In order for the viscosity of the engine oil to be determined as directly as possible, particularly in the case of a motor vehicle with hydraulic control of the gas exchange valves, provision is made for a time period which a hydraulic component, in particular a solenoid valve, requires to move from a first position to a second position to be used as a measure of the viscosity. In particular, an electrical control signal for the solenoid valve is evaluated in the process. An additional sensor arrangement is not required. The determined viscosity is preferably actively used for controlling the gas exchange valves.
Fig. 3

Fig. 4
METHOD AND CONTROL DEVICE FOR DETERMINING A CHARACTERISTIC VISCOSITY VARIABLE OF AN OIL

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of DE 10 2010 020 754.3 filed May 17, 2010, which is incorporated by reference herein.

FIELD OF THE INVENTION

[0002] The invention relates to a method and to a control device for determining a characteristic viscosity variable of an oil in a machine with hydraulic control, in particular of an engine oil in a motor vehicle preferably with hydraulic control of the gas exchange valves, with a hydraulic component being adjusted from a first position to a second position with the aid of a control signal.

BACKGROUND OF THE INVENTION

[0003] In modern motor vehicles, the so-called gas exchange valves, that is to say the inlet and/or outlet valves for the motor vehicle engine, are nowadays controlled in a load-dependent manner for the purposes of minimizing pollutants and reducing consumption. Various systems are used in the process. All systems share the common feature that the closing and/or opening times of the gas exchange valves are changed in a load-dependent manner in relation to the crankshaft position (rotational angle). Hydraulic control systems in which a change in the closing and/or opening times of the gas exchange valve is induced with the aid of a hydraulic fluid, specifically the engine oil, are also used here.

[0004] EP 1 544 419 A1, for example, discloses a first hydraulic control system, specifically a hydraulic camshaft adjuster. In a system of this kind, the phase angle between the crankshaft and the camshaft of a motor vehicle engine is changed with the aid of the hydraulic fluid. This is achieved by variably filling pressure chambers of an actuating apparatus. Control valves, which are in the form of solenoid valves in particular, are usually provided for actuating and filling and emptying the pressure chambers.

[0005] The article "Elektrohydraulische Ventilsteuerung mit dem "MultiAir"-Verfahren [Electrohydraulic valve control using the "MultiAir" method]" in the German automotive engineering journal MTZ, December 2009, discloses an alternative hydraulic control system for actuating the gas exchange valves. In the case of this electrohydraulic valve control arrangement, provision is made for the movement of the camshaft to be transmitted to a respective gas exchange valve via the hydraulic liquid. A control or switching valve, which is in the form of a solenoid valve in particular, is provided for control purposes. In the closed state, the camshaft is connected to the respective gas exchange valve via a so-called hydraulic linkage, and therefore the gas exchange valve necessarily follows a cam of the camshaft. By also partially opening the switching valve, the hydraulic fluid can pass into a compensation or pressure chamber, and therefore the gas exchange valve is decoupled from the movement of the cam. As a result, it is possible to vary the opening time point, the closing time point and the stroke of the gas exchange valve within an envelope curve which is predefined by the movement of the cam. This variation can be performed in a cylinder-selective manner.

[0006] Exact actuation of the gas exchange valves is of critical importance with regard to the high level of efficiency together with low emission of pollutants as is required in modern internal combustion engines. In hydraulic systems, the type of hydraulic liquid used, that is to say, in particular, the quality of the engine oil used, has a significant effect on operation. In particular, the effectiveness of the hydraulic control means is sensitive to fluctuations in the viscosity of the oil used. Such fluctuations occur for operational reasons due to different oil temperatures. As disclosed in the article "Elektrohydraulische Ventilsteuerung mit dem "MultiAir"-Verfahren [Electrohydraulic valve control using the "MultiAir" method]," the temperature-dependent fluctuations in oil viscosity have to date been taken into consideration in a model-based control algorithm which takes into consideration the measurement values from an oil temperature sensor.

[0007] This temperature-dependent and therefore indirect determination operation has disadvantages and does not take into consideration, for example, aging of the engine oil or wear of the hydraulic components.

[0008] Proceeding from this, the invention is based on the problem of specifying an improved method and an improved control device for directly determining a characteristic viscosity variable for an oil, it being possible, in particular, to take aging and wear effects into consideration too.

SUMMARY OF THE INVENTION

[0009] According to the invention, the problem is solved by a method and a control device for determining a characteristic viscosity variable of an oil in a machine with hydraulic control, with a hydraulic component being adjusted from a first position to a second position with the aid of a control signal which is usually electrical. The time period during which the component requires for the changeover from the first position to the second position is used as a measure of the characteristic viscosity variable.

[0010] This refinement is based on the basic consideration that the movement sequence of a hydraulic component of the hydraulic system in the event of an adjusting movement of the hydraulic component from a first position to a second position is critically dependent on the quality of the oil used and, in particular, on the viscosity. A frictional force which counteracts the movement of the hydraulic component is, as it were, exerted by means of the viscosity, and therefore the time period for the adjusting movement of the hydraulic component allows a conclusion to be drawn about the viscosity.

[0011] In this case, the hydraulic component is, in particular, a component which changes over from the first position to the second position in a force-controlled manner, but not in a mechanically positively controlled manner, in such a way that different frictional resistances lead to different time periods for the adjusting movement. This free, unforced movement is also called a ballistic movement. In this case, the force is applied, for example, by a spring. On account of the countering viscosity-induced frictional force of the oil (possibly additionally against the oil pressure-induced force), the time period for the actuating movements varies as a function of the viscosities.

[0012] The oil is preferably an engine oil in a motor vehicle which is equipped, in particular, with hydraulic control of the gas exchange valves, for example with a hydraulic camshaft adjuster and, in particular, with an electrohydraulic valve control means, as disclosed, for example, in EP 1 544 419 A1.
A characteristic viscosity variable is understood to mean a characteristic variable which is directly correlated with the viscosity. In this case, the characteristic viscosity variable is, in particular, the viscosity itself, in particular the so-called kinematic viscosity, or a viscosity indicator, for example the change in the viscosity, a relative viscosity etc., which is derived from the viscosity.

The particular advantage of evaluating the time period of the adjusting movement of the hydraulic component during the ballistic movement is that of—in contrast to computer determination from the oil temperature—the actual system behavior, which is induced by the viscosity, being evaluated and therefore a direct characteristic variable for the current viscosity being obtained. A more definite and reliable conclusion about the actual value of the viscosity can be drawn solely from detecting the time period. In comparison to only indirect determination by means of the temperature of the engine oil, the properties of the oil are directly detected by means of the movement sequence of the component in this method, and therefore aging effects of the engine oil can also be detected.

According to an expedient refinement, the hydraulic component is an electrically controllable control or switching valve, in particular a solenoid valve. Valves of this kind are used, for example, for controlling the gas exchange valves in order to switch and control the oil. The valve itself moves, particularly in the case of ballistic movement, between a closed position and an open position, these positions therefore forming the first and second positions of the switching valve. Since a closure element of the switching valve, for example a valve disk, is guided within the flow path of the oil, the actuating movement of the closure element is influenced by the properties of the oil. In the case of a solenoid valve, the valve usually moves into one position, preferably into the closed position, in a magnetic-force-operated manner, and the valve moves back into the second position, in particular into the open position, in a spring-force-operated manner after the magnetic force is discontinued.

According to a preferred development, the time or adjustment period is determined from a control signal of the switching valve, in particular from the field current of said switching valve. Therefore, no additional measuring devices, such as position sensors, are required according to this preferred refinement. The time period and therefore the viscosity are therefore determined solely by evaluation (using software), without additional hardware components being required. As a result, the costs of a system of this kind are kept low.

A switch-off time of the valve is preferably used to determine the time period. In this case, a switch-off time is understood to mean the time between a switch-off signal, in particular switch off of the field current of the solenoid valve, and an, in particular spring-force-operated, end position (closed position) being reached.

This evaluation is based on the consideration that, after the field current is switched off, the closure element moves from the first position to the second position and, as a result, in particular on account of the resulting accelerations, produces an inductive response signal which can be detected. Since this response signal is correlated with the movement, evaluation of this response signal (current signal) can define an end position and determine said end position in a reproducible manner. In principle, a voltage signal can be evaluated instead of the field current. The switch-off time of the switching valve is established and evaluated, for example, in accordance with the method as described in EP 1 535 506 A2.

A direct conclusion is preferably drawn about the viscosity of the oil on the basis of a known association using the determined time period. To this end, an association between the values for the time period and the values for the characteristic viscosity variable, in particular for the absolute viscosities, is preferably stored in an evaluation unit. The current value of the viscosity is therefore determined, in particular, by a simple comparison. In this case, the association can be made, for example, in a table, a mathematical function or a characteristic diagram. In this case, different associations are preferably stored for different types of oil.

In an expedient refinement, this association is determined in test runs in the new state of the system as a function of a very wide variety of operating parameters and operating points, and the results obtained in this way are stored in the evaluation unit. In this case, extensive families of characteristic curves can be provided, these representing, for example, the effect of different types of oil, the influence of the temperature etc. on the respective viscosity.

The association between the time period and the viscosity is preferably made by means of linear regression. Experiments have shown that there is a simple linear relationship between the time period and the absolute value of the viscosity according to the following equation:

\[ \eta = \eta_0 + kt \]

where \( \eta \) is the viscosity of the oil, for example in [m²/s], \( t \) is the determined time period (switch-off time) and \( \eta_0, k \) are constants which characterize the system, in particular the solenoid valve.

In a preferred development, provision is made for the time period to be repeatedly determined during operation and for a check for a change to be made. Since the time period depends to a great extent on the operating conditions, in particular temperature of the oil, only the time periods of a specific operating point, in particular the time periods at the same oil temperature, are compared with one another for this purpose. Therefore, a change in the characteristic viscosity variable is determined by this comparison. In this case, “during operation” is to be understood to mean normal operation of the machine as intended. In the case of a motor vehicle, this is normal driving over days, weeks, months and years. Therefore, the time period is preferably continuously detected over the entire service life. In this case, the time period is preferably detected at periodic intervals, triggered, for example, by specific events, for example starting of the engine. However, in addition, evaluation can also take place at shorter, regular time intervals, for example as a function of the revolutions of the engine.

In an expedient development, a conclusion can be drawn about aging of the engine oil and/or of the hydraulic component, that is to say the switching valve, on the basis of this change. In an alternative refinement, a conclusion is drawn about the aging solely on the basis of the determined time period. Therefore, aging of the engine oil generally leads, for example, to an increase in the viscosity and therefore to an increase in the time period at the same temperature. Therefore, different curves can, in principle, be stored for different aging states, and therefore a conclusion can be
drawn about the state of the engine oil in terms of an increase in the viscosity solely on the basis of the measurement of the time period (given a defined temperature).

[0024] In addition to aging of the oil, aging of the switching valve also has an influence on the time periods. Therefore, according to a preferred refinement, provision is made for aging of the hydraulic component to be determined when determining the characteristic viscosity variable. In this case, empirically determined aging can, in principle, be determined, for example as a function of the length of operation, and taken into consideration.

[0025] However, provision is preferably made for aging of the hydraulic component to also be derived from the determined time period at a defined operating point. The defined operating point is, in particular, a high engine oil temperature, preferably a temperature of >80° C, and, in particular, >100° C. On account of a measure of the aging being derived from the time period, the actual behavior of the system and not, for example, only a postulated behavior of the system is evaluated—as is already the case when establishing the characteristic viscosity variable for the oil. Therefore, the direct evaluation understood in this sense is more accurate and more reliable. The preferred evaluation at a high engine oil temperature is based on the consideration that, at these high temperatures, the influence of the viscosity of the oil on the time period is at least negligible on account of the very low viscosity, which tends toward zero, at high temperatures. At these high temperatures, the time period is therefore established solely by the configuration of the switching valve.

[0026] Aging of the component can also be established from the time period without establishing the characteristic viscosity variable, and this forms a separate, independent inventive aspect.

[0027] Therefore, a measure of the aging state can be derived on the basis of the determined time period. This is again possible both in absolute terms when an association between the respective time period and the aging state of the switching valve is stored in corresponding association tables. As an alternative, a relative aging state can also be determined by comparison with time periods which were detected previously during operation.

[0028] A shift in a regression line, which shift is produced on account of the linear regression for the association between the time period and the viscosity, is preferably used as a measure of aging, in particular in accordance with the following formula:

\[ n = m (t_{\text{aging}}) + b, \]

where

\( t_{\text{aging}} \) is the additional time period caused by aging.

[0029] The determined characteristic viscosity variable, in particular also the determined change in the characteristic variable, preferably the absolute viscosity, is expediently used selectively or in combination for different derived measures. According to a preferred first alternative, the quantity of oil used is established and derived therefrom. The oil can be very readily characterized overall by measurements, for example, at different operating points (temperatures). It is possible, in particular, to create an association to a respective oil quality on the basis of the measured time periods, in particular in combination with storage of a large number of families of characteristic curves for different types of oil and qualities of oil. In addition, impermissible oil qualities are preferably identified, and, if required, a warning signal is output, for example to request a change in engine oil.

[0030] Furthermore, the oil change interval or the next time point at which an oil change is due is preferably established. It is therefore possible, on account of the actual state of the oil being detected, to reliably detect in very good time whether the oil still meets the requirements, and therefore a time point for the next oil change can be reliably established. Therefore, it is generally also possible to establish the oil change interval by identifying the engine oil quality.

[0031] Furthermore, diagnosis of the hydraulic component, that is to say in particular the solenoid valve, is preferably performed, and a check is made, for example, as to whether replacement is required, a reference preferably also being made to this within the scope of the evaluation and diagnosis.

[0032] Finally, in a particularly expedient refinement, valve control is influenced on the basis of the determined variables. Firstly, for example when aging of the engine oil is detected, that is to say when an increase in the viscosity is detected, the time points for actuating the switching valve are varied and matched to the new conditions in order to maintain gas valve control as exactly as possible in accordance with the respective requirements. Furthermore, in a preferred alternative, the entire hydraulic control operation is performed on the basis of the determined characteristic variable for the viscosity, and no longer on the basis of the current oil temperature as was previously customary. The entire control operation therefore takes into consideration the actual state of the oil.

[0033] According to a preferred refinement, provision is also made for a warning signal to be output when the determined oil viscosity does not permit disturbance-free operation of the engine. Furthermore, provision is made for even starting of the engine to be suppressed, in order, for example, to prevent damage to the engine on account of excessively high viscosity and the associated lack of lubrication of the engine. This is advantageous, for example, in winter when the initial viscosity during cold-starting is too high on account of the external temperatures. Therefore, a minimum external temperature which must not be undershot can be established on the basis of the oil state determined in a preceding operating cycle.

BRIEF DESCRIPTION OF THE DRAWING

[0034] An exemplary embodiment of the invention will be explained in greater detail below with reference to the drawing, in which:

[0035] FIG. 1 shows, in a schematic and highly simplified illustration of a detail, the basic manner of operation of an electrohydraulic control means of a gas valve in a motor vehicle engine.

[0036] FIG. 2 shows a schematic, highly simplified illustration of the profile of a control or field current for a switching valve which is in the form of a solenoid valve.

[0037] FIG. 3 shows a graph in which the kinematic viscosity of an oil is plotted against the switch-off time of a solenoid valve for a system in the new state (new oil and new switching valve).

[0038] FIG. 4 shows a graph which is comparable to FIG. 3, with an additional regression line for a system with an aged switching valve being added.

[0039] FIG. 5 shows a schematic, highly simplified graph in which the time period and viscosity are plotted against the oil temperature for two different types of oil or oil qualities, and
FIG. 6 shows a schematic graph, in which the time period and viscosity are plotted against the oil temperature for an oil in the new state and in the aged state.

Identically acting parts are provided with the same reference symbols in the figures.

DETAILED DESCRIPTION OF THE INVENTION

An electrohydraulic control system for hydraulically controlling a gas exchange valve 2 in a motor vehicle which is indicated by a dashed border in FIG. 1 comprises a hydraulic system which transmits a movement of a cam 6 of a camshaft 7 to a respective gas exchange valve 2 by means of a hydraulic liquid, specifically the engine oil. The electrohydraulic valve control means is known per se. An essential feature is a switching valve which, in particular, is in the form of a solenoid valve 8 and is connected in a hydraulic line 10. The hydraulic line 10 is connected firstly to the cam 6 and secondly to the gas exchange valve 2 via a hydraulic cylinder 12. The hydraulic line 10 to a compensation or pressure chamber 14 can be blocked by means of the solenoid valve 8. Pistons 18 are mounted within the hydraulic cylinder 12, for example such that they can be moved against the force of a spring 16. In the event of rotation of the cam 6, the piston 18 of the associated hydraulic cylinder 12 follows the movement of the cam. When the solenoid valve 8 is closed, the hydraulic system acts in the manner of a hydraulic linkage, and therefore the piston 18 in the hydraulic cylinder 12 which is associated with the gas exchange valve 2 directly follows the movement of the cam 6.

The oil can pass into the pressure chamber 14 by opening of the solenoid valve 8, and therefore the movement of the gas exchange valve 2 is decoupled from the movement of the cam 6.

The solenoid valve 8 is connected to a control or evaluation unit 20. The control unit 20 is integrated, for example, in the engine control means. The solenoid valve is supplied with a control signal by means of the control unit 20. In the exemplary embodiment, this control signal is a field current I for a magnet coil of the solenoid valve 8.

The solenoid valve 8 is usually open in the activated state, and therefore the hydraulic line 10 is free in the direction of the pressure chamber 14. In the activated state, that is to say when the solenoid valve 8 is supplied with an adequate field current I, the solenoid valve 8 is in its closed position. In this case, the solenoid valve 8 has a design which is known per se and is typical of a solenoid valve. An armature is operated by the magnet, which is formed by an electrical coil, in the closing and opening directions. A closure element for closing the hydraulic line 10 is arranged on this armature. The magnetic force usually acts against a spring force of a spring which is mounted in the solenoid valve 8 and pushes the solenoid valve 8 into its starting position, in particular its open position, in the inactive state.

The field current I usually exhibits a typical profile, as illustrated in FIG. 2. The coil is usually initially supplied with a switch-on current I at a time t. This switch-on current h leads only to pre-magnetization, but not to a movement of the closure element. For the purpose of activating, that is to say closing, the valve 8, said valve is supplied with a closing current I which is established at time point t. At this time point, the closure element moves to its closed position. On account of an inductive response, the closing current drops to a certain extent. After the closing operation, the current is reduced to a holding current I, usually at a time t.
As soon as a shift of this kind on account of aging of the solenoid valve 8 is observed, the shifted regression line is used for the association between the time period Δt and the viscosity η.

FIG. 5 illustrates a highly simplified graph in which the temperature is plotted against the time period Δt and, corresponding to this, η. The same applies for the graph according to FIG. 6.

FIG. 5 shows two curves A, B for two different types of engine oil or engine oil qualities.

In particular, the following procedure is followed in order to determine the engine oil quality used or to determine the type of oil used:

- The time periods Δt for different oil temperatures T are detected. A curve of best fit is, for example, created by the measurement points determined in this way. The measured association between the temperature and time period Δt is compared with known associations, for example families of characteristic curves, which are stored in the control unit 20.

- On the basis of correspondence upon comparison with a known family of characteristic curves, the currently used oil is then associated with a known oil of a specific quality. However, in principle, it is also possible to establish the quality solely on the basis of the measurement values, without comparison with the stored families of characteristic curves.

The graph according to FIG. 6 shows, in a schematic and highly simplified manner, the effect of aging of the engine oil. The two curves C, D represent firstly the temperature dependence for a new oil (curve C) and secondly for the same, aged oil (curve D). Aging of the oil is reflected in an increase in the viscosity η and therefore the time period Δt at the same temperature T.

FIG. 6 shows, by way of example, a maximum permissible value max for the time period Δt and for the viscosity η. Different minimum temperatures T minC, minD are assigned to this maximum value for the two curves. As can be read from the graph, a lower minimum temperature minC is permissible with the new oil than with the aged oil (minD).

This is used, for example, in order to output a warning signal when the minimum permissible temperature minC, minD is undershot or, in extreme cases, to suppress starting of the engine.

The aged curve D is determined in a similar way to that described in FIG. 5 by the time periods Δt being determined at different temperatures T. The increasing aging is detected by continuous or periodic measurement during operation. A change in engine oil is detected by an abrupt change in the curve profile.

The method described here is distinguished in that the time period Δt is detected and evaluated as a characteristic variable for the current viscosity η of the engine oil. Therefore, the actual state of the hydraulic system is determined.

It is also of particular importance that the time period for the actuating movement of the solenoid valve is evaluated in order to determine the time period Δt, and that this is done, in particular, by evaluating the control signal l for the solenoid valve 8.

A further essential consideration is that aging of the switching valve 8 is taken into consideration. It is again of particular importance here that aging of the switching signal is also obtained by evaluating the time period Δt.

Therefore, in general, the link or relationship between the electrical actuation of the hydraulic component (solenoid valve 8) and the hydraulic action (closing/opening) triggered by said hydraulic component is evaluated and the viscosity η is derived. Independently of the electrical actuation of the solenoid valve, this correlation, which is reflected in the reaction time and therefore the time period Δt, is established by a change in the functioning of the solenoid valve 8 (mechanical wear) and by a change in the viscosity η of the hydraulic liquid. In this case, the change in viscosity is caused by wear and/or aging of the oil and/or by the current temperature of the hydraulic liquid.

The particular advantage of determining the actual viscosity η is, particularly in the case of a time-critical and emissions-relevant system, such as in an electrohydraulic valve control means, that a hydraulic control system of this kind for actuating the gas exchange valves can be operated independently of aging of the oil without adversely affecting the functioning and the exhaust gas values.

To this end, control of the gas exchange valves is expediently influenced on the basis of the information obtained. The entire control operation of the gas exchange valves is preferably carried out with the aid of the present method based on the actually existing viscosity η (and not indirectly by means of the temperature as was the case previously). The control parameter is therefore the actual viscosity determined over the time period Δt.

LIST OF REFERENCE NUMERALS

2 Gas Exchange Valve
4 Motor Vehicle
6 camshaft
8 Solenoid Valve
10 Hydraulic Line
12 Hydraulic Cylinder
14 Pressure Chamber
16 Spring
18 Piston
20 Control Unit
13. (canceled)
14. A method for determining a characteristic viscosity variable of a hydraulic fluid in a motor vehicle having gas exchange valves and a hydraulic control system with a hydraulic component for hydraulically controlling the gas exchange valves, the method comprising the steps of:

- adjusting the hydraulic component from a first position to a second position by means of a control signal;
- determining a time period which the hydraulic component requires for changeover from the first position to the second position; and

using the determined time period determined to measure the characteristic viscosity variable

15. The method according to claim 14, wherein the hydraulic liquid is engine oil.

16. The method according to claim 14, wherein the hydraulic component is an electrically controllable switching valve.

17. The method according to claim 6, wherein the electrically controllable switching valve is a solenoid valve.

18. The method according to claim 16, wherein the switching valve is supplied with a control signal and the control signal is evaluated to determine the time period.

19. The method according to claim 18, wherein the control signal is a switching valve.

20. The method according to claim 19, wherein a switching time of the switching valve between the control signal and an end position of the switching valve is used as the time period.
21. The method according to claim 14, wherein there is a linear correlation between the viscosity of the hydraulic liquid and the time period.

22. The method according to claim 21, wherein the time period is linked directly to the viscosity such that the time period and the viscosity have a linear relationship and individual measurement points of the time period and viscosity with respect to each other can be connected by a regression line, which is determined by means of linear regression.

23. The method according to claim 14, wherein the time period is repeatedly determined at a specific temperature of the hydraulic liquid and a check for a change is made.

24. The method according to claim 23, wherein a conclusion can be drawn about aging of the hydraulic component and/or about aging of the hydraulic liquid at a specific operating point based on the time period.

25. The method according to claim 24, wherein the aging of the hydraulic component is taken into consideration when determining the characteristic viscosity variable.

26. The method according to claim 15, wherein the aging of the hydraulic component is derived from the time period at a high temperature of the oil at a temperature of greater than 80°C.

27. The method according to claim 24, wherein an association between the time period and the viscosity of the hydraulic liquid is made by a regression line, which is determined by means of linear regression, and a shift in the regression line in relation to an unaged state of the hydraulic liquid is used as a measure of aging.

28. The method according to claim 14, wherein the determined characteristic viscosity variable is evaluated and used selectively or in combination for:
   - determining a measure of an oil quality;
   - identifying impermissible engine oils;
   - establishing an oil change interval;
   - diagnosing the hydraulic component; and
   - valve control.

29. A control device for determining a characteristic viscosity variable of an engine oil in a motor vehicle having a gas exchange valves with the gas exchange valves being hydraulic controlled by a hydraulic component being adjusted from a first position to a second position with by means of a control signal,

   wherein the hydraulic component requires a measurement of a time period for changeover from the first position to the second position and the time period is used as a measure of the characteristic viscosity variable.

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