the supply line will be constant, and here is used a common pressure valve 20 where the pressure is constant. Alternatively, one can use the supply pressure in the supply line 31 as an additional parameter for the system such that it is possible to use various supply pressures depending on the amounts to be dosed, the time available for delivery (e.g. 3 - 6 crank degrees in order to impinge on the piston), viscosity conditions (oil type and temperature), and so on.

As shown on Figure 1, the pressure valve 20 can be an electronically controlled pressure valve with adjustable pressure which via the connection 505 to the general

Figures 4.1 and 4.2 show an injector as can be used in a system of the above mentioned type. On the Figure 3 is shown that each cylinder 1 has a number of injectors 2 (four are shown per cylinder on the drawing). Pressurised oil is supplied through the branch pipe 21 (see Fig. 2.1 and 3) to the injector 2 through supply channel 20100.

The injector shown in Figures 4 and 5 includes a nozzle 1001 which via an external screw thread is mounted in an internal valve housing 1006. The valve housing 1006 itself has a flange that partially rests upon the injector housing 1017 itself and partially upon an assembly flange 1007. The injector housing 1017 is fitted externally of the assembly of nozzle 1001 and valve housing 1006, and where the injector housing 1017 is mounted in a flange, e.g. by an interference fit. At the top, the internal valve housing 1006 consists of a flange with an O-ring groove and a subsequent turning that makes the valve housing 1006 continue a length up into the solenoid core/armature housing 1009. The O-ring 1008 ensures that the pressurised oil remains within valve housing 1006 and solenoid core/armature housing 1009. Around solenoid core/armature housing 1009 is provided a main flange 1010 which via screws 1011 clamps injector housing with nozzle, solenoid core/armature housing 1009 and assembly flange 1007. The nozzle/valve housing assembly 1001/1006 is located in the injector housing and by means of an O-ring 1002 it is ensured that no dirt or oil residues enter farther up in the injector housing 1017.

In the solenoid core/armature housing 1009 is located an armature/piston 1012 with an internal screw thread where the valve body 1003 is mounted, and where the threaded joint is secured by a pointed screw 1013. In the armature 1012 there are some channels 1023 for conducting the pressurised oil on in direction towards the nozzle. The possible travel of valve body/armature 1003/1012 is given by the cavity 20200.

In the injector 2, the oil is conducted through the injector via the cavity 20200 and through the channel 1023. The oil then continues out into the cavity 1022 and through the channel 1021 to the cavity 1020 from where the oil is conducted on via the gap 1030 to the cavity around the ball valve seat 1019. The gap is formed between the valve body stem 1003 and the wall 1031 in the boring in which the valve body stem is received.