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(54) METHOD FOR OPERATING A DIVE DEVICE AND CORRESPONDING DRIVE DEVICE

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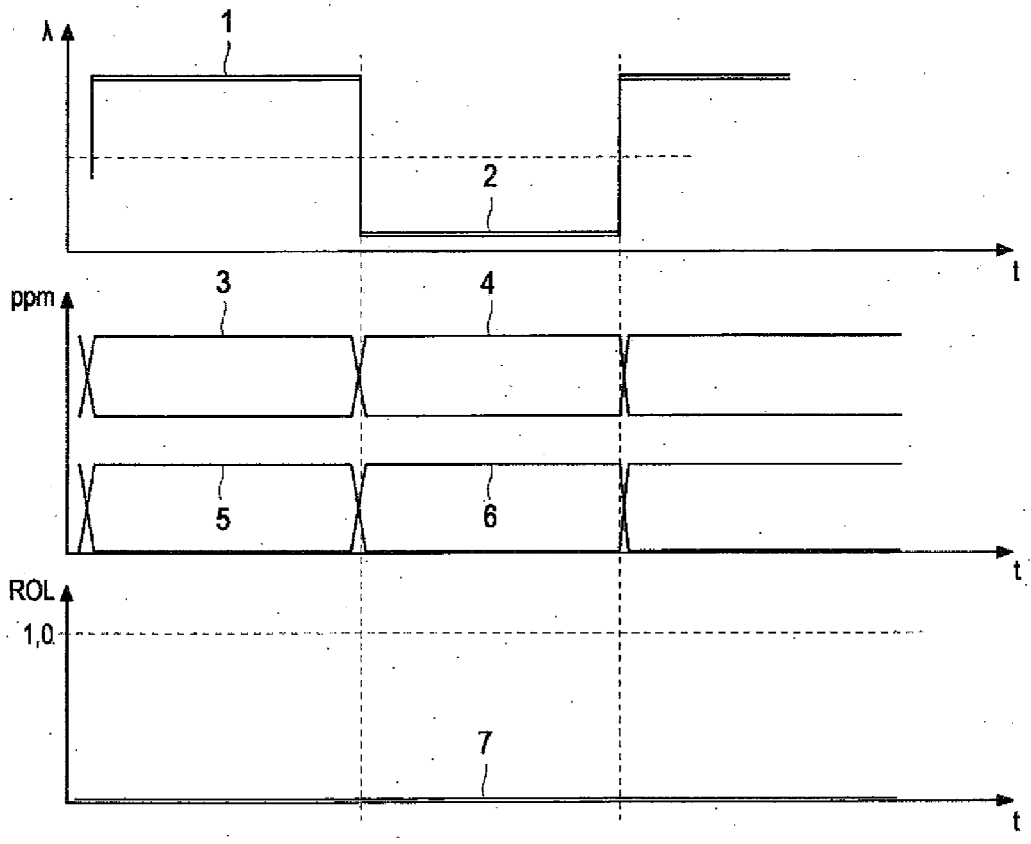
(57) ABSTRACT

A method for operating a drive device, which has a catalytic converter with an oxygen accumulator for purifying exhaust gas, includes determining upstream of the catalytic converter a pre catalytic converter molecular mass of a first substance and a pre catalytic converter molecular mass of oxygen; determining a post catalytic converter oxygen molecular mass by applying a first reaction equation which describes a reaction of the oxygen with the first substance, a second reaction equation, which describes a reaction of the first substance with oxygen stored in the oxygen accumulator, and a third reaction equation which describes an introduction of oxygen from the exhaust gas into the oxygen accumulator, wherein a reaction speed of the second reaction equation and a speed of the third reaction equation is a function of a load state of the oxygen accumulator



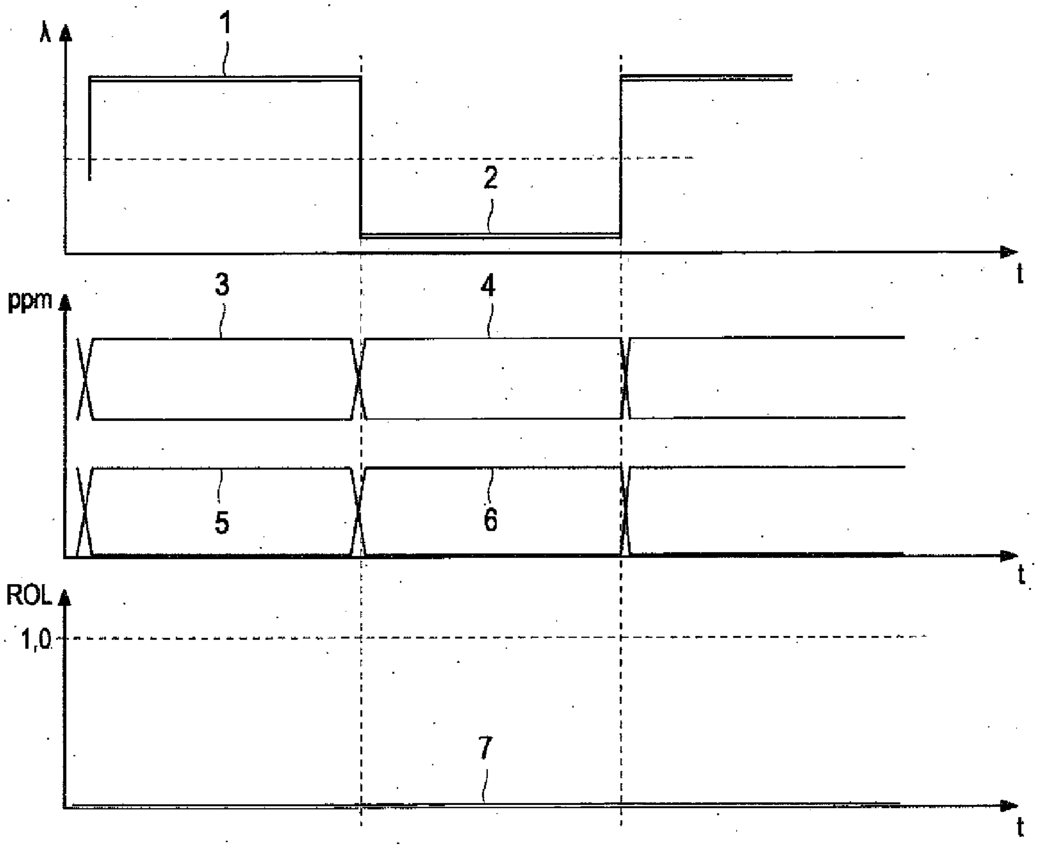


Fig. 1

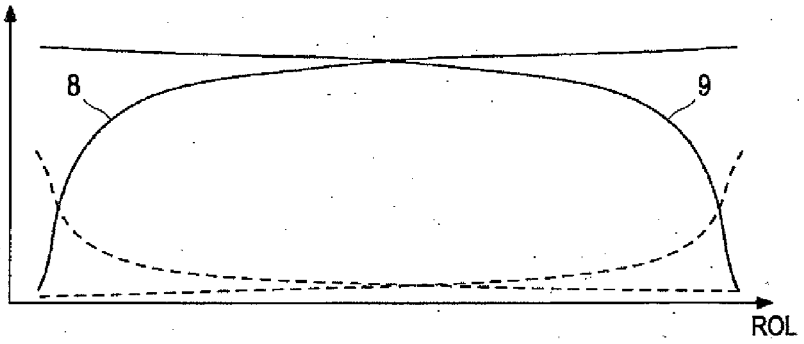


Fig. 2

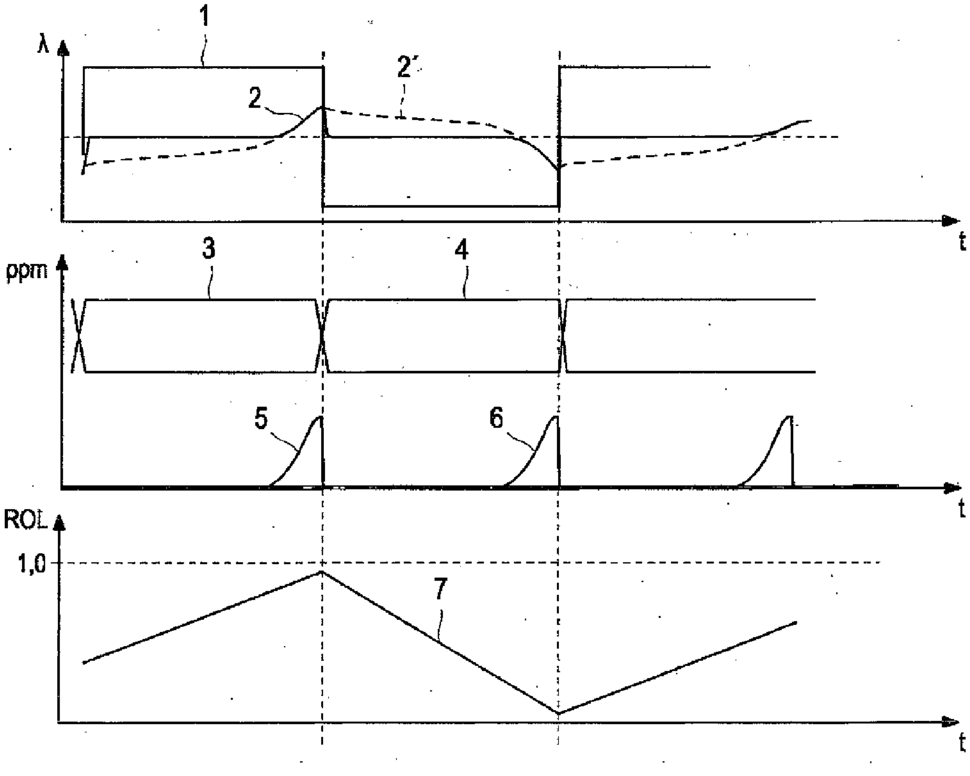


Fig. 3

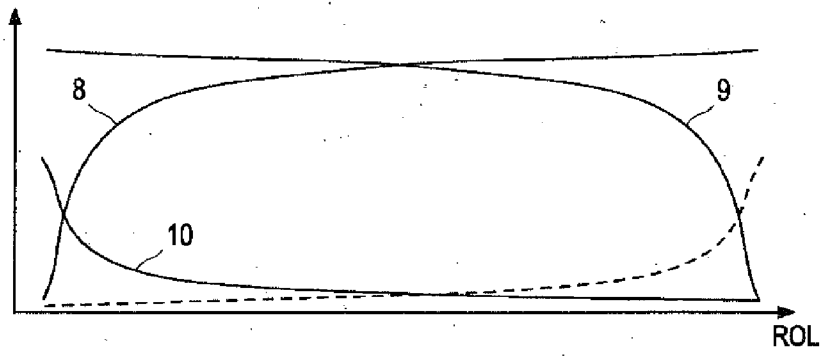


Fig. 4

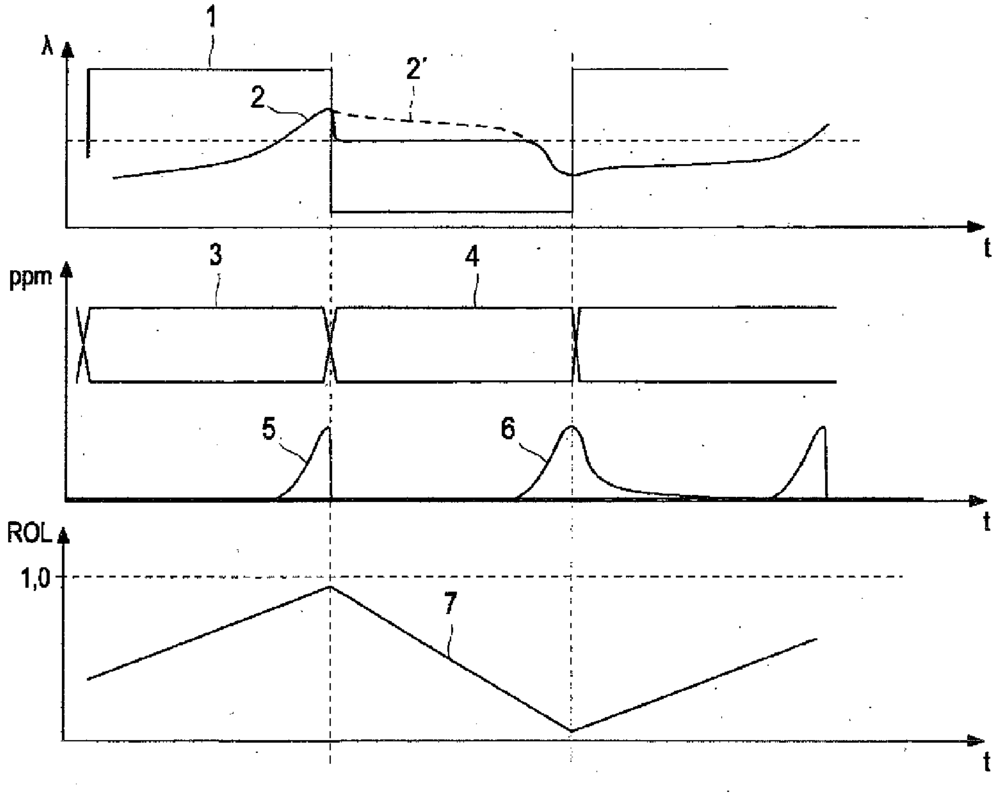


Fig. 5

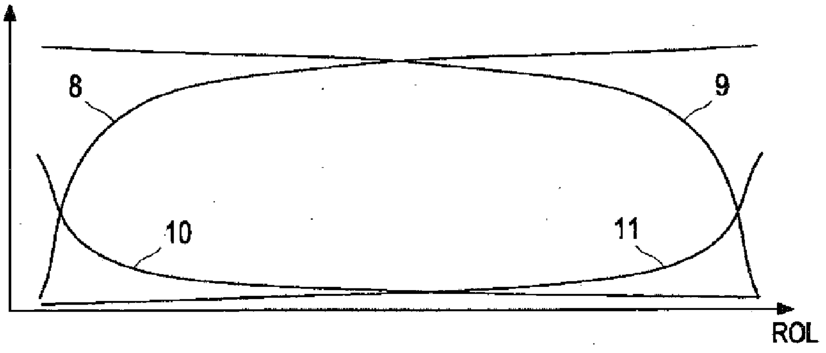


Fig. 6

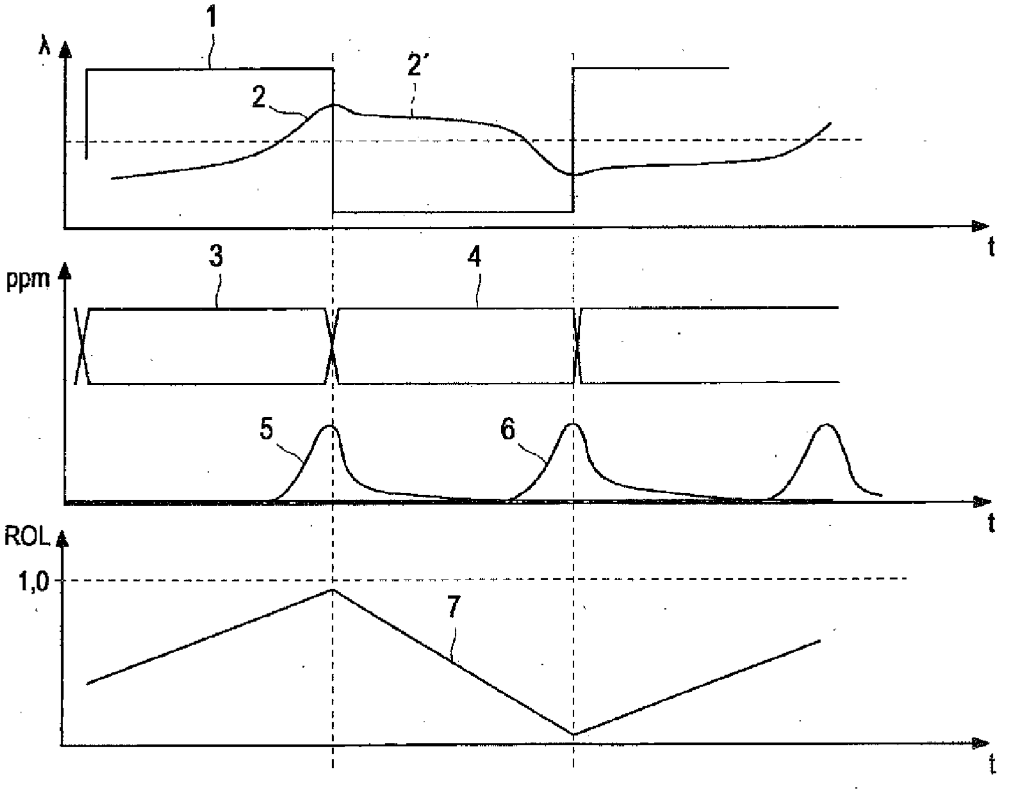


Fig. 7

METHOD FOR OPERATING A DIVE DEVICE AND CORRESPONDING DRIVE DEVICE

[0001] The invention relates to a method for operating a drive device with the features of the preamble of claim **1**. The invention also relates to a drive device.

[0002] The method serves for operating a drive deceive which is for example a component of a motor vehicle or serves for driving the motor vehicle.the drive device has an exhaust generating device for example an internal combustion engine, a fuel cell or the like. For purifying the exhaustgas the catalytic converter is provided which has the oxygen accumulator and is insofar configured as a storage catalytic converter. The oxygen accumulator is hereby present as a separate element. As an alternative or in addition it can also be provided by a catalytically active element of the catalytic converter.

[0003] For operating the drive device it is advantageous when the lambda value of the exhaust gas is known. Thus for example with a first lambda probe a first lambda value can be adjusted upstream of the catalytic converter and with a second lambda probe a second lambda value can be adjusted downstream of the catalytic converter and based thereon the composition of a fuel air mixture which is converted or combusted in the drive device can be adjusted. As an alternative it is also possible to measure the first lambda value by means of a first lambda probe and to determine the second lambda value by means of a model. This is often inaccurate however so that a setting of the composition of the fuel air mixture is not possible without limits.

[0004] From the state of the art for example the patent document U.S. Pat. No. 5,214,915 is known which describes a method for simulating the dynamic of an exhaust gas catalytic converter. Reaction pathways occurring in automobile exhaust gas systems and reaction velocities are explained in the doctoral thesis of Mr. Dipl.-Ing. Matja Bogdanic: "Simulation of car exhaust gas systems"; Faculty III—process Sciences, Technical University Berlin; 2007. The state of the art also includes the patent documents DE 41 12 477 A1, DE 10 2007 060 331 A1, DE 601 14 906 T2 and DE 10 2013 422 A1.

[0005] It is an object of the invention to propose a method for operating a drive device, which has advantages compared to the state of the art and in particular enables a more accurate modeling of a post catalytic converter lambda value, for example corresponding to the second lambda value described above.

[0006] According to the invention this is achieved with a method with the features of claim **1**. Hereby it is provided that as second reaction equation

$$M_2+\tfrac{1}{2}O_{2,sp}\rightarrow M_2O$$

is used, wherein the reaction speed for the second reaction equation is

$$k_{M_{2},O_{2,sp}}(T, OSC, ROL) = y_{M_2}\cdot OSC\cdot\frac{k_{ROL_{M_2}}\cdot ROL}{1+k_{ROL_{M_2}}\cdot ROL}\cdot k_{M_2,O_{2,sp}}^{300^\circ\ C.}\cdot e^{\frac{E_{M_2,O_{2,sp}}}{R}\left(\frac{1}{T}-\frac{1}{573.15K}\right)},$$

wherein M stands for the first substance, y for the partial pressure , k for the reaction speed prevailing under standard ambient conditions, E for the activation energy of the reaction equation, R for the universal gas constant, T for the absolute temperature of the exhaust gas, $O_{2,sp}$ for the molecular oxygen present in the oxygen accumulator, OSC for the storage capacity of the catalytic converter, ROL for the relative load sfte of the oxygen accumulator and k_{ROL} for the influence of the availability of the oxygen stored in the oxygen storage on the reaction, and or that as third reaction equation

$$O2\rightarrow O_{2,sp}$$

is used, wherein the reaction speed for the third reaction equation is

$$k_{O_{2},O_{2,sp}}(T, OSC, ROL) = y_{O_2}\cdot OSC\cdot\frac{k_{ROL_{O_2}}\cdot(1-ROL)}{1+k_{ROL_{O_2}}\cdot(1-ROL)}\cdot k_{O_2,O_{2,sp}}^{300^\circ\ C.}\cdot e^{\frac{E_{O_2,O_{2,sp}}}{R}\left(\frac{1}{T}-\frac{1}{573.15K}\right)},$$

wherein M stands for the first substance, y for the partial pressure, k for the reaction speed prevailing under standard ambient conditions, E for the activation energy of the reaction equation, R for the universal gas constant, T for the absolute temperature of the exhaust gas, $O_{2,sp}$ for the molecular oxygen present in the oxygen accumulator, OSC for the storage capacity of the catalytic converter, ROL for the relative load state of the oxygen accumulator and k_{ROL} for the influence of the availability of the oxygen stored in the oxygen accumulator on the reaction.

[0007] Generally for calculating a post catalytic converter lambda value a post catalytic converter oxygen molecular mass is determined by taking the reaction of the oxygen with the first substance into account by means of a first reaction equation, and when determining the post catalytic converter molecular oxygen molecular mass additionally a second reaction equation which describes a reaction of the first substance with the oxygen stored in the oxygen accumulation, and a third reaction equation which describes the introduction of oxygen from the exhaust gas into the oxygen accumulator into account, wherein a load state of the oxygen accumulator factors into a reaction speed of the second reaction equation and a reaction speed of the third reaction equation. Generally the goal is thus to determine the post catalytic converter lambda value. For this purpose first the pre catalytic converter molecular mass of the first substance and a pre catalytic converter oxygen molecular mass of oxygen is determined upstream of the catalytic converter. For this purpose for example a lambda probe, in particular the first lambda probe, is used.

[0008] Based on the pre catalytic converter molecular mass and the pre catalytic converter oxygen molecular mass the behavior of the catalytic converter together with its oxygen accumulator is then modeled. For this purpose three reaction equations are first used which at least approximately describe a part of the reactions that occur in the catalytic converter. Each reaction equation is hereby assigned a defined reaction speed which itself is determined from defined variables. By using the reaction equations and the respective reaction speed the post catalytic converter oxygen molecular mass is determined from the pre catalytic converter molecular mass of the first substance and the pre catalytic converter oxygen molecular mass, i.e., the molecular mass of oxygen being present downstream of the catalytic converter. By using this post catalytic converter oxygen molecular mass the post catalytic converter lambda value can be determined in a simple manner, in particular because the fuel amount per time unit used for operating the drive device is known.

[0009] The post catalytic converter lambda value can thus for example be determined according to Brettschneider, for example with the relationship

$$\lambda = \frac{[\mathrm{CO_2}] + \left[\frac{\mathrm{CO}}{2}\right] + [\mathrm{O_2}] + \left[\frac{\mathrm{NO}}{2}\right] + \left(\left(\frac{H_{CV}}{4} \cdot \frac{3.5}{3.5 + \frac{[\mathrm{CO}]}{[\mathrm{CO_2}]}}\right) - \frac{\mathrm{O}_{CV}}{2}\right) \cdot ([\mathrm{CO_2}] + [\mathrm{CO}])}{\left(1 + \frac{H_{CV}}{4} - \frac{O_{CV}}{2}\right) \cdot ([\mathrm{CO_2}] + [\mathrm{CO}] + (C_f \cdot [HC]))}.$$

[0010] Hereby the square brackets stand for the concentration of the corresponding species, in vol %, HCV for the molecular ratio of water to carbon in the used fuel, O_{CV} for the molecular ratio of oxygen to carbon in the fuel. The value C_f is fuel specific. The species used in the relationship beside the (molecular) oxygen or their molecular mass and thus the concentration can be determined in any desired manner, preferably by means of one or multiple reaction equations which are simultaneously used with the reaction equations for the oxygen.

[0011] The first reaction equation directly takes the reaction of the oxygen with the first substance into account. The first substance generally may be any desired substance present in the exhaust gas which reacts with the oxygen. For example hydrogen, in particular molecular hydrogen, is used as the first substance. The reaction equations explained in the present description however can be applied to any other exhaust gas species so long as the reaction speeds and the reaction ratios are correspondingly adjusted.

[0012] The first reaction equation, however, completely ignores the oxygen accumulator and only describes the indirect reaction of the first substance with the oxygen, which is already present in the exhaust gas, i.e., which was already present upstream of the catalytic converter. In order to improve the accuracy of the determined post catalytic converter oxygen molecular mass the second reaction equation and the third reaction equation are therefore used. The second reaction equation addresses the circumstance that the first substance, when flowing through the catalytic converter, does not only react with the oxygen present in the exhaust gas but additionally also with the oxygen stored in the oxygen accumulator. With the third reaction equation the circumstance is taken into account that the oxygen present upstream of the catalytic converter may be introduced into the oxygen accumulator when flowing though the catalytic converter.

[0013] The second reaction equation as well as the third reaction equation focus on the oxygen accumulator. Correspondingly it is necessary to at least factor the load state of the oxygen accumulator into the reaction speeds. The reaction speeds of the second reaction equation and the third reaction equation are therefore a function of the load state.

[0014] According to the invention it is provided that as second reaction equation

$$M_2 + \tfrac{1}{2}O_{2,sp} \rightarrow M_2O$$

is used, wherein the reaction speed for the second reaction equation is

$$k_{M_2,O_{2,sp}}(T, OSC, ROL) = y_{M_2} \cdot OSC \cdot \frac{k_{ROL_{M_2}} \cdot ROL}{1 + k_{ROL_{M_2}} \cdot ROL} \cdot k_{M_2,O_{2,sp}}^{300^\circ\,C.} \cdot e^{-\frac{E_{M_2,O_{2,sp}}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)}.$$

[0015] The subscript "sp" indicates that the respective component is assigned to the oxygen accumulator. The term "$O_{2,sp}$" thus indicates the molecular oxygen present in the oxygen accumulator.

[0016] Beside the already mentioned variables the equation of the reaction speed for the second reaction equation includes in particular the storage capacity of the catalytic converter, which is referred to as OSC ("Oxygen Storage Capacity"). In addition the relative oxygen load ROL of the oxygen accumulator is taken into account.

[0017] The variable $k_{ROL,\,x}$ describes the influence of the availability of the oxygen stored in the oxygen accumulator on the reaction, because the oxygen cannot be introduced into or retrieved from the oxygen accumulator with infinite speed. The subscript "x" stands for the species, which is mainly observed in the reaction equation, i.e., for example "H_2". The variable $k_{ROL,x}$ is for example experimentally determined so that the actual conditions in the catalytic converter are described as accurately as possible. Based on this variable a calibration of the reaction speeds can thus be performed. It can be seen that beside the temperature the reaction speed for the second reaction equation additionally takes the storage capacity and the load state of the oxygen accumulator into account.

[0018] In addition or as an alternative it is provided that as third reaction equation

$$O_2 \rightarrow O_{2,sp}$$

is used, wherein the reaction speed for the third reaction equation is

$$k_{O_2,O_{2,sp}}(T, OSC, ROL) = y_{O_2} \cdot OSC \cdot \frac{k_{ROL_{O_2}} \cdot (1 - ROL)}{1 + k_{ROL_{O_2}} \cdot (1 - ROL)} \cdot k_{O_2,O_{2,sp}}^{300^\circ\,C.} \cdot e^{-\frac{E_{O_2,O_{2,sp}}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)}.$$

[0019] Also in this case the load state of the oxygen accumulator is used beside the temperature and the storage capacity. The additional use of the second reaction equation and the third reaction equation already significantly qualitatively improves the results for the post catalytic converter oxygen molecular mass.

[0020] A further embodiment of the invention provides that as first reaction equation

$$M_2 + \tfrac{1}{2}O_2 \rightarrow M_2O$$

is used, wherein a reaction speed of the first reaction equation is

$$k_{M_{2},O_2}(T) = y_{M_2} \cdot y_{O_2} \cdot k_{M_2,O_2}^{300^\circ\, C.} \cdot e^{-\frac{E_{M_2,O_2}}{R}\left(\frac{1}{T}-\frac{1}{573.15K}\right)}.$$

[0021] The term M hereby stands for the first substance, i.e., the species to be oxidized. It correspondingly becomes clear that this substance is present in molecular form in the first reaction equation, i.e., in the form M_2.

[0022] In the equation for the reaction speed y stands for the partial pressure or the molecular mass of the respective substance, k for the reaction speed prevailing under standard ambient conditions, in particular at a temperature of 300° C. for the respective reaction equation, R for the universal gas constant, which has for example the value R=8.314 Joule/(mol K), and T for the absolute temperature of the exhaust gas in the unit Kelvin.

[0023] The absolute temperature is hereby for example determined approximately for the catalytic converter by using the temperature prevailing immediately upstream of the catalytic converter, the temperature prevailing immediately downstream of the catalytic converter or an average value of these two temperatures. Overall it becomes clear that the reaction speed for the first reaction equation beside the molecular masses substantially depends on the temperature of the exhaust gas. Further parameters are not taken into account.

[0024] In a further embodiment of the invention it is provided that additionally a fourth reaction equation is taken into account, which describes the influence of the stored oxygen on a reaction of water contained in the exhaust gas with a second substance, wherein the load state of the oxygen accumulator is factored into a reaction speed of the fourth reaction equation. The use of the fourth reaction equation is thus required to determined a pre catalytic converter molecular mass of the second substance. The second substance is for example carbon monoxide. Insofar the fourth reaction equation describes a water-gas-shift-reaction, which can generally be described with the reaction equation

$$CO+H_2O \rightarrow CO_2+H_2.$$

[0025] In addition this water-gas-shift-reaction is to additionally take the oxygen stored in the oxygen accumulator into account.

[0026] A further embodiment of the invention provides that as fourth reaction equation

$$H_2O \rightarrow H_2+O_{2,sp}$$

is used, wherein the reaction speed for the fourth reaction equation is

$$k_{H_2O,O_{2,sp}}(T, OSC, ROL) =$$

$$y_{H_2O} \cdot OSC \cdot \frac{1}{1+k_{ROL_{H_2O}} \cdot (1-ROL)} \cdot k_{H_2O,O_{2,sp}}^{300^\circ\, C.} \cdot e^{-\frac{E_{H_2O,O_{2,sp}}}{R}\left(\frac{1}{T}-\frac{1}{573.15K}\right)}.$$

[0027] With the mentioned reaction equation the usually significant portion of water in the exhaust gas can be better taken into account. It becomes clear that the reaction speed for the fourth reaction equation is also based on the storage capacity and the load of the oxygen accumulator in addition to the temperature as described above.

[0028] A preferred embodiment of the invention provides that additionally a fifth reaction equation is taken into account which describes the efflux of stored oxygen into the exhaust gas, wherein the load state of the oxygen accumulator factors into a reaction speed of the fifth reaction equation. The fifth reaction equation is addresses the circumstance that the oxygen accumulator tends to give off the more oxygen into the exhaust gas the fuller the oxygen accumulator is without a reaction with another element necessarily taking place.

[0029] In a further embodiment of the invention it is provided that as fifth reaction equation

$$O_{2,sp} \rightarrow O_2$$

is used, wherein the reaction speed for the fifth reaction equation is

$$k_{O_{2,sp},O_2}(T, OSC, ROL) =$$

$$OSC \cdot \frac{1}{1+k_{ROL_{O_2}} \cdot (1-ROL)} \cdot k_{O_{2,sp},O_2}^{300^\circ\, C.} \cdot e^{-\frac{E_{O_{2,sp},O_2}}{R}\left(\frac{1}{T}-\frac{1}{573.15K}\right)}.$$

[0030] The meaning of the fifth reaction equation and the corresponding reaction speed was explained above. Also the here described reaction speed is directly dependent on the storage capacity and the load state beside the temperature.

[0031] Finally it can be provided that the load state is determined by at least one reaction equation by integration, wherein the at least one reaction equation is selected from the second reaction equation, the third reaction equation, the fourth reaction equation and the fifth reaction equation. When performing the method of course the load state of the oxygen accumulator has to be accurately recognized. The storage capacity on the other hand remains usually constant, even though of course also for this a model or measuring values can be used.

[0032] The load state is hereby determined in a simple manner from the at least one reaction equation and its reaction speed, which is for example accomplished by integration at the beginning of the method starting from a start value. Preferably at least one reaction equation is used which takes the oxygen stored in the oxygen accumulator into account, i.e., for example the second reaction equation, the third reaction equation, the fourth reaction equation or the fifth reaction equation. Particularly preferably multiple of these reaction equations, in particular all of these reaction equations, are used in order to determine the load state as accurately as possible.

[0033] The invention also relates to a drive device, in particular for implementing the method described above, wherein the drive device has the features of claim **8**.

[0034] The advantages of such a drive device or such a method were described above. The drive device and also the method can be modified according to the description above so that reference is made thereto.

[0035] In the following the invention is described in more detail with reference to the exemplary embodiments shown in the drawing, without limiting the invention. Hereby it is shown in:

[0036] FIG. **1** diagrams in which a pre catalytic converter lambda value, a determined and an actual post catalytic converter lambda value, a pre catalytic converter molecular mass of a first substance, a pre catalytic converter oxygen molecular mass, a post catalytic converter molecular mass of the first substance and a post catalytic converter oxygen molecular mass and a load state of an oxygen accumulator of a catalytic converter are plotted over time, wherein only a first reaction equation is taken into account,

[0037] FIG. **2** a diagram in which reaction speeds of a second and a third reaction equation are shown,

[0038] FIG. **3** diagrams which show values analogous to FIG. **1**, wherein in addition the second reaction equation and the third reaction equation are taken into account,

[0039] FIG. **4** a diagram in which reaction speeds for the second, the third and a fourth reaction equation are shown,

[0040] FIG. **5** diagrams which show values analogous to FIG. **1**, wherein in addition a fourth reaction equation is taken into account,

[0041] FIG. **6** a diagram in which reaction speeds for the second reaction equation, the third reaction equation, the fourth reaction equation and a fifth reaction equation are shown plotted over the load state of the oxygen accumulator, and

[0042] FIG. **7** diagrams, which show values in analogy to FIG. **1**, wherein in addition the fifth reaction equation is taken into account.

[0043] FIG. **1** shows multiple diagrams in which a course **1** describes a pre catalytic converter lambda value and course **2** describes a post catalytic converter lambda value over time t. A second diagram shows courses **3**, **4**, **5** and **6** over the time t. The course **3** describes a pre catalytic converter oxygen molecular mass, the course **4** a pre catalytic converter molecular mass of a first substance, the course **5** a post catalytic converter oxygen molecular mass and the course **6** a post catalytic converter molecular mass of the first substance. Finally the third diagram shows a course **7**, which represents a filing level of an oxygen accumulator of a catalytic converter over the time t. the course **2** is herby determined by way of the first reaction equation and the corresponding reaction speed described above.

[0044] FIG. **2** shows a diagram in which a course **8** shows a reaction speed of a second reaction equation on dependence on the load state of the oxygen accumulator. The course **9** on the other hand shows the reaction speed of a fourth reaction equation also over the load state.

[0045] FIG. **3** shows diagrams analogous to those of FIG. **1**, wherein the here shown values however were determined by way of the first reaction equation, the second reaction equation and the third reaction equation, respectively with the corresponding reaction speeds. The additional course **2'** represents the actually present post catalytic converter lambda value. It can be seen that the modeled post catalytic converter lambda value, which is described by the course **2**, is already significantly closer to the actual course **2'** than was the case in FIG. **1**.

[0046] The diagram of FIG. **4** shows beside the courses **8** and **9**, as they are already known from FIG. **2**, a course **10**. This course described the reaction speed of a fourth reaction equation over the load state of the oxygen accumulator. The fourth reaction equation essentially represents a water-gas-shift-equation.

[0047] The diagrams shown in FIG. **5** correspond to those shown in FIGS. **1** and **3**, wherein the values shown therein, however, were determined by way of the reaction equations 1 to 4. A further improvement of the results compared to those of FIG. **3** can be seen.

[0048] FIG. **6** shows a diagram, which again shows the courses **8**, **9** and **10**. In addition a course **11** is shown which represents the reaction speeds of a fifth reaction equation. The fifth reaction equation describes the transition of oxygen form the oxygen accumulator into the exhaust gas.

[0049] The results when taking the reaction equations 1 to 5 into account are shown in FIG. **7**. It can be seen that the course **2** corresponds to the course **2'**. This means that by taking the reaction equations 1 to 5 into account for modeling the post catalytic converter oxygen molecular mass and thus in the calculation of the post catalytic converter lambda value, results are achieved that reflect the theoretical results with good accuracy.

List of Reference Signs

[0050] **1** course
[0051] **2** course
[0052] **3** course
[0053] **4** course
[0054] **5** course
[0055] **6** course
[0056] **7** course
[0057] **8** course
[0058] **9** course
[0059] **10** course
[0060] **11** course

1.-**8**. (canceled)

9. A method for operating a drive device, which has a catalytic converter with an oxygen accumulator for purifying exhaust gas, said method comprising:

determining upstream of the catalytic converter a pre catalytic converter molecular mass of a first substance and a pre catalytic converter molecular mass of oxygen; and

determining, for calculating a post catalytic converter lambda value, a post catalytic converter oxygen molecular mass by applying a first reaction equation which describes a reaction of the oxygen with the first substance, a second reaction equation, which describes a reaction of the first substance with oxygen stored in the oxygen accumulator, and a third reaction equation which describes an introduction of oxygen from the exhaust gas into the oxygen accumulator, wherein a reaction speed of the second reaction equation and a speed of the third reaction equation is a function of a load state of the oxygen accumulator, wherein the second reaction equation is defined as

$$M_2+½O_{2,sp}\rightarrow M_2O$$

with the reaction speed for the second reaction equation being defined as

$$k_{M_2,O_{2,sp}}(T, OSC, ROL) = y_{M_2}\cdot OSC\cdot\frac{k_{ROL_{M_2}}\cdot ROL}{1+k_{ROL_{M_2}}\cdot ROL}\cdot k_{M_2,O_{2,sp}}^{300^\circ\ C.}\cdot e^{\frac{E_{M_2,O_{2,sp}}}{R}\left(\frac{1}{T}-\frac{1}{573.15K}\right)},$$

wherein M stands for the first substance, y for the partial pressure, k for the reaction speed prevailing at standard ambient conditions, E for the activation energy of the reaction equation, R for the universal gas constant, T for the absolute temperature of the exhaust gas, $O_{2,sp}$ for the molecular oxygen present in the oxygen accumulator, OSC for the storage capacity of the catalytic converter, ROL of the relative load state of the oxygen accumulator and k_{ROL} for an influence of an availability of the oxygen stored in the oxygen storage on the reaction.

10. The method of claim **9**, wherein the third reaction equation is defined as

$O_2 \rightarrow O_{2,sp}$

with a reaction speed for the third reaction equation being defined as

$$k_{O_{2},O_{2,sp}}(T, OSC, ROL) = y_{O_2} \cdot OSC \cdot \frac{k_{ROL_{O_2}} \cdot (1 - ROL)}{1 + k_{ROL_{O_2}} \cdot (1 - ROL)} \cdot k_{O_2,O_{2,sp}}^{300^\circ C.} \cdot e^{-\frac{E_{O_2,O_{2,sp}}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)},$$

wherein M stands for the first substance, y for the partial pressure, k for the reaction speed prevailing under standard ambient conditions, E for the activation energy of the reaction equation, R for the universal gas constant, T for the absolute temperature of the exhaust gas, $O_{2,sp}$ for the molecular oxygen present in the oxygen accumulator, OSC for the storage capacity of the catalytic converter, ROL for the relative load state of the oxygen accumulator and k_{ROL} for the influence of the availability of the oxygen stored in the oxygen accumulator on the reaction.

11. The method of claim **1**, wherein the first reaction equation is defined as

$M_2 + \frac{1}{2}O_2 \rightarrow M_2O$

with a reaction speed of the first reaction equation being defined as

$$k_{M_{2},O_2}(T) = y_{M_2} \cdot y_{O_2} \cdot k_{M_2,O_2}^{300^\circ C.} \cdot e^{-\frac{E_{M_2,O_2}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)}.$$

12. The method of claim **1**, wherein the step of determining the post catalytic converter oxygen molecular mass further comprises applying a fourth reaction equation, which describes an influence of the stored oxygen on a reaction of water contained in the exhaust gas with a second substance, wherein a reaction speed of the fourth reaction equation is a function of the load state of the oxygen accumulator.

13. The Method of claim **12**, wherein the fourth reaction equation is defined as

$H_2O \rightarrow H_2 + O_{2,sp}$

with the reaction speed for the fourth reaction equation being defined as

$$k_{H_2O,O_{2,sp}}(T, OSC, ROL) = y_{H_2O} \cdot OSC \cdot \frac{1}{1 + k_{ROL_{H_2O}} \cdot (1 - ROL)} \cdot k_{H_2O,O_{2,sp}}^{300^\circ C.} \cdot e^{-\frac{E_{H_2O,O_{2,sp}}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)}.$$

14. The method of claim **1**, wherein the step of determining the post catalytic converter oxygen molecular mass further comprises applying a fifth reaction equation, which describes an efflux of stored oxygen into the exhaust gas, wherein a reaction speed of the fifth reaction equation is a function of the load state of the oxygen accumulator.

15. The method of claim **14**, wherein the fifth reaction equation is defined as

$O_{2,sp} \rightarrow O_2$

with the reaction speed for the fifth reaction equation being defined as

$$k_{O_{2,sp},O_2}(T, OSC, ROL) = OSC \cdot \frac{1}{1 + k_{ROL_{O_2}} \cdot (1 - ROL)} \cdot k_{O_{2,sp},O_2}^{300^\circ C.} \cdot e^{-\frac{E_{O_{2,sp},O_2}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)}.$$

16. The method of claim **1**, wherein the load state is determined by integrating using least one of the second reaction equation, the third reaction equation, the fourth reaction equation and the fifth reaction equation.

17. A drive device, comprising:

at least one catalytic converter comprising an oxygen accumulator for purifying exhaust gas, said drive being configured

to determine upstream of the catalytic converter a pre catalytic converter molecular mass of a first substance and a pre catalytic converter oxygen molecular mass of oxygen, and

to determine, for calculating a post catalytic converter lambda value, a post catalytic converter oxygen molecular mass by applying a first reaction equation which describes a reaction of the oxygen with the first substance, a second reaction equation, which describes a reaction of the first substance with oxygen stored in the oxygen accumulator, and a third reaction equation which describes an introduction of oxygen from the exhaust gas into the oxygen accumulator, wherein a reaction speed of the second reaction equation and a speed of the third reaction equation is a function of a load state of the oxygen accumulator, wherein the second reaction equation is defined as

$M_2 + \frac{1}{2}O_{2,sp} \rightarrow M_2O$

with the reaction speed for the second reaction equation being defined as

$$k_{M_{2},O_{2,sp}}(T, OSC, ROL) = y_{M_2} \cdot OSC \cdot \frac{k_{ROL_{M_2}} \cdot ROL}{1 + k_{ROL_{M_2}} \cdot ROL} \cdot k_{M_2,O_{2,sp}}^{300^\circ C.} \cdot e^{-\frac{E_{M_2,O_{2,sp}}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)},$$

wherein M stands for the first substance, y for the partial pressure, k for the reaction speed prevailing at standard ambient conditions, E for the activation energy of the reaction equation, R for the universal gas constant, T for the absolute temperature of the exhaust gas, $O_{2,sp}$ for the molecular oxygen present in the oxygen accumulator, OSC for the storage capacity of the catalytic converter, ROL of the relative load state of the oxygen accumulator and k_{ROL} of the influence of the availability of the oxygen stored in the oxygen storage on the reaction.

18. The drive device of claim **17**, wherein the third reaction equation is defined as

$$O_2 \rightarrow O_{2,sp}$$

with the reaction speed for the third reaction equation being defined as

$$k_{O_2,O_{2,sp}}(T, OSC, ROL) = y_{O_2} \cdot OSC \cdot \frac{k_{ROL_{O_2}} \cdot (1 - ROL)}{1 + k_{ROL_{O_2}} \cdot (1 - ROL)} \cdot k_{O_2,O_{2,sp}}^{300^\circ C.} \cdot e^{-\frac{E_{O_2,O_{2,sp}}}{R}\left(\frac{1}{T} - \frac{1}{573.15K}\right)},$$

wherein M stands for the first substance, y for the partial pressure, k for the reaction speed prevailing under standard ambient conditions, E for the activation energy of the reaction equation, R for the universal gas constant, T for the absolute temperature of the exhaust gas, $O_{2,sp}$ for the molecular oxygen present in the oxygen accumulator, OSC for the storage capacity of the catalytic converter, ROL for the relative load state of the oxygen accumulator and k_{ROL} for the influence of the availability of the oxygen stored in the oxygen accumulator on the reaction.

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