METHOD AND DEVICE FOR OPERATING AN EXHAUST-GAS AFTER-TREATMENT SYSTEM

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ABSTRACT

The invention relates to a method for operating a motor vehicle exhaust-gas aftertreatment system (1), in which oxygen is fed to and removed from the oxygen tank (8) of an exhaust-gas aftertreatment component (7). According to the invention, the oxygen quantity in the oxygen tank (8) is determined and a rich-lean cycle is influenced in accordance with the determined oxygen quantity. The invention also relates to a motor vehicle exhaust-gas aftertreatment system (1), which permits a temperature regulation of the oxygen tank (8) and/or an uninterrupted desulphation during the transition between a rich operation and a lean operation.
Fig. 3

- Stored O₂ Quantity
- Total Transferred O₂ Quantity
- Temperature
- Max O₂ Storage Capacity
- Stored O₂ Menge
- Gespeicherte O₂-Menge
- Insgesamt umgesetzte O₂-Menge
- Temperatur

Zeit (Time)

λ

Δλ

λ = 1

A

B

1

II
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CROSS-REFERENCE TO RELATED APPLICATIONS


FIELD OF THE INVENTION

[0002] The present invention relates to a method for operating a motor vehicle exhaust-gas after-treatment system and also to an exhaust-gas after-treatment system with a connected internal combustion engine.

BACKGROUND OF THE INVENTION

[0003] From U.S. Pat. No. 6,843,052, it is known that a rich-lean cycle can be used so that the oxygen accumulator of an exhaust-gas after-treatment component is used for the oxidation of H₂S. The accumulator is filled during a lean phase and at least partially emptied during a rich phase. For regulating O₂ content, a lambda probe placed downstream of the exhaust-gas after-treatment component is used. Here, if a substoichiometric air ratio is detected, a lean transition is triggered. For a hyperstoichiometric air ratio, a rich transition is triggered. In EP 0 893 154 B1, an oxygen accumulator connected downstream of an NOx-accumulating catalytic converter (NAC) is used for supplying oxygen for the H₂S oxidation.

[0004] From DE 197 47 222 C1, an internal combustion engine system with NAC and secondary air injection with a method for desulfurization of the NAC is known. In this system, the desulfurization control system is regulated by the output signal of a lambda probe placed downstream.

[0005] From DE 198 27 195 A1, it is known that for a lean-rich transition, initially SO₂ is produced for a short time and formation of H₂S follows with a time delay. Therefore, H₂S emission can be suppressed by an early rich-lean transition.

[0006] In DE 101 26 455 A1, a method for the desulfurization of an NAC is described that follows the regeneration of a particulate filter, whereby the heating to a desulfurization temperature is eliminated or shortened.

[0007] From DE 199 22 962 C2, it is known that the air ratio in the exhaust gas can be set by supplying secondary air during NAC desulfurization.

[0008] The regulation or control system concepts emerging from the above documents relate to a lambda probe signal downstream of an oxygen-storing component in the exhaust-gas train. Especially at high temperatures, the lambda probe here shows a value that is not equal to one only when an oxygen accumulator is completely filled (λ>1) or is completely empty (λ<1). Therefore, e.g., for desulfurization, rich breakthroughs with accompanying H₂S emission can appear.

SUMMARY OF THE INVENTION

[0009] The task of the present invention is to create an improvement in the operating behavior of an exhaust-gas after-treatment system that takes into account, in particular, the actual conditions in an exhaust-gas after-treatment system and allows a rapid and also reliable reaction.

[0100] This task is achieved with a method with the features of claim 1 and also with an exhaust-gas after-treatment system with the features of Claim 19. Other advantageous configurations are specified in each subordinate claim.

[0111] According to the invention, a method for operating a motor-vehicle exhaust-gas after-treatment system is proposed in which oxygen is fed to and removed from an oxygen accumulator of an exhaust-gas after-treatment system, wherein at least one variable parameter influenced by the oxygen accumulator and its oxygen content is determined and is used for operation of the motor-vehicle exhaust-gas after-treatment system.

[0122] Advantageously, the oxygen quantity in the oxygen accumulator is determined and, according to one improvement, a rich-lean cycle is influenced as a function of the determined oxygen quantity. For example, an oxygen quantity in the oxygen accumulator can be included as a parameter for setting a rich-lean cycle. An example configuration provides that the oxygen quantity is used as a regulating or control parameter for a rich-lean cycle. Another example configuration provides that an oxygen quantity in the oxygen accumulator is regulated by means of at least one rich-lean cycle, advantageously by means of different rich-lean cycles. One possible realization has a motor control system that controls or regulates the rich-lean cycles wherein the oxygen content in the oxygen accumulator is controlled or regulated. For this purpose, the motor control system can use, for example, a plurality of characteristic engine maps or an oxygen calculation that is performed continuously or discontinuously.

[0133] In particular, a fill level of the oxygen accumulator is taken into account. Thus, for control or regulation systems with respect to individual components or all of the components of the exhaust-gas after-treatment system, not only is a lambda probe signal taken into account, but the current state of the oxygen accumulator is detected and taken into account insofar as this is in the position, for example, to discharge oxygen for operation in a rich section of the rich-lean cycle or, conversely, to be able to store oxygen in a lean range of the rich-lean cycle.

[0144] In addition, an additional oxygen supply into the motor-vehicle exhaust-gas after-treatment system can be provided as a function of the determined oxygen quantity of the oxygen accumulator. Such an oxygen supply can be performed, for example, by means of an air supply, also like an oxygen supply into the exhaust-gas after-treatment system. There is also the possibility, for example, to change the air supply in the exhaust-gas after-treatment system additionally or also independently through corresponding valve overlap in a connected internal-combustion engine.

[0155] Preferably, the oxygen quantity is calculated by means of an oxygen balance across the oxygen accumulator. This can be realized, for example, by means of a first probe and a second probe. The first probe is preferably arranged in the flow direction before the oxygen accumulator, advantageously at least directly before the oxygen accumulator. The second probe is preferably arranged in the immediate vicinity downstream of the oxygen accumulator. In addition, there is the possibility that at least one of the two probes is arranged directly on an opening of the oxygen accumulator. There is also the possibility that at least one of the probes is arranged in the oxygen accumulator. For example, the entire accumulation behavior of the entire oxygen accumulator can be determined from the partial behavior of the oxygen accumulator.
Preferably, a first probe for a continuous measurement of the oxygen content before the oxygen accumulator is used. Here, instead of the oxygen content, the air content before the oxygen accumulator can also be determined, and the oxygen content can be determined from this. The second probe preferably determines the oxygen content after the oxygen accumulator, at least at time intervals. It is preferred that a continuous measurement of the oxygen content or the air ratio is performed. For example, it is provided that, of the two probes, at least the probe in front in the flow direction is a broadband lambda probe. In contrast, the other of the two probes can be a transition probe. However, two broadband lambda probes can also be used. Advantageously, at least one of the probes is in a position to also record the temperature.

According to one improvement, the exhaust-gas after-treatment system is equipped with a separate control device. The control device stores, advantageously, not only a control or regulation system with respect to the oxygen accumulator. Advantageously, other components of the exhaust-gas after-treatment components are also included in the control device. In addition to the oxygen accumulator, this can be additional catalysts, particulate filters, injection devices in the exhaust-gas after-treatment system, for example, ammonia-containing means or the like. A configuration provides that such functionality is implemented in a motor control device. Another configuration provides that the control device is arranged separately from the motor control system.

According to one configuration, the method is used to achieve a targeted influence on the rich-lean cycle with the oxygen quantity stored in the oxygen accumulator. For example, it is possible through targeted filling and emptying of the oxygen accumulator to be able to change a quantity of heat released per unit of time. Thus there is the possibility to be able to influence, for example, the temperature of the oxygen accumulator or a component that has the oxygen accumulator.

For example, it is provided that regeneration of an exhaust-gas purification component of the motor vehicle has to be performed within a certain temperature range. This is the case, for example, for a regeneration of a diesel particulate filter, as well as for a desulfurization of a nitrogen oxide-accumulating catalytic converter. For example, in a particulate filter, if an internal combustion engine is operated in a lean mode, then soot collects. For burning off soot, advantageously a temperature greater than 500°C is set. If, for example, an uncoated particulate filter is used, a temperature greater than 600°C is used. For a catalytically-coated filter, for example, a temperature greater than 550°C. Exhaust gas temperature is set on the particulate filter. According to one configuration, a rich-lean cycle is used for increasing temperature during regeneration. Here, an oxygen accumulator is at least partially filled and emptied cyclically. Reactions performed in this way in the oxygen accumulator generate heat that is used for increasing the temperature. The temperature increase can be performed, for example, before the actual regeneration, so that for triggering the actual regeneration, advantageously only little enthalpy must still be provided. For example, the oxygen quantity present in the oxygen accumulator can be used to generate, at least partially, a required temperature and/or temperature increase for regeneration. For this purpose, the oxygen accumulator stores oxygen accordingly in phases of an oxygen excess supply, wherein this oxygen can be output in phases of regeneration.

Such an operation of the oxygen accumulator in interaction with regeneration is supported, for example, in various ways by means of the motor control system and/or the separate control device. For example, the temperature increase can be achieved in such a way that an exhaust-gas temperature is detected at the internal combustion engine or else also for operation of a turbine at the outlet of the turbine. For example, in an internal combustion engine, this can be realized by a reduction of the air ratio, for example, by post injection, through a change of an injection angle and also through throttling of the air fed to the engine or a turbine. To allow an amplification of the temperature increase, fuel that has not combusted or that has combusted only incompletely can be fed to the oxygen accumulator. For example, for this purpose, a delayed post injection of fuel can be used in an expansion cycle of the internal combustion engine. Furthermore, there is the possibility to provide an injection of the fuel into a displacement cycle. In addition there is the possibility of direct fuel supply into the exhaust-gas flow, for example, by means of an additional injection. There is also the possibility of reforming fuel and supplying it as synthesis gas. For example, there is also the possibility that, in a motor vehicle that has a bivalent drive, for example, a liquid gas accumulator, a natural gas accumulator, or the like is used in addition, in order to allow a corresponding fluid inflow into the exhaust-gas after-treatment system.

The oxygen to be stored in the oxygen accumulator is fed, for example, from residual oxygen from the engine combustion. However, there is also the possibility of providing an external air supply into the exhaust gas. For this purpose, for example, a secondary air line can be used. There is also the possibility of being able to use a charging device of an internal combustion engine for this purpose. In addition there is the possibility of using oxygen stored at other locations of the exhaust-gas after-treatment system for enriching the oxygen output from this system in the oxygen accumulator.

A combustible gas component can be converted in the exhaust-gas after-treatment system through sufficient oxygen made available, for example, by means of oxygen fed exclusively from the oxygen accumulator or additionally from the oxygen accumulator, in particular, as a supplement from the oxygen accumulator. For the operation of the motor vehicle exhaust-gas after-treatment system, it is geared in a targeted way to the use of the present oxygen accumulator in a controlled way. For example, there is the possibility of performing a temperature control or regulation of the particulate filter, in particular, when the particulate filter itself has the ability to act as an oxygen accumulator.

According to another configuration, the determined oxygen quantity of the oxygen accumulator is included as a parameter in a desulfurization process of an oxide accumulator advantageously for influencing a rich-lean cycle. The oxide accumulator can be, for example, a nitrogen oxide-accumulating catalytic converter and/or a sulfur oxide accumulator. In desulfurization, an oxygen supply from the oxygen accumulator is used to oxidize, for example, for H₂S created during substoichiometric operation into SO₂. By determining the current oxygen content in the oxygen accumulator, it is advantageously implemented in the corresponding operating strategy that complete emptying of the oxygen accumulator is avoided especially during rich operation. Thus, a risk of H₂S output is prevented. In particular, if it is provided as an operating strategy that the oxygen accumulator may never be
completely emptied, then instead of a lambda probe after the oxygen accumulator, in particular, a transition probe can also be provided.

[0024] Advantageously, not just a determination of a beginning of a desulfurization process and/or a regeneration process can be determined by means of the considered oxygen quantity. There is also the possibility that the determined oxygen quantity is incorporated as a parameter for determining a time period of the desulfurization and/or the regeneration.

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[0026] The oxygen quantity required for the method in the oxygen accumulator is determined, according to one configuration, through integration of the oxygen mass flow exchanged with the accumulator. The oxygen mass flow is here calculated with reference to a difference in the probes, in particular, the lambda probes, and also the exhaust-gas mass flow. For this purpose, the following formula is used:

$$m_{\text{O}_2} = \frac{\Delta \rho (\lambda_{\text{meas}} - \lambda_{\text{ref}})}{\rho_{\text{air}} \cdot L}$$

where

- $m_{\text{O}_2}$: stored oxygen mass
- $m_{\text{O}_2}^\text{out}$: exchanged oxygen mass flow
- $m_{\text{O}_2}^\text{in}$: exhaust-gas mass flow
- $L$: stoichiometric factor
- $\lambda$: air ratio

[0027] The result of such a calculation or another may be incorrect, for example, due to inaccurate lambda signals or an inaccurate exhaust-gas mass flow, so that the calculated oxygen content does not correspond to the actual oxygen content. Also, through integration, an error can continue to grow over time. It is then possible that undesired rich or lean breakthroughs are realized. If such a breakthrough should occur, with reference to this breakthrough the actual state of the accumulator can be identified and the calculation can be reset to a certain value. In addition, a targeted breakthrough situation can be created, in order to also achieve a calibration of the measurement. There is also the possibility for initiating a calibration from the operating behavior of the oxygen accumulator. For example, a maximum storage state can also be tested through corresponding air or oxygen supply and advantageously a calibration for the storage capacity and the storage state of the oxygen accumulator can be determined.

[0028] One improvement provides that, in the scope of a control or regulation system, the oxygen accumulator, advantageously also its oxygen storage capacity and, in particular, the current, determined stored oxygen quantity are used to set at least one threshold value. When this threshold is exceeded, a cycle change is triggered between lean and rich operation. The threshold value can be fixed. However, there is also the possibility that the threshold value can be adapted, for example, due to aging of the oxygen accumulator. For example, for a calibration of the oxygen storage capacity or the calculation of the oxygen storage capacity, the threshold value can be increased or decreased. For example, the threshold value is stored in the control device of the exhaust-gas after-treatment system. However, it can also be provided, for example, in the motor control system. Preferably it is provided that a lower and an upper threshold are set with respect to the oxygen quantity and a cycle change between lean and rich operation is triggered when the threshold is exceeded. A trigger point for the cycle change can here be provided when the threshold is reached but also only after the threshold is exceeded. Preferably, a hysteresis response can be triggered for a cycle change. This means that after a threshold is reached, the oxygen accumulator either continues to store oxygen in a slowed manner before discharging the oxygen or, in the inverse case, a discharge of the oxygen is performed in a slowed manner before oxygen is stored again in the oxygen accumulator. Advantageously it is provided that the threshold with respect to the oxygen quantity in the oxygen accumulator can be exceeded once the threshold is reached and then after the cycle change has been completed and the operating behavior with respect to the oxygen discharge or absorption of the oxygen accumulator is reversed.

[0029] In addition, it can be provided that an internal combustion engine is operated in a rich-lean cycle, wherein a temperature of the oxygen accumulator is determined and an operating parameter influencing the stored oxygen quantity is changed as a function of the determined temperature. In particular, there is also the possibility that temperature control of the exhaust-gas after-treatment component having the oxygen accumulator changes an oxygen quantity discharged per unit time from the oxygen accumulator for adjusting the temperature of the exhaust-gas after-treatment component. In the case of temperature regulation through the use of the oxygen accumulator, for example, a PI regulator can be used.

[0030] In addition, as well as also separately, an operation of the motor-vehicle exhaust-gas after-treatment system can be provided in which a rich-lean cycle is performed at least partially during desulfurization of an oxide, in particular, a nitrogen oxide-accumulating catalytic converter, and an air ratio is stored after the oxide, in particular, the nitrogen oxide-accumulating catalytic converter, wherein the oxygen quantity is determined and used to prevent stoichiometry and/or hyperstoichiometry of the air ratio after the oxide, in particular, the nitrogen oxide-accumulating catalytic converter. Here, reference is made, in particular, to one or more thresholds that can be set with respect to the storage quantity of oxygen in the oxygen accumulator. For example, there is the possibility that not just one threshold value, but several threshold values are provided. Here there is the possibility to be able to operate the oxygen accumulator with different temperatures or oxygen discharge or oxygen absorption.

[0031] The operation of the oxygen accumulator is integrated into the exhaust-gas after-treatment concept of the motor vehicle. Therefore, the oxygen accumulator can be arranged as an individual component in the exhaust-gas after-treatment system. It is preferred, however, that the oxygen accumulator is a part of a component of the exhaust-gas after-treatment system. This can be a catalytic converter, a particulate filter, or some other element in the exhaust-gas after-treatment system.

[0032] According to another concept of the invention, an exhaust-gas after-treatment system with a connected internal combustion engine is proposed, wherein the internal combustion engine has a motor control system and the exhaust-gas after-treatment system has at least one regulated catalytic converter and an oxygen accumulator, wherein a first probe is arranged before the oxygen accumulator and a second probe is arranged after the oxygen accumulator, wherein the first
probe detects a first parameter characterizing an oxygen content, a signal transmission of the parameter recorded by the first and second probes to an evaluation unit is provided, and the evaluation unit is coupled with a motor control system with a regulation or control unit that takes into account a rich-lean cycle based on the determined parameter.

[0033] By means of such an exhaust-gas after-treatment system with connected internal combustion engine, the method described above is preferably performed for operating a motor-vehicle exhaust-gas after-treatment system.

[0034] One improvement provides that the second probe is a temperature probe whose parameter is included in a control or regulation system of a lambda value of the motor control system. Advantageously, a rich-lean cycle is included as a desired value in a lambda regulation of the internal combustion engine.

[0035] Another configuration of the exhaust-gas after-treatment system provides that the first and the second probes each determine a first parameter characterizing an oxygen content, and a signal transmission of the first parameter from the first and the second probes to an evaluation unit is provided; the evaluation unit determines, from the first parameters, a second parameter characterizing an oxygen content of the oxygen accumulator, and the motor control system is coupled with a device for setting an air ratio in the exhaust-gas after-treatment system, wherein an adaptation of the air ratio as a function of the second parameter is provided by means of the device.

[0036] One improvement of the exhaust-gas after-treatment system provides that the oxygen accumulator has a first part and a second part that are arranged in at least two different exhaust-gas after-treatment components. For example, the oxygen accumulator can be formed from an NOx catalytic converter and also from a particulate filter. These can also be provided separate from each other. In addition, there is the possibility that a three-way catalytic converter also includes an oxygen accumulator or a part of this oxygen accumulator. It is preferred when a measurement probe is provided for determining a temperature of the oxygen accumulator. This permits a direct coupling of the measured temperature for a calculation of the oxygen content of the oxygen accumulator. For example, this determined temperature value can be used for testing the oxygen content set, for example, by means of the oxygen balance. Alternatively or additionally, the determination of the temperature of the oxygen accumulator also allows one or more of the thresholds named above to change to influence the rich-lean cycle according to the temperature-dependent oxygen storage capacity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] Other advantageous configurations and improvements are specified in the following drawings. The resulting features, however, are not limited to the individual configurations. Instead, to form improvements, individual features can be combined with those of other configurations of the drawings and also with features of the above description. Shown are:

[0038] FIG. 1, a first schematic view of a first exhaust-gas after-treatment system,

[0039] FIG. 2, a schematic view of a second exhaust-gas after-treatment system with temperature regulation,

[0040] FIG. 3, a schematic diagram of a temperature change through a change in the operation of an internal combustion engine under consideration of the oxygen quantity stored per unit time in an oxygen accumulator of the exhaust-gas after-treatment system connected to the internal combustion engine,

[0041] FIG. 4, a schematic view of a control loop for setting a temperature change through a change in the use of an oxygen accumulator,

[0042] FIG. 5, a schematic view of a third exhaust-gas after-treatment system that allows, for example, the prevention of a rich breakthrough by means of calculating a stored oxygen quantity,

[0043] FIG. 6, a schematic diagram of a conventional regulation of a conventional catalytic converter with an oxygen accumulator by means of a lambda probe arranged at an outlet of the catalytic converter, and

[0044] FIG. 7, a changed operation of the catalytic converter from FIG. 6 that acts as an oxygen accumulator under consideration of a calculated oxygen content based on a two-point regulation according to the proposed operating method.

DETAILED DESCRIPTION OF THE INVENTION

[0045] FIG. 1 shows, in a schematic view, a first exhaust-gas after-treatment system 1 in an example configuration. The exhaust-gas after-treatment system 1 is arranged after an internal combustion engine 2. This system has an exhaust-gas train 3 in which, for example, an additional air feed 4 and also an additional fuel feed 5 are provided. Both feeds 4, 5 are arranged before a first probe 6, in particular, a lambda probe. The first probe 6 is connected in front of an exhaust-gas after-treatment component 7 viewed in the flow direction. The exhaust-gas after-treatment component 7 has an oxygen accumulator 8. In addition, the exhaust-gas after-treatment component 7 can have a catalytic converter, in particular, a regulated catalytic converter, an NOx-accumulating catalytic converter, a particulate trap, a sulfur trap, and/or some other component that is in the position to change an exhaust gas originating from the internal combustion engine 2. The oxygen accumulator 8 has a first part 9 and a second part 10. These are arranged, for example, separately from each other in different areas of the exhaust-gas after-treatment component 7. For example, the first part of the oxygen accumulator 8 can be arranged in a particulate filter, while the second part 10 of the oxygen accumulator 8 is arranged in an NOx-accumulating catalytic converter. The particulate filter and the NOx-accumulating catalytic converter together form, for example, the exhaust-gas after-treatment component 7. A second probe 11 is arranged after this component, wherein this probe can also be, for example, a lambda probe. After the second probe 11, viewed in the flow direction, there can be another exhaust-gas after-treatment component that can also have an oxygen accumulator. For example, the second probe 11 can be used for more than balancing the oxygen content for the exhaust-gas after-treatment component 7 by determining the corresponding air ratio or the oxygen content after the exhaust-gas after-treatment component 7. The second probe 11 can use, preferably simultaneously, the same signal as an input parameter for the oxygen content or the air ratio for the subsequent exhaust-gas after-treatment component in the scope of a calculation or balancing. For this purpose, another probe, not shown here in more detail, is arranged after the following exhaust-gas after-treatment component. Furthermore, there is the possibility that one or more other probes are provided in the exhaust-gas after-treatment component 7. For example, one or more of these probes can also form a replacement of the second probe 11 if, by means of the determined
balancing, the oxygen content of the region outside of the balancing limits can be determined. By means of a motor control system 12, in particular, the air ratio in the exhaust-gas train can be changed under consideration of the oxygen accumulator 8. The motor control system 12 is connected, for example, to a separate control device 13 of the first exhaust-gas after-treatment system 1. The control device 13 records, for example, the measurement values provided by the different probes and uses these values in a separate evaluation unit 14. By means of this unit, the currently stored oxygen quantity can be determined, for example, by means of oxygen balancing across the oxygen accumulator 8. This value can be forwarded, for example, to the motor control system 12. The control device 13 is in the position, in turn, to be able to adapt, for example, also under consideration of the determined current oxygen quantity, an exhaust-gas strategy in connection with the motor control system 12. This can be incorporated, for example, in such a way that an ammonia-containing medium is fed in a targeted way by means of the control device 13. In particular, the control device 13 is in the position, together with the motor control system 12, to be able to set a turnover between rich operation and lean operation in the first exhaust-gas after-treatment system 1 under consideration of the oxygen accumulator 8. According to another configuration, however, functionality of the control device 13, shown separately, can also be implemented in a motor control device of the motor control system 12.

[0046] FIG. 2 shows, in a schematic view, a second exhaust-gas after-treatment system 15. A control/regulation unit 16 that is coupled, in turn, to the internal combustion engine 2 and is connected to this system. The control/regulation unit 16 is preferably a motor control device, but can also be a control device arranged separately from the motor control device. Control signals 17 and sensor signals 18 can be exchanged between the control/regulation unit 16 and the internal combustion engine 2. A lambda probe 19 is connected upstream in the direction of flow between the internal combustion engine 2 and a catalytic converter 20 that contains an oxygen accumulator 8. By means of the lambda probe 19, a signal characterizing an oxygen content before the catalytic converter 20 is fed to the control/regulation unit 16. By means of a temperature sensor 21 that is arranged after the catalytic converter 20, viewed in the direction of flow, a temperature signal is also fed to the control/regulation unit 16. By means of this device, showing the most important components of an exhaust-gas after-treatment system 15 only schematically, it is possible to perform temperature regulation of the oxygen accumulator 8. In particular, this device made from second exhaust-gas after-treatment system 15 and internal combustion engine 2 allows that a rich-lean cycle can be performed that is influenced by a change of an air ratio and/or a time, a rich phase, and/or a lean phase so that the oxygen quantity originating from the oxygen accumulator 8 per unit time can be changed and therefore a temperature of the oxygen accumulator 8 and thus also the catalytic converter 20 is regulated or controlled.

[0047] FIG. 3 shows, in a schematic view, an example of the use of the oxygen accumulator from FIG. 2 for setting a temperature change of the oxygen accumulator 8 from FIG. 1 or FIG. 2. In an upper first diagram of FIG. 3, the air ratio lambda is shown, plotted on the y-axis, versus time, which is plotted on the x-axis. Under this, the profile of a stored oxygen quantity in the oxygen accumulator is specified, wherein the solid line running parallel to the x-axis, the time axis, specifies a maximum oxygen storage capacity of the oxygen accumulator. Under this, a converted oxygen quantity from the oxygen accumulator is also recorded versus time on the x-axis. Under this, a temperature profile of the oxygen accumulator or the catalytic converter that contains, for example, the oxygen accumulator, is specified, in turn, versus time. In the diagrams of FIG. 3 are two different rich-lean cycles set in comparison. A first rich-lean cycle A is characterized with the dashed line in the uppermost diagram of FIG. 3. A second rich-lean cycle B is shown with a dash-dot line. A thin line running parallel to the x-axis specifies the air ratio lambda=1 in the uppermost diagram of FIG. 3. The two rich-lean cycles A, B differ by an amplitude of a change of the respective air ratio delta lambda. Both cycles have in common that the oxygen accumulator is neither completely filled nor completely emptied. This starts from the profile of the stored oxygen quantity in the oxygen accumulator that at no time exceeds the maximum oxygen storage capacity. In a lean phase, a stored oxygen quantity increases. This takes place in time period I. In a subsequent rich phase, the oxygen present in the oxygen accumulator is converted with combustible exhaust-gas components. This is shown in time phase II. By setting a high amplitude as shown, for example, in the second rich-lean cycle B, more oxygen is converted in each rich phase II. Therefore, there is a higher heat flux, so that a higher temperature increase is set by means of the oxygen accumulator. This is reproduced in the lowermost diagram of FIG. 3. While a temperature at an inlet of the oxygen accumulator remains constant, this changes at the outlet as a function of the set air ratio or the change in the air ratio, as emerges from the uppermost diagram of FIG. 3. Taking advantage of this relationship, the temperature of the oxygen accumulator and thus, for example, a catalytic converter can be controlled or regulated.

[0048] In a schematic view, FIG. 4 shows a possibility for implementing temperature regulation with reference to an action diagram for using the oxygen accumulator. The action diagram provides the internal combustion engine 2 that delivers a time-varying air ratio lambda as a current state. The value of the current state of the air ratio is included, on one hand, in an oxygen accumulator 8. By this, a temperature T is detected by means of a corresponding temperature sensor. Here, the temperature of the oxygen accumulator 8 and/or a temperature of an exhaust-gas flow can be detected at an outlet from the oxygen accumulator 8, for example, a catalytic converter, a particulate trap, or another exhaust-gas after-treatment component. The temperature value is used as a control parameter. This allows a temperature value to be set that specifies a desired value of the temperature to be set in the oxygen accumulator or in the exhaust-gas after-treatment component. This desired value is set, for example, by means of the motor control system or by means of a separate control device. From the comparison of the control parameter with the desired value, the control difference can be determined that is fed as an input parameter to a regulator 15. From this, the regulator generates an amplitude of the air ratio, advantageously in the form of an air ratio change. By means of a corresponding generator, for example, by means of a pulse-width modulation generator, a desired value of the air ratio can be formed from the change of air ratio delta lambda. This means the corresponding rich-lean cycle delivers the desired value of the air ratio that is included together with the current value of the air ratio in a lambda regulator 16 of the internal combustion engine 2.
As an alternative to the schematic temperature regulation from FIG. 4 in a closed control loop with the required temperature measurement, there is also the possibility of using a pure control system in which a change in the air ratio is stored in a characteristic map or a characteristic line.

In an example schematic view, FIG. 5 shows a third exhaust-gas after-treatment system 22 with an internal combustion engine 2 and also a controller/regulation unit 16, between which control signals 17 and sensor signals 18 can be exchanged. A broadband lambda probe 23 is arranged before an oxygen accumulator 8, for example, in the form of a catalytic converter. Viewed in the direction of flow, a control probe 24 is located after the oxygen accumulator 8. The control probe 24 can be a broadband lambda probe or a transition probe. By means of the lambda probe 23, an air ratio or an oxygen content in the exhaust-gas flow is transmitted with reference to a characterizing parameter to the control/regulation unit 16. From the control probe 24, an air ratio or an oxygen-characterizing signal value is also forwarded to the control/regulation unit 16. This signal can also represent a transition signal on the basis of the probe that is used. This configuration allows, on one hand, a determination of the stored oxygen quantity in the oxygen accumulator 8 by means of balancing across the oxygen accumulator 8. On the other hand, the configuration is suitable for preventing a rich breakthrough by the oxygen accumulator 8 and thus, for example, the connected catalytic converter, with the resulting H₂S emissions, in particular, for desulfurization.

In a schematic diagram, FIG. 6 shows a conventional regulation of a catalytic converter that uses a lambda probe arranged at an outlet. In the upper diagram of FIG. 6, the air ratio is shown, and in the lower diagram of FIG. 6, the stored oxygen quantity in the catalytic converter is reproduced. All values are plotted versus time. If it is determined by means of the lambda probe that the air ratio after the catalytic converter is greater than 1, then a switch point is set at which a transition from lean operation to rich operation is performed. In contrast, if it is determined by means of the lambda probe that there is an air ratio less than 1 after the catalytic converter, then the control system is switched from rich operation to lean operation. From the lower diagram, the respective switch points are drawn using dotted lines downward from the upper diagram. The stoichiometric or hyperstoichiometric air ratios are advantageously set so that the respectively stored oxygen quantities in the oxygen accumulator have been completely removed from the oxygen accumulator or else the storage capacity of the oxygen accumulator was exceeded. Starting from the upper diagram of FIG. 6, the desired value of the air ratio before the catalytic converter emerges as a solid line c. In the dotted diagram a, the actual value of the air ratio before the catalytic converter is shown, while the air ratio after the catalytic converter is also recorded with dashed lines. From this emerges the following relationship with respect to the rich-lean cycle that is controlled with respect to the lambda signal after the catalytic converter: in the lean phase 1 with lambda greater than 1 before the catalytic converter, this and thus the oxygen accumulator are filled. If accumulation of oxygen in this phase is not controlled, no oxygen is led through the accumulator and the lambda signal that is recorded after the catalytic converter as the oxygen accumulator remains at the value of 1. Only when the oxygen accumulator is completely filled can an oxygen breakthrough be detected with reference to the lambda signal and a rich transition can be triggered. In this rich phase II, the accumulator empties. If a sufficiently high temperature is provided here, nearly all of the reduction agent is converted, so that the lambda signal again remains at 1. After complete emptying of the oxygen accumulator, however, a reduction agent breakthrough is realized that is indicated by means of the probe. Only when this has been detected by the lambda probe can a lean transition be realized. Through the inertia provided in the control path and in the respective actuators, reduction agent is discharged for a certain time. During desulfurization, this can mean that H₂S is discharged. In contrast, with the device emerging from FIG. 5, there is the possibility of preventing such discharge and allowing, in particular, another type of regulation.

FIG. 7 shows the configuration of 2-point regulation of the oxygen accumulator that is possible relative to the catalytic converter emerging from FIG. 6. Here, the rich-lean cycle is controlled with reference to the stored oxygen quantity, for example, in the catalytic converter. This allows rich and also lean breakthroughs to be prevented. Here, preferably, for example, a 2-point regulation with hysteresis is used. If a certain oxygen threshold is exceeded, a rich transition is triggered. When the value falls below another threshold, a lean transition is realized. In the case of desulfurization, at any time there is sufficient oxygen that can be used for the oxidation of H₂S. The upper threshold 25 and lower threshold 26 in the lower diagram from FIG. 7 can thus be guaranteed for sufficient spacing relative to a maximum oxygen absorption capacity of the oxygen accumulator or a safe operation in all operating points of the exhaust-gas after-treatment system for an emptied state of the oxygen accumulator. From the upper diagram of FIG. 7 it is to be taken that, in turn, the desired value before the catalytic converter, shown as a solid line c, and also the current value of the air ratio before the catalytic converter, shown as a dotted line a, can lead to an air ratio of lambda=1 after the catalytic converter for consideration of the oxygen quantity in the oxygen accumulator and thus in the exhaust-gas after-treatment component. In particular, this permits a constant air ratio b of lambda =1 to be reliably set after the catalytic converter or the exhaust-gas after-treatment component.

1. A method for operating a motor-vehicle exhaust-gas after-treatment system in which oxygen is fed to or removed from an oxygen accumulator of an exhaust-gas after-treatment component, wherein at least one changing parameter defined by the oxygen accumulator and its oxygen content is determined and is used in the operation of the motor-vehicle exhaust-gas after-treatment system.

2. The method according to claim 1, wherein an oxygen quantity in the oxygen accumulator is defined.

3. The method according to claim 1, wherein the oxygen quantity in the oxygen accumulator is incorporated as a parameter for setting a rich-lean cycle.

4. The method according to claim 1, wherein a cyclical change of a stored oxygen quantity is used for the defined influence of a temperature of the exhaust gas or the oxygen accumulator.

5. The method according to claim 1, wherein an additional oxygen supply in the motor-vehicle exhaust-gas after-treatment system is performed as a function of the determined oxygen quantity.

6. The method according to claim 1, wherein the oxygen quantity is calculated by means of an oxygen balancing across the oxygen accumulator.
7. The method according to claim 6, wherein a first probe determines a continuous measurement of an oxygen content before the oxygen accumulator, while a second probe determines whether an exhaust gas is a rich mix or lean mix.

8. The method according to claim 1, wherein for a regeneration of a particulate filter and/or an NOx-accumulating catalytic converter, the determined oxygen quantity is included as a parameter.

9. The method according to claim 1, wherein for desulfurization of an oxygen accumulator, the determined oxygen quantity is included as a parameter.

10. The method according to claim 8, wherein for determining a beginning of the desulfurization and/or the regeneration, the determined oxygen quantity is included as a parameter.

11. The method according to claim 8, wherein for determining a time period of the desulfurization and/or the regeneration, the determined oxygen quantity is included as a parameter.

12. The method according to claim 1, wherein a cyclical use of the oxygen accumulator is used for increasing the temperature before a diesel particulate filter regeneration.

13. The method according to claim 1, wherein at least one threshold is set with respect to the determined stored oxygen quantity, and when this threshold is exceeded, a cycle change between lean operation and rich operation is triggered.

14-15. (canceled)

16. The method according to claim 1, wherein an internal combustion engine is operated in a rich-lean cycle, wherein a temperature of the oxygen accumulator is determined and an operating parameter influencing the stored oxygen quantity is changed as a function of the determined temperature.

17. The method according to claim 1, wherein a temperature regulation or temperature control system, with respect to the exhaust-gas after-treatment component having the oxygen accumulator changes an oxygen quantity discharged from or absorbed in the oxygen accumulator per unit time for adjusting the temperature of the exhaust-gas after-treatment component.

18. The method according to claim 1, wherein during desulfurization of an oxide-accumulating catalytic converter, a rich-lean cycle is at least partially performed and an air ratio is detected before and after the oxide-accumulating catalytic converter, wherein the oxygen quantity is determined and the oxygen accumulator is used to avoid substoichiometry and/or hyperstoichiometry of the air ratio after the oxide-accumulating catalytic converter.

19. An exhaust-gas after-treatment system with a connected internal combustion engine, wherein the internal combustion engine has a motor control system, and the exhaust-gas after-treatment system has at least one regulated catalytic converter and an oxygen accumulator, wherein a first probe is arranged before the oxygen accumulator and a second probe is arranged after the oxygen accumulator, wherein at least the first probe determines a first parameter characterizing the oxygen content, and a signal transmission of the parameter recorded by the first and the second probes to an evaluation unit is provided, and the evaluation unit is coupled with a motor control system with a regulation or control unit that takes into account a rich-lean cycle based on the determined parameter.

20. The exhaust-gas after-treatment system according to claim 19, wherein the second probe is a temperature probe whose parameter is included in a control or regulation system of a lambda value of the motor control system.

21. The exhaust-gas after-treatment system according to claim 20, wherein a rich-lean cycle is included as a desired value in a lambda regulation of the internal combustion engine.

22. The exhaust-gas after-treatment system according to claim 19, wherein the first and the second probes each determine a first parameter characterizing an oxygen content, and a signal transmission of the first parameter from the first and the second probes to an evaluation unit is provided, and the evaluation unit determines, from the first parameters, a second parameter characterizing the oxygen content of the oxygen accumulator, and the motor control system is coupled with a device for setting an air ratio in the exhaust-gas after-treatment system, wherein an adaptation of the air ratio is provided as a function of the second parameter by means of the device.

23. The exhaust-gas after-treatment system according to claim 19, wherein the first probe is a broadband lambda probe and the second probe is a transition probe.

24. The exhaust-gas after-treatment system according to claim 19, wherein the oxygen accumulator has a first part and a second part that are arranged in one or at least two different exhaust-gas after-treatment components.

25. The exhaust-gas after-treatment system according to claim 19, wherein the oxygen accumulator is a component of an NOx catalytic converter or a particulate filter.

26. (canceled)

27. The exhaust-gas after-treatment system according to claim 19, wherein a measurement probe is provided for determining a temperature of the oxygen accumulator.

28. The exhaust-gas after-treatment system according to claim 22, wherein at least one of a control system or a regulation system is included and is geared toward the second parameter, in order to trigger a change between rich and lean operation.

29-32. (canceled)