ABSTRACT

METHOD AND DEVICE FOR CONTROLLING THE REGENRATION OF A PARTICLE FILTER

Described herein is a method for controlling the regeneration of a particle filter (42) in a exhaust gas channel (30) of an internal combustion engine (10), which in its air supply channel (20) comprises a throttle valve (24) and an exhaust gas recirculation (25) with an exhaust gas recirculation valve (26) between the air supply channel (20) and the exhaust gas channel (30). The method includes initiating and controlling the combustion of particles in a particle filter (42) during a regeneration process by intervention with air flow and additional fuel injections. In an implementation, the method is divided in a conventional regeneration phase (122) and in an extended regeneration phase (123) for fast oxidation of soot particles in the particle filter (42), wherein within the extended regeneration phase (123), post-injections (115, 116), as applied in the conventional regeneration phase (122), are omitted.

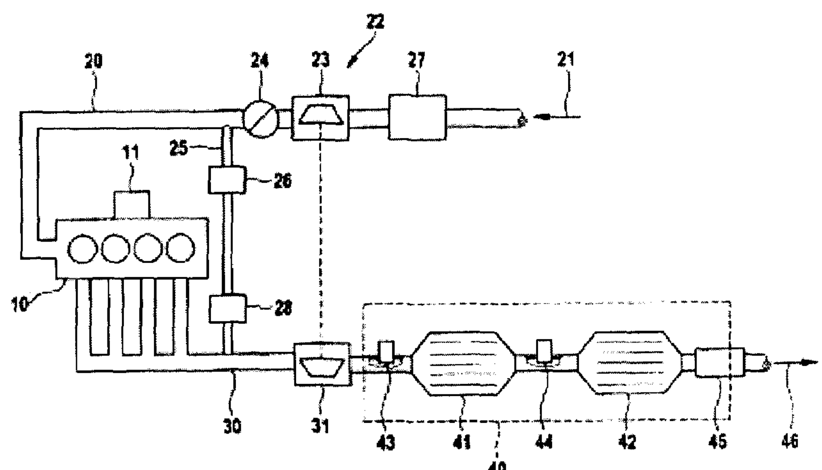

Fig. 1

I/We claim:

1. A method for controlling the regeneration of a particle filter (42) in a exhaust gas channel (30) of an internal combustion engine (10), wherein the internal combustion engine (10) comprises an air supply channel (20) having a throttle valve (24) and an exhaust gas recirculation (25) with an exhaust gas recirculation valve (26) between the air supply channel (20) and the exhaust gas channel (30), the method comprising:

initiating and controlling the combustion of particles in a particle filter (42) during a regeneration process by intervening with air flow and additional fuel injections;

characterized in that,

the regeneration process is divided in a conventional regeneration phase (122) and in an extended regeneration phase (123) for fast oxidation of soot particles in the particle filter (42), wherein within the extended regeneration phase (123) post-injections (115, 116), as applied in the conventional regeneration phase (122), are omitted.

2. The method as claimed in claim 1, wherein the extended regeneration phase (123) by means of reduction of a supply air flow (21) in the air supply channel (20), is initiated by at least partially closing the throttle valve (24) and/or by increasing a proportion of recirculated exhaust gas due to at least a partial opening of the exhaust gas recirculation valve (26) along with a deactivation of the post injections (115, 116).

3. The method as claimed in one of the claim 1 or 2, wherein the extended regeneration phase (123) is initiated upon reaching a temperature of about 580°C to 610°C.

4. The method as claimed in one of the preceding claims 1 to 3, wherein the entire regeneration process (123) is started at a lower projected soot loading of the particle filter (42).

5. The method as claimed in one of the preceding claims 1 to 4, wherein the regeneration of the particle filter (42) is initiated during an inner-city driving operation (133).

6. The method as claimed in claim 5, wherein after the initiation of the regeneration during the transition from the inner-city driving operation (133) to an outer city driving

operation (134), the extended regeneration (123), if it is already activated, is canceled, and (122) is replaced by the conventional regeneration phase, whereby this is carried out until reaching an at least partially successful soot reduction.

7. The method as claimed in one of preceding claims 1 to 4, wherein after the initiation of the regeneration of the particle filter (42) during an outer city driving operation (134), only a conventional regeneration phase (122) is carried out, wherein in transition to the inter city driving operation (122) during the regeneration, the extended regeneration phase (123) is started, if the predicted soot load still has a high value.

8. An application of the method according to any one of the preceding claims for controlling the regeneration of particle filters (42) in the exhaust gas after treatment system (40) of an internal combustion engine (10) configured as a diesel engine having a base body having a comparatively low temperature stability.

9. A device for controlling the regeneration of a particle filter (42) in an exhaust system of an internal combustion engine (10), wherein an air supply channel (20) of the internal combustion engine comprises a throttle valve (24) and an exhaust gas recirculation (25) with an exhaust gas recirculation valve (26) between the air supply channel and the exhaust gas channel (30), wherein the combustion of particles in the particle filter (42) during a regeneration process is initiated and controlled by means of a control unit through interventions in the air flow and additional fuel injections,

characterized in that,

the control unit comprises units for performing the method as claimed in claims 1 to 7.

10. The device as claimed in claim 9, wherein a functionality of the method as claimed in one of claims 1 to 7 is implemented by software as an add-on to a conventional regeneration strategy within the control unit.

Dated this 22 day of February 2012

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To
The Controller of Patents
The Patent office at New Delhi

Applicant(s) Name: **ROBERT BOSCH GmbH**

Application No.:

ORIGINAL Sheet No.: 1

Total No. of Sheets: 4

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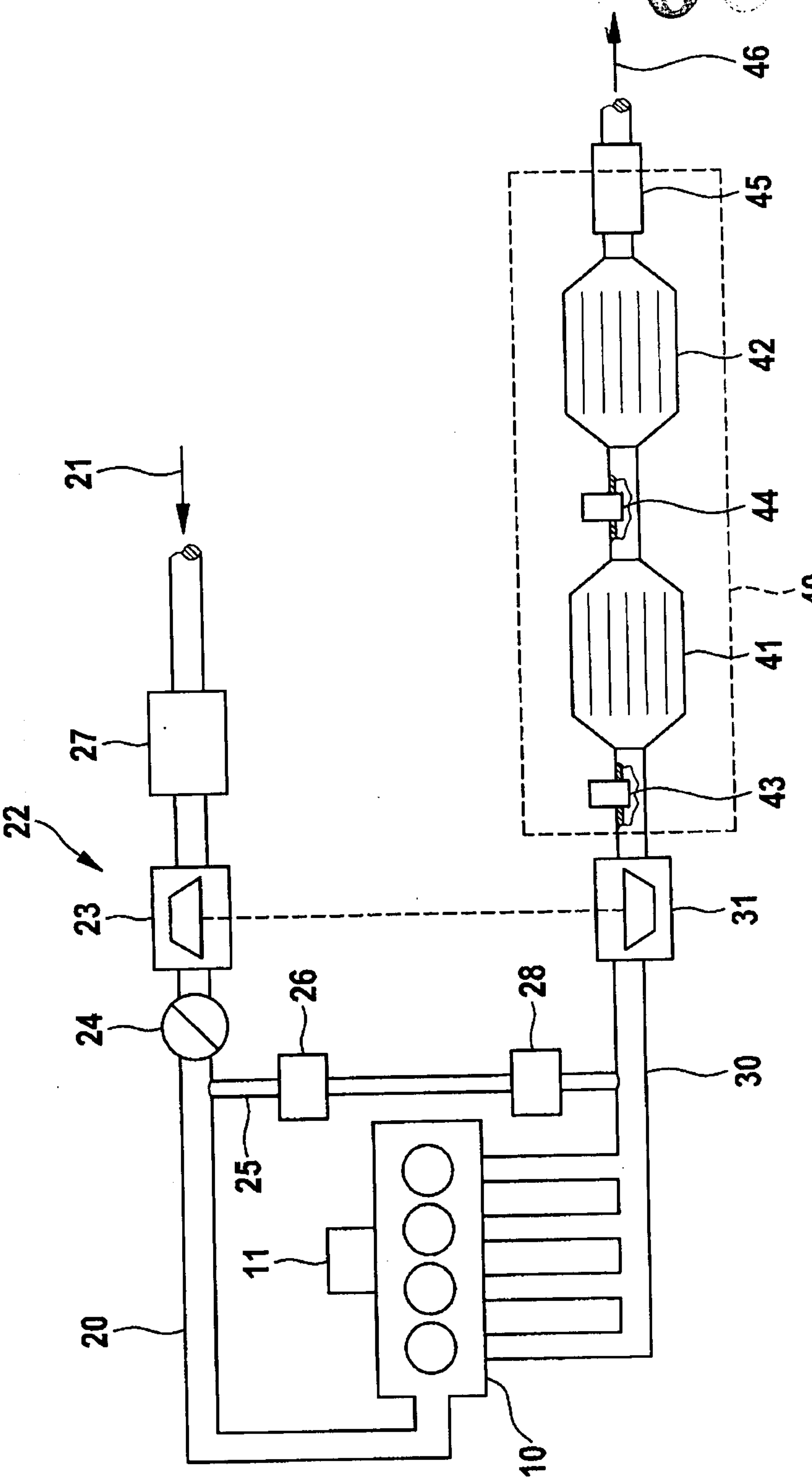

Fig. 1

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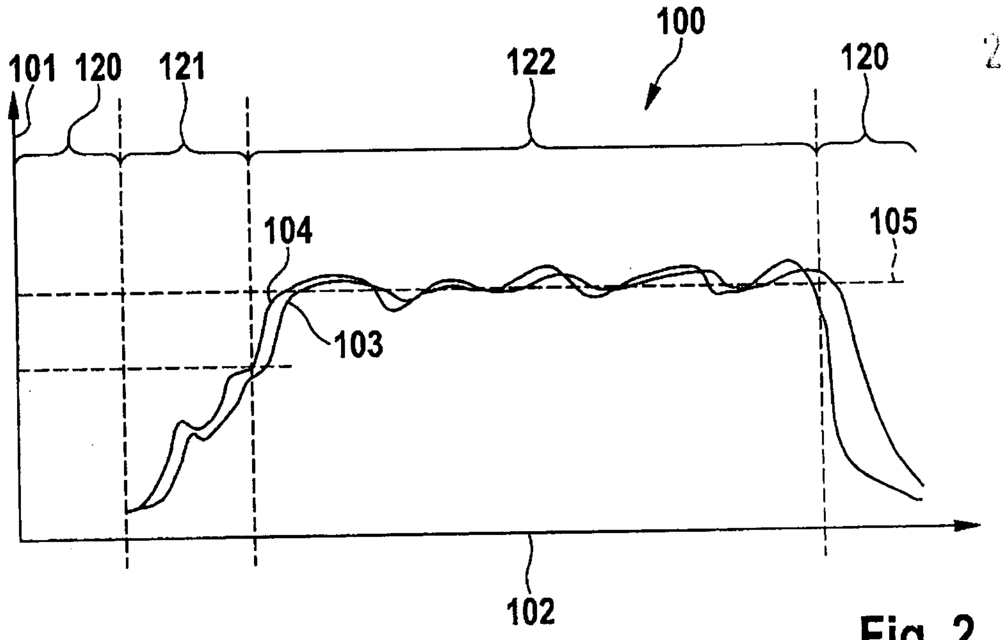

Fig. 2

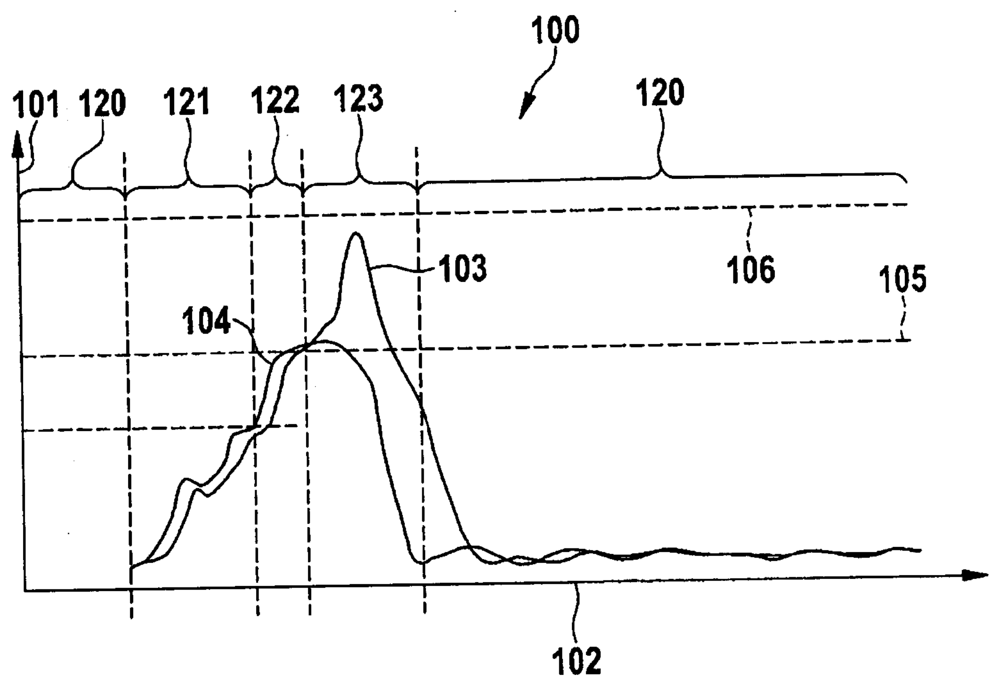

Fig. 3

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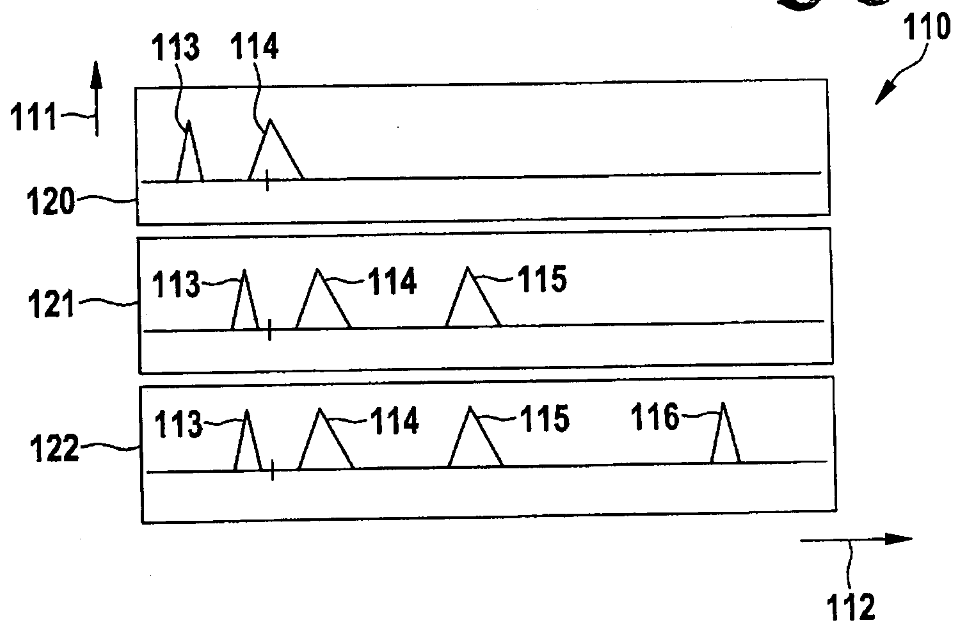

Fig. 4

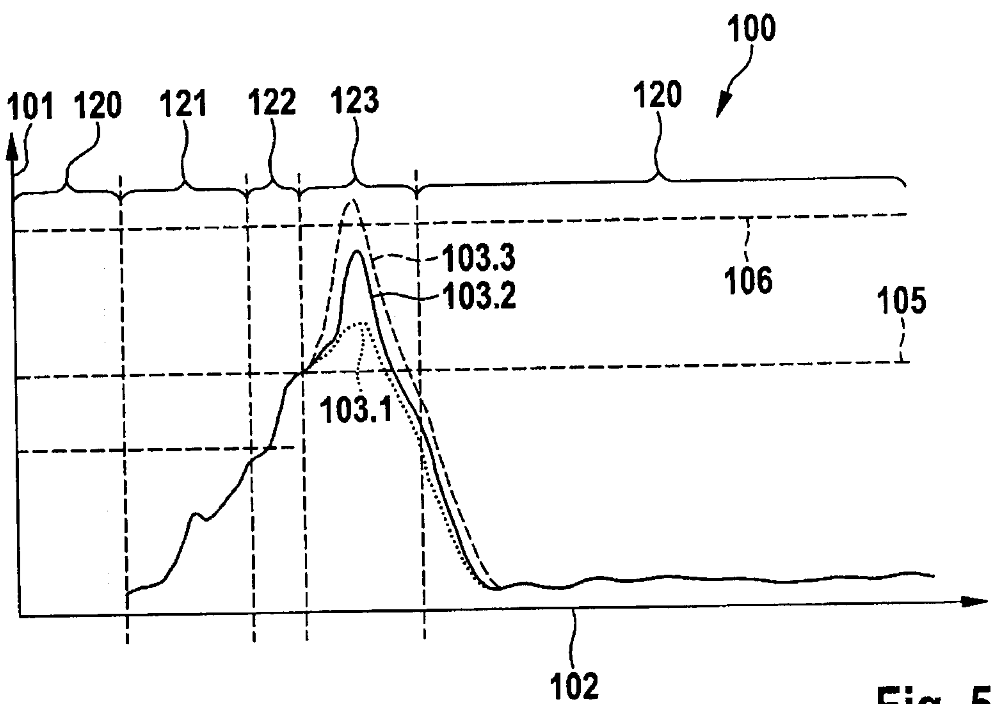

Fig. 5

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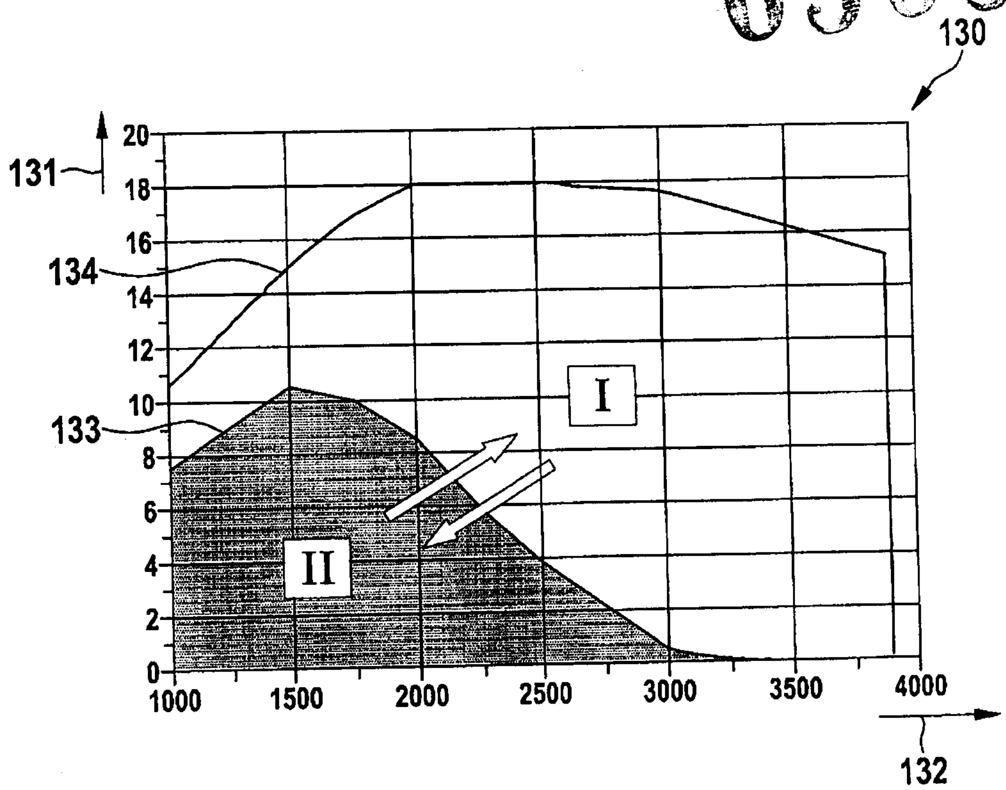

Fig. 6

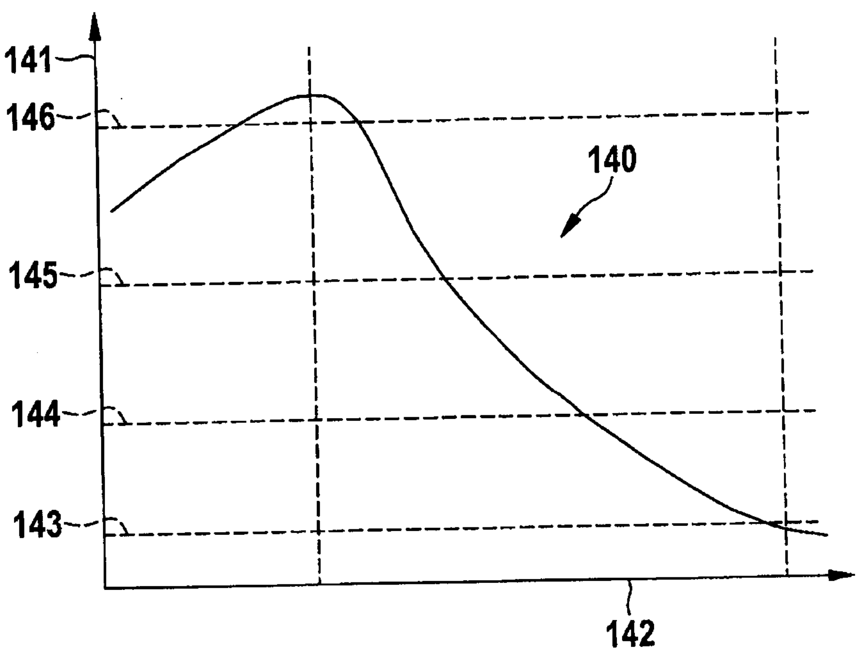

Fig. 7

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TECHNICAL FIELD

The present subject matter relates to a method for controlling regeneration of a particle filter in an exhaust gas channel of an internal combustion engine, and a corresponding device for executing the method.

BACKGROUND

In a conventional internal combustion engine, a throttle valve and an exhaust gas recirculation with an exhaust gas recirculation valve between the air supply channel and the exhaust gas channel exist in an air supply channel. In order to regenerate a particle filter provided in an exhaust gas channel, combustion of particles in the particle filter during a regeneration process is initiated and controlled by intervention in air flow and additional fuel injections.

Often, internal combustion engines, especially diesel engines are equipped with exhaust gas after-treatment systems, which may include, in particular, a diesel particle filter (DPF). This particle filter during the operation consists of soot and therefore needs to be regenerated at certain time intervals.

Control and regulating units are required, in which the management for the DPF regeneration is implemented. The functionality can be divided into three basic functional blocks:

Estimating soot load, which is stored in the particle filter,

Controlling of active regeneration and

Coordination of regeneration between the various operating phases of the internal combustion engine.

The last functional block starts the process of the regeneration as soon as possible, when a certain value of the soot load is reached or exceeded. This must be done, however, under favorable operating conditions of the internal combustion engine. The function block controlling active regeneration includes all control measures on the internal combustion engine, which allows oxidation of soot particles stored in the DPF. This process is carried out periodically in order to burn the particle in a soot-free manner.

In EP 1 364 110 B1, for example, a method and device is described for controlling an internal combustion engine, which contains a particle filter arranged in an exhaust gas after-treatment system, in which a regeneration process is provided for reducing the loading of the particle filter. A characteristic variable (a filter temperature TF) is determined in dependence of at least one operating variable (rotational speed N, injected fuel quantity QK, quantity of air sucked ML and/or oxygen concentration O_2) of the internal combustion engine and at least one operating characteristic variable (burning rate AV, quantity of air sucked ML, exhaust gas temperature TA and/or loading condition DP) of the particle filter, which characterizes a future intensity of a reaction in the particle filter. It is provided that when the characteristic variable TF exceeds a threshold value, at least one measurement is carried out, which reduces oxygen concentration in the exhaust gas from the internal combustion engine, with the aim that the characteristic variable TF does not reach the threshold value.

The maximum soot loading of the particle filter depends on a substrate material of the filter, such as its porosity, cell density, and a geometry of channels, and in particular depends on its melting temperatures and thermal capacity.

The heat released during regeneration is proportional to the soot loading in the particle filter and is largely responsible for the maximum temperature in the particle filter.

Conventional regeneration strategies are based on special injection profiles and air flow rates, so that an elevated temperature is achieved in the exhaust gas channel of the internal combustion engine so as to carry out the oxidation of the soot.

For this purpose, a number of measures need to be taken because the necessary high exhaust gas temperatures of 600°C to 650°C can be reached only close to full load capacity during the normal operation of a diesel engine. Particularly, in case of low engine loads and speeds, in addition to air system operations (throttle valve); injection measures are required to adjust the temperature range. These include measures such as a late shift in the main injection quantity (MI), discontinuation of burning injection (Pol2) in the engine, and discontinuation of post-injection burning (Pol1) at the diesel oxidation catalyst (DOC). Certain amount of residual oxygen content is present in the exhaust gas in order to allow the oxidation.

The duration of regeneration depends on soot oxidation rate and an amount of soot in the particle filter. Main influencing factors for the rate of oxidation are the oxygen content and temperature of the filter substrate.

Further, the driving conditions affect the ability of the internal combustion engine to increase the exhaust gas temperature for a complete regeneration. Especially in inner city driving operation with low loads and frequent overrun, it is difficult to achieve the required high temperature range for optimal regeneration. The result is an extension of the regeneration phase with respect to regeneration phases, which are carried out under favorable driving operations. Such good driving conditions include, for example, highway driving.

As primary side effects, a lubricating oil dilution or mixing with fuel is observed in the so-called regeneration strategies for the particle filter due to the injection profile and the post-injection quantity. This leads to a negative impingement of fuel on the cylinder wall. Due to a high mass in oil-dilution/mixing, the mechanics of the engine can be damaged, and field defects may be witnessed.

The following have been identified for oil dilution/mixing:

Injection Profile (time and injection volume)

Soot emission rate, which limits the rate of DPF loading and regeneration frequency and

Regeneration period, which determines entry in the fuel oil at each regeneration.

SUMMARY

This summary is provided to introduce concepts related to a method and a device for controlling the regeneration of a particle filter, and the concepts are further described below in the detailed description. This summary is neither intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

In one embodiment, the subject matter describes a method for controlling the regeneration of a particle filter in an exhaust gas channel of an internal combustion engine, which in its air supply channel includes a throttle valve and an exhaust gas recirculation with an exhaust gas recirculation valve between the air supply channel and the exhaust gas channel. The method includes initiating and controlling the combustion of particles in a particle filter during a regeneration process by intervention with air flow and additional fuel injections. In an implementation, the method is divided in a conventional regeneration phase and in an extended regeneration phase for fast oxidation of soot particles in the particle filter, wherein within the extended regeneration phase, post-injections, as applied in the conventional regeneration phase, are omitted.

In another embodiment, the subject matter further describes a device for controlling the regeneration of a particle filter in an exhaust system of an internal combustion engine. An air supply channel of the internal combustion engine includes a throttle valve and an exhaust gas recirculation with an exhaust gas recirculation valve between the air supply channel and the exhaust gas channel. The combustion of particles in the particle filter during a regeneration process is initiated and controlled by means of a control unit through interventions in the air flow and additional fuel injections. The control unit includes units for performing the method proposed according to the present subject matter.

BRIEF DESCRIPTION OF DRAWINGS

The present subject matter is described hereinafter with reference to an exemplary embodiment illustrated in the figures. In the drawings:

Fig. 1 shows a schematic representation of a technical environment in which a method for controlling regeneration of a particle filter in an exhaust gas channel of an internal combustion engine can be applied, in accordance with an embodiment.

Fig. 2 shows a temperature history chart for a conventional regeneration of a particle filter.

Fig. 3 shows a temperature profile diagram for a regeneration of the particle filter, according to the method of the present subject matter.

Fig. 4 shows an injection profile diagram for various stages of regeneration.

Fig. 5 shows a temperature profile chart, depending on a load state of the particle filter.

Fig. 6 shows a schematic representation of different load profiles of the internal combustion engine.

Fig. 7 shows a schematic representation of soot combustion time.

DETAILED DESCRIPTION

There exists a demand as a requirement that diesel particle filter (DPF) regeneration is carried out for a driver with no discernible loss of performance and no additional noise.

It is therefore an object of the present subject matter to provide a method with which a particle filter is regenerated and the oil dilution/mixing and the fuel consumption can be reduced.

It is a further object of the present subject matter to provide a corresponding device for implementing the method.

The method of the present subject matter provides that the regeneration process is divided into a conventional regeneration phase and into an extended regeneration phase, for a rapid oxidation of soot particles in the particle filter, where within the extended regeneration phase, post-injections, as it is used in the conventional regeneration phase the rapid oxidation, are omitted. The conventional regeneration phase, which is used for typically 1 to 3 minutes, is provided initially for a heating of an exhaust gas purification system including the particle filter (DPF). With the extended recovery period, the temperature is further increased in order to speed up the soot combustion. Thus, the time duration of the entire regeneration phase can be significantly reduced. Since the usual post-injection in this second phase is waived, oil dilution and oil mixing can be reduced by the fact that the conventional recovery phase lasts only for 1 to 3 minutes instead of the usual 10 to 15 minutes.

The extended regeneration phase after reaching the start temperature for the oxidation of the soot particles, in accordance with an implementation of the present method, is initialed by means of reducing a supply air flow in the supply air channel by at least partially closing the throttle valve and/or by increasing a proportion of re-circulated exhaust gas by at least partial opening of the exhaust gas recirculation valve in conjunction to a deactivation of the injections. With these measures, the gas stream in the exhaust gas channel of the particle filter can be reduced and the O_2-concentration can be increased. This supports a rise in temperature within the particle filter, since the cooling effect of the gas flow is reduced during the exothermic oxidation reaction and the speed of the reaction increases the O_2 concentration.

The extended regeneration phase, that is, the start of the oxidation of soot particles, is initiated advantageously on reaching a temperature range of about 580°C to 610°C. A rapid soot oxidation is possible if the heat release due to the soot combustion increases the temperature in the DPF, until the soot oxidation is completed and thus reduces the temperature again. This self-regulating "chain reaction" therefore leads to short term high peak temperatures in the particle filter, which is determined by the soot concentration by the oxygen concentration, and by the temperature level in the particle filter.

In order to limit the maximum allowable temperature or the maximum allowable temperature gradient for the substrate material and/or a substrate coating of the particle filter, in an embodiment, it is provided that the regeneration process is initiated at a lower projected soot loading of the particle filter.

In an embodiment, an operation phase for such regeneration is resulted when the regeneration of the particle filter is initiated during city driving operation, where the engine load and speed are rather low. In such an operating phase, the injected fuel quantity in ratio to available air amount is small, so that the gas flow can be drastically reduced and still enough residual oxygen is available for the soot combustion. In a conventional regeneration of the particle filter, in contrast to the above variant of the method, this operation phase is rather critical, since the soot loading due to high smoke levels is the highest, and it also results in a long regeneration phases, which leads to high amount of fuel entering into engine oil. An inner-city driving operation represents a critical case in the conventional regeneration. For the proposed regeneration method, the operating phase offers a large potential for improvement.

In an operation phase with high engine load and high speed, usually during an outer city driving operation (for example, fast highway driving), the extended regeneration phase, as described above, cannot be used, since the fuel injection quantity is high and due to significant reduction of the gas flow, no more residual oxygen is present for the soot combustion and also not enough torque can be provided. Therefore, it is provided that after the initiation of regeneration during moving from inner city driving operation to the outer city driving operation, the extended regeneration phase, unless it is already activated, is waived and replaced by the conventional regeneration phase, wherein this is carried out to achieve at least partially successful soot reduction.

Due to the high engine load, a conventional regeneration phase be carried out only after the initiation of the regeneration of the particle filter during an outer city driving operation, wherein with change in the inner city driving operation, during the ongoing regeneration, the extended regeneration phase is started if the predicted soot loading still has a high value.

In another embodiment, as previously described, a controlling of the regeneration of particle filters in the exhaust gas after treatment system of the internal combustion engine designed as a diesel engine is provided, wherein cheaper, less temperature stable filter material can be used as the filter material for the diesel particle filter. An example of it is bases of cordierite, which can be protected with the method.

Further, the object of the present subject a matter is related to the device is achieved by the fact that the combustion of particles in the particle filter during regeneration process is initiated and controlled by a control unit by interfering with air flow and additional fuel injections. The control unit includes devices for performing the method of the present subject matter and variants of the method, as previously described.

In an embodiment, it can be provided that the functionality of the method is implemented with its variants in software as an add-on to conventional regeneration strategy within the control unit. The application effort is therefore small and can easily be upgraded by a software update. The control unit can be an integral part of a super ordinate engine controller (for example, within the Engine Control Unit, ECU).

Fig. 1 shows a schematic representation of a technical environment, in which the method for controlling regeneration of a particle filter in an exhaust gas channel of an internal combustion engine can be implemented. An internal combustion engine 10 is shown in the form of a diesel engine with a fuel metering system 11, an air supply channel 20, in which a supply air flow 21 is guided, and an exhaust gas channel 30, in which an exhaust gas mass flow 46 of the internal combustion engine 10 is guided. Along the air supply channel 20 in a flow direction of the supply air flow 21, an air supply measurement device 27, for example, in the form of a hot-film measurement system (HFM), a compression stage 23 of a turbocharger 22, and a throttle valve 24 are arranged. An exhaust gas recirculation 25 connects the air supply channel 20 to the exhaust gas channel 30 via an exhaust gas recirculation valve 26 (AGR) and a cooler 28. In the flow direction of the exhaust gas mass flow 46, in the illustrated example, after the internal combustion engine 10, are represented an exhaust gas turbine 31 of turbocharger 22 as well as a lambda probe 43 as components of an exhaust gas after treatment system 40, an oxidation catalyst 41 in the form of a diesel oxidation catalyst (DOC), a temperature probe 44 and a further separate temperature probe (not shown here), and a particle filter 42 in the form of a diesel particle filter (DPF) and a muffler 45. In principle, other sensor arrangements for determining the oxygen content and temperature in the exhaust passage 30 are also possible before the particle filter 42. In addition, in the exhaust gas channel 30, between the internal combustion engine 10 and the exhaust gas turbine 31 in a region of an exhaust gas manifold of each individual cylinders of the internal combustion engine 10, the so-called pre-turbo catalysts or also PTC's (Pre Turbo Catalyst), are arranged as further components of the exhaust gas after-treatment system 40.

Fresh air is supplied to the internal combustion engine 10 via the air supply channel 20. The fresh air is adjusted by the compression stage 23 of the turbocharger 22, which is driven via the exhaust gas turbine 31 from the exhaust gas mass flow 46. Through the throttle valve 24, the amount of air supplied can be adjusted. For pollutant reduction, quantity of exhaust gas from the exhaust gas channel 30 is mixed to the supply air 21 via the exhaust gas recirculation depending on the operating parameters of the internal combustion engine 10. The exhaust gas recirculation rate can be adjusted by means of the exhaust gas recirculation valve 26. The cooler 28 cools the exhaust gas flow coming from the exhaust gas channel 30.

In the exhaust gas after-treatment system 40, pollutants emitted by the internal combustion engine 10 are converted or filtered out. Thus, in the oxidation catalyst 41, hydrocarbons and carbon monoxide is oxidized, while the particle filter 42 holds back soot particles.

Control and regulation units necessary for the operation of the internal combustion engine 10 and the exhaust gas after-treatment system 40, if necessary, additional temperature sensor and diagnostic units for charging of the particle filter 42 are not shown.

By operation of the internal combustion engine 10, the particle filter 42 is filled, until the reaching of its storage capacity is signaled. A regeneration phase of the particle filter 42 is triggered, wherein the particles stored in the particle filter 42 are burned in an exothermic reaction. To initiate the exothermic reaction before the particle filter 42, an exhaust gas temperature of about 600°C to 650°C is required. Since these temperatures in normal operation of the internal combustion engine 10 reaches only near the full load, a temperature increase is caused by additional measures.

Fig. 2 shows a DPF-temperature profile 103 and a DPF temperature profile 104, in a temperature history diagram 100 (temperature 101 vs. time 102), during an initiated regeneration of the particle filter 42 (DPF). The temperature profile for a conventional regeneration strategy is shown. Starting from a normal operating phase 120, after activation of the regeneration, a heating phase 121 is followed, which is initiated by certain engine measures. After reaching a reference temperature (about 600 °C) for the subsequent conventional regeneration phase 122, in which the soot combustion takes place, this temperature is maintained, wherein periodically these measures are applied until a particular soot loading level for the particle filter 42 falls below and the conventional regeneration phase 122 is completed. It again follows the normal operating phase 120.

Fig. 3 shows, as shown above in Fig. 2, in a further temperature profile diagram 100, the course of the DPF temperature 103 and the temperature before DPF 104 for a regeneration strategy, in accordance with an embodiment of the present subject matter. In contrast to temperature course shown in Fig. 2, already after the heating phase 121 and a subsequent short conventional regeneration phase 122 (typically 1 to few minutes) after reaching a reference temperature 105, the temperature until reaching a maximum DPF temperature 106 increases again (adjusted regeneration phase 123), which depends on the substrate material and the substrate coating of the particle filter 42. Compared with the conventional regeneration shown in Fig. 2, a much shorter period is resulted during the regeneration shown in Fig. 3.

In Fig. 4, in an injection profile diagram 110, the injection quantity 111 is shown schematically in dependence of time 112 for various phases of the regeneration cycle.

Particularly, in case of low engine loads and speeds, other measures in the field of fuel injection through the fuel metering system 11 are common, in addition to air system interventions, such as via the throttle valve 24. These can be engine-internal measures, such as a late-shift of the main injection (MI) 114 or may be torque-neural after-injection 115 (Pol2) burning in the internal combustion engine 10 or an after-injection 116 burning via a fuel supply to the exhaust gas channel 30 supplied before the oxidation catalyst 41 and to the oxidation catalyst 41 and at the oxidation catalyst 41 burning (Pol1), wherein the post-injection 116 (Pol1) is carried out generally via the fuel metering system 11. Furthermore, a change in the exhaust gas recirculation rate is possible through the exhaust gas recirculation valve 26.

The above measures, in addition to affecting the exhaust gas temperature, also influence the composition of the exhaust gas, particularly its oxygen content. Since the oxygen content has a significant influence on the combustion rate of the particle stored in the particle filter 42 during the regeneration process, and accordingly on the released energy depending on each time unit, it is known, for example, to control the course of the particle combustion and thus the temperature of the particle filter via the controlling of the oxygen content of the exhaust gas via the above measures.

Fig. 4 shows the above-described injection processes typical to the normal operating phase 120, the heating phase 121, and the conventional regeneration phase 122, wherein in the diagrams shown, a pre-injection (PI) 113 can be provided.

Fig. 5 shows, as already shown in Fig. 3, the course of the DPF temperature 103 for the regeneration strategy of the present subject matter in a further temperature profile diagram 100. On the basis of different soot loadings of the particle filter 42, peak temperature of different heights are achieved due to the above-described kinetics of soot oxidation. Temperature gradients for a DPF-temperature (low) 103.1, that is, with a relatively low soot loading, for DPF temperature (medium) 103.2, that is, with comparatively moderate soot loading, and for a DPF-temperature (high) 103.3, that is, with relatively high soot loading are shown. In order to limit the maximum permissible temperature (maximum DPF temperature 106) or the maximum allowable temperature gradient for the substrate material and/or the substrate coating of the particle filter 42, it can be provided that the extended regeneration phase 123, in dependence of a predicted soot loading of the particle filter 42, is limited in its duration.

Fig. 6 shows different phases of operation in a load-speed diagram 130 for the internal combustion engine 10, wherein for the course for an inner-city driving operation 133 and an outer city driving operation 134, the load 131 is represented in relation to a speed 132.

Fig. 7 shows in a soot-combustion-profile diagram 140, the soot mass 141 in dependence of the time 142. Various load levels 143 to 146 are shown.

The load level 143 represents an almost soot-free particle filter 42 (only small residual soot loading), as it can be observed shortly after a carrying out successful regeneration cycles. The load level 144 is present for a partially successfully performed regeneration. The load level 145 corresponds to a particle filter 42 completely loaded with soot. The load level 146 corresponds to the trigger level for the start of the regeneration and represents the highest soot loading level.

Specifically, during dynamic driving, the internal combustion engine 10 switches between operating phases with low load 131 and low speed 132 (see Fig. 6, zone II corresponding to an inner-city driving operation 133) and operating phases with a high load 131 and high speed 132 (see Fig. 6, zone I corresponding to an outer city driving operation 134). The present method controls the different regeneration processes corresponding to the transitions between the different operating phases. We distinguish between four cases:

Case 1: During the inner city driving operation 133 (Fig. 6, zone II), the regeneration is started (reaching the load level 146, Fig. 7), wherein the inner city driving operation 133 is maintained during the entire duration of regeneration. In this case, the complete regeneration performed with the extended regeneration phase 123 (fast soot oxidation) until the loading level 143 (Fig. 7) is reached and the particle filter 42 is completely burnt.

Case 2: During the inner-city driving operation 133 (Fig. 6, region II), the regeneration is started (reaching the load levels 146, Fig. 7), wherein in this case a change in the outer city diving operation 134 (Fig. 6, move to Zone I) takes place. In this case, even the extended regeneration phase 123 is carried out, as long as the internal combustion engine 10 is still found to be in the inner city driving operation 133. The extended recovery phase 123 is interrupted immediately and the conventional regeneration phase 122 is initiated until the load level 144 (Fig. 7) is reached. Here it may happen that when the change in the outer city driving operation 134 already applies, the predicted soot-loading is below the load level 144, which is an equally successful regeneration.

Case 3: During the outer city driving operation 134 (Fig. 6, Zone I), the regeneration is started (reaching the load level 3 146, Fig. 7), wherein the outer city driving operation 133 is maintained during the entire duration of regeneration. In this case, the complete regeneration is carried out with the conventional regeneration phase 122 until the load level 143 (Fig. 7) is reached and the particle filter 42 is completely burnt.

Case 4: During the outer city driving operation 134 (FIG. 6, Zone I), the regeneration of the conventional regeneration stage 122 is started (reaching the load levels 3 146, fig. 7), wherein in this case a change in the inner city driving operation 133 (Fig. 6, move to Zone II) takes place. In this case, even the conventional regeneration phase 122 is carried out, as long as the internal combustion engine 10 is still found to be in the outer city driving operation 134. The extended recovery phase 123 is executed soon after the inner-city driving operation 133 is achieved. In the case that with the predicted soot load changing to below the load level 145 (Fig. 7), the regeneration is aborted.

Load level 144 or 145 is intended in normal driving operation. This can achieve a good compromise between performance and fuel consumption.