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(54) **PROTECTING AN OXIDATION CATALYST
UPSTREAM OF A PARTICULATE FILTER
FOR A DIESEL ENGINE BY LIMITATION OF
INJECTED FUEL**

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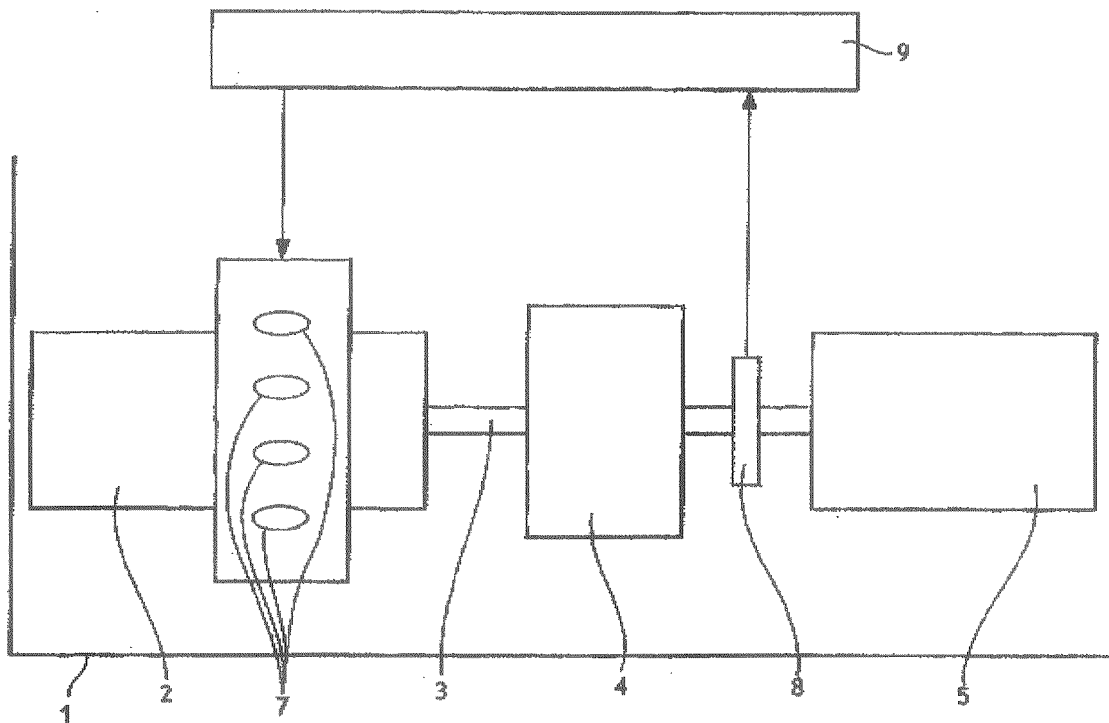
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(57) **ABSTRACT**

A method for controlling an engine including an oxidation catalytic converter. The method, if certain criteria are verified, calculates a maximum amount of fuel to be post-injected based on a measured air flow rate and a threshold operating temperature of the oxidation catalytic converter.

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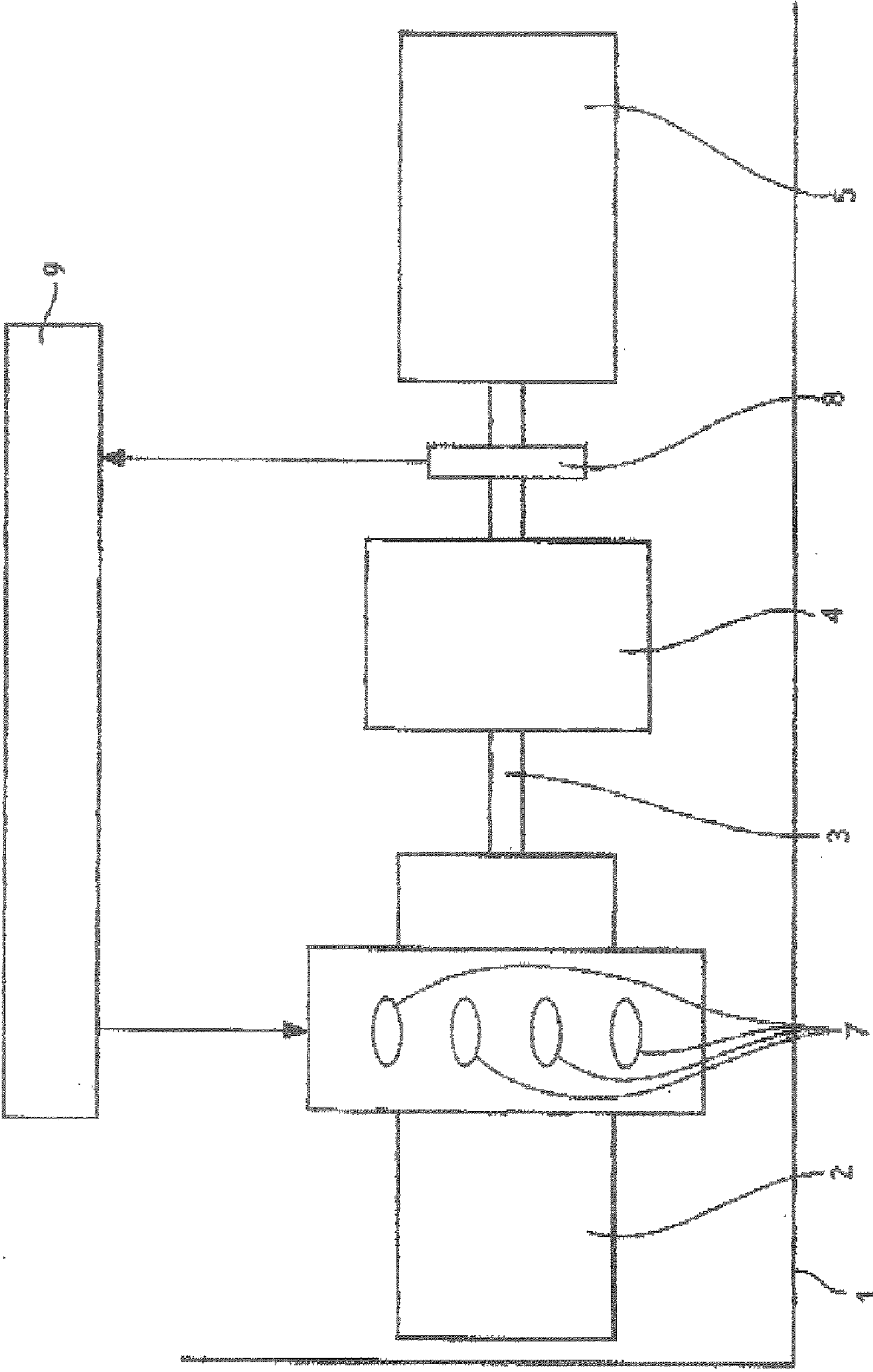


FIG. 1

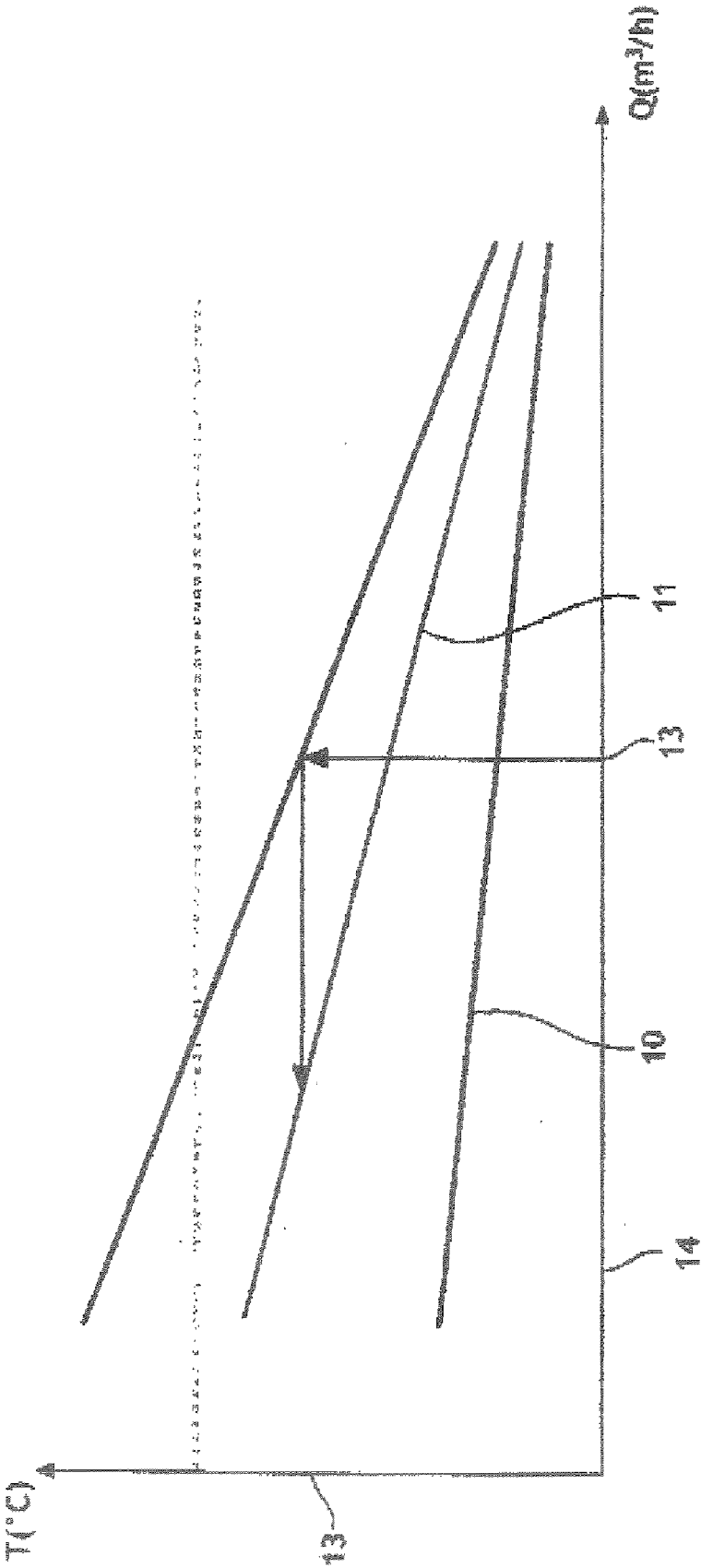


FIG.2

**PROTECTING AN OXIDATION CATALYST
UPSTREAM OF A PARTICULATE FILTER
FOR A DIESEL ENGINE BY LIMITATION OF
INJECTED FUEL**

[0001] The present invention relates to a method for controlling an engine, and to an associated system for implementing same.

[0002] More particularly, the present invention relates to a method for controlling a vehicle engine, preferably of the diesel type, and to a associated system for implementing same.

[0003] As known per se, diesel engine vehicle exhaust systems are commonly equipped with an oxidation catalytic converter (CO) and a particulate filter (FAP) for limiting the pollutant emissions into the environment.

[0004] The CO stops the release of unburnt hydrocarbons and carbon monoxide into the environment. The FAP stops the release of polluting articles of soot into the environment.

[0005] To prevent the clogging of the FAP by the accumulation of polluting soot particles, it is necessary periodically to regenerate the FAP.

[0006] An FAP regeneration method consists in burning the polluting particles present in the FAP. For this purpose, one or more delayed diesel injections are made in the engine combustion chambers during the expansion phase. This post-injected diesel (that is, injected after the top dead center) does not burn in the combustion chambers, but is expelled into the exhaust line and converted to harmless gas by the CO.

[0007] During this conversion, the CO liberates heat. This heat is used to raise the temperature of the gases in the exhaust line, thereby increasing the internal temperature of the FAP to a target temperature at which the particulates present in the FAP burn.

[0008] The temperature in the exhaust line depends on two main variables: the air flow rate in the exhaust line and the quantity of post-injected diesel. For a constant quantity of post-injected diesel, the lower the air flow rate, the higher the internal temperature of the exhaust line. For a constant air flow rate, the higher the quantity of post-injected diesel, the higher the internal temperature of the exhaust line.

[0009] In diesel engine vehicle exhaust systems, the engine settings for reaching the target temperature at the FAP inlet are made for a liberation of heat at the thermomechanical limit (or "limit temperature before destruction") of the CO. Moreover, these engine settings are made under steady state conditions. This means that for a constant air flow rate, the quantity of diesel to be post-injected to reach the target temperature in the exhaust line is determined.

[0010] However, during unsteady state conditions, the air flow rate in the exhaust line is not constant and may be lower than the air flow rate under steady state conditions.

[0011] In this case, if the quantity of post-injected diesel is constant and the air flow rate is lower than the steady state air flow rate, the internal temperature of the CO will increase and exceed the thermomechanical limit of the CO, thereby causing damage thereto.

[0012] It is one object of the present invention to protect the CO against the damage associated with exceeding its limit operating temperature.

[0013] For this purpose, the invention provides for a method or controlling an engine comprising an oxidation catalytic converter, the method comprising the step consist-

ing, if at least one pre-defined criterion is satisfied, in calculating a maximum quantity of fuel to be post-injected based on a measured air flow rate and a limit operating temperature of the oxidation catalytic converter.

[0014] This engine control method is used to calculate the maximum allowable quantity of diesel to be injected to prevent the delayed injection of excessive quantities of fuel, causing damage to the CO by exceeding the limit operating temperature thereof.

[0015] Within the context of the present invention, "post-injection" (also known as "delayed injection"), means one or more injections of fuel into the compression chambers after the top dead center, that is, in the engine expansion phase.

[0016] Within the context of the present invention, "limit operating temperature" means the maximum temperature that the CO can withstand without damage. The use of the CO at a temperature above the limit operating temperature causes damage thereto.

[0017] The following are preferred but nonlimiting aspects of the inventive method:

[0018] the method further comprises the step consisting in measuring the air flow rate in an exhaust line,

[0019] the or one of the criteria is that the measured air flow rate is lower than an air flow rate setpoint,

[0020] the method further comprises the steps consisting in:

[0021] measuring an exhaust gas temperature in the exhaust line,

[0022] ordering an increase in the quantity of fuel post-injected into the exhaust line if the measured exhaust temperature is lower than a temperature setpoint,

[0023] ordering a decrease in the quantity of fuel post-injected into the exhaust line if the measured exhaust gas temperature is higher than the temperature setpoint.

[0024] The invention also relates to an engine comprising an oxidation catalytic converter, characterized in that it comprises a computer for calculating a maximum quantity of fuel to be post-injected based on a measured air flow rate and a limit operating temperature of the oxidation catalytic converter.

[0025] The following are preferred but nonlimiting aspects of the inventive system:

[0026] the system further comprises a flowmeter for measuring the air flow rate in the exhaust line,

[0027] the system further comprises a temperature probe for measuring the exhaust gas temperature in the exhaust line, and the computer is further capable of ordering an increase, respectively a decrease, in the quantity of fuel post-injected into the exhaust line if the measured exhaust temperature is lower, respectively higher, than a temperature setpoint.

[0028] The invention also relates to a motor vehicle, the motor vehicle comprising an engine as previously described.

[0029] Other features and advantages of the invention will further appear from, the description that follows, which is purely illustrative and nonlimiting and must be read in conjunction with the drawings appended hereto, in which:

[0030] FIG. 1 is a diagram representing a system for implementing the inventive method,

[0031] FIG. 2 is a graph showing the internal temperature of the oxidation catalytic converter as a function of an air flow rate and a quantity of post-injected diesel.

[0032] This figure show a motor vehicle 1 comprising a diesel type of engine 2, that is, running on diesel fuel, and an exhaust line 3 equipped with an oxidation catalytic converter 4, a flowmeter 8, a computer 6 and a particulate filter 5.

[0033] The computer 6 is suitable for supervising the operation of the engine 2, the oxidation catalytic converter 4 and the particulate filter 5. The computer comprises, for example, one or more processors, one or more microcontrollers, one or more microcomputers, one or more programmable robots, one or more specific integrated circuits for application, or other programmable circuits known to a person skilled in the art.

[0034] The engine 2 comprises combustion chambers 7 into which the diesel is injected. The diesel injection in the combustion chamber 7 is controlled by the computer 6.

[0035] The oxidation catalytic converter (CO) 4 is located upstream of the particulate filter (FAP) 5 on the exhaust line 3, that is, the CO 4 is closer to the engine 3 than the FAP 5. However, the CO 4 may also be directly installed in the FAP 5. The CO 4 comprises a catalytic agent such as a mixture of palladium and platinum.

[0036] The flowmeter 8 is used to measure the mass air flow rate in the exhaust line 3. The flowmeter 8 may be any type of air flowmeter such as a flow measuring instrument with a Pitot tube or a model.

[0037] The FAP 5 retains the particulates which accumulate therein as the engine 2 is used. This accumulation of particulate ultimately clogs the FAP 5, creating a high back-pressure at the exhaust of the engine 2 (that is, the gases have difficulty escaping from the engine), thereby considerably decreasing its performance. In order to recover the performance of the engine 2, a method is used to regenerate the FAP 5.

[0038] As previously recalled, the FAP 5 regeneration method consists in raising the temperature of the exhaust gases to a target temperature to cause the combustion of the soot inside the FAP 5. For this purpose, a computer 6 controls delayed injections, or post-injections, in the combustion chambers 7. The post-injected diesel is expelled into she exhaust line 3, then oxidized in the CO 4 which liberates heat during the conversion of the post-injected diesel to harmless gas. This heat liberated by the CO 4 causes an increase in the gas temperature in the exhaust line 3, and therefore also an increase in the internal temperature of the FAP.

[0039] The quantity of heat liberated by the CO depends on the quantity of post-injected diesel on the one hand, and the air flow rate in the exhaust line 3 on the other. In fact, it has been found that:

[0040] for a constant quantity of post-injected diesel, the lower the air flow rate, the higher the internal temperature of the CO;

[0041] for a constant air flow rate, the higher the quantity of post-injected diesel, the higher the internal temperature of the CO.

[0042] For information, this finding is illustrated in FIG. 2, which is a graph showing the internal temperature of the CO (on the y-axis 13) as a function of the air flow rate (on the x-axis 14). This graph comprises three segments 10, 11, 12 obtained for three different quantities of post-injected diesel.

[0043] The first segment 10 is obtained for a quantity of post-injected diesel of 5 mg/cp, the second segment 11 is obtained for a quantity of post-injected diesel of 10 mg/cp, and the third segment 12 is obtained for a quantity of pest-injected diesel of 20 mg/cp.

[0044] These three segments 10, 17, 12 are decreasing, which confirms that the higher the air flow rate, the lower the internal temperature of the CO. Furthermore all the points of the third segment 12 are located above all the points of the second segment which is itself located above the first segment. This confirms that the higher the quantity of post-injected diesel, the higher the internal temperature of the CO.

[0045] We therefore have: $T_{internal-catalyst} = f(Q_{air_mass}; Q_{post_delayed})$

[0046] Where:

[0047] $T_{internal-catalyst}$ is the internal temperature of the catalyst,

[0048] Q_{air_mass} is the mass air flow rate in the exhaust line,

[0049] $Q_{post_delayed}$ is the volumetric quantity of post-injected diesel.

[0050] In fact, the quantity of diesel to be post-injected is set for an air flow rate under steady state conditions, that is, for a constant air flow rate. A problem therefore arises when the air flow rate of the engine is not equal to the air flow rate under steady state conditions, particularly during transients. Under these conditions, the real air flow rate may be lower than the value considered under steady state conditions, which guaranteed the integrity of the CO for the set post-injection quantity. The internal temperature of the catalyst is then higher than the temperature observed under steady state conditions, causing damage to the CO.

[0051] To avoid the risks of damage to the CO 4, it is necessary to implement an engine control method to limit the quantities of post-injected diesel like that of the present invention, in order to guarantee that the temperature of the gases in the exhaust line does not exceed the limit temperature before destruction of the CO 4.

[0052] The engine control method for limiting the quantities of post-injected diesel comprises the following steps.

[0053] One step of the method consists in measuring the real air flow rate in the exhaust line using the flowmeter 8. The measured value of the real air flow rate is sent to the computer 6 which compares it to a steady state air flow rate used for the engine settings suitable for reaching the target temperature.

[0054] Another step consists in determining, according to a set of criteria, whether a step for calculating a maximum allowable quantity of post-injected diesel can be activated. If the measured real air flow rate is lower than the steady state air flow rate, the step for calculating the maximum allowable quantity of post-injected diesel is carried out.

[0055] Another step consists in calculating the maximum allowable quantity of post-injected diesel. To carry out this step, the computer 6 uses an equation of the type

$$Q_{post_delayed_MAX} = f(Q_{air_mass}; T_{internal-catalyst_MAX})$$

Where $Q_{post_delayed_MAX}$ is the maximum allowable volumetric quantity of post-injected diesel.

[0056] Q_{air_mass} is the mass air flow rate measured in the exhaust line,

[0057] $T_{internal-catalyst_MAX}$ is the limit operating temperature of the CO.

[0058] The mass air flow rate in the exhaust line is known because measured by the flowmeter 8, the limit operating temperature of the CO is known because given by the manufacture so that the form of equation given above can be used to determine the maximum allowable quantity of post-injected diesel.

[0059] In another step, the computer orders the delayed injection into the combustion chambers of a quantity of diesel lower than or equal to the maximum allowable quantity of post-injected diesel calculated.

[0060] The engine control method for limiting the quantities of post-injected diesel can be used in association with a method for controlling the temperature in the exhaust line.

[0061] The method for controlling the temperature of the exhaust line comprises the following steps.

[0062] In one step, the temperature in the exhaust line is measured using a temperature sensor placed upstream of the FAP.

[0063] In another step, if the temperature measured by the temperature sensor is lower than the target temperature, the computer orders an increase in the quantity of post-injected fuel to raise the gas temperature in the exhaust line to the target temperature. In contrast, if the temperature measured by the temperature sensor is higher the target temperature, the computer orders a decrease in the quantity of post-injected fuel to lower the temperature of the gases to the target temperature.

[0064] The control method uses saturation terminals to limit the quantity of post-injected diesel. By using the method for limiting the quantity of post-injected diesel in the computer, this serves to adapt the saturation terminals used in the temperature control method and thereby avoid the risk of catalyst damage.

[0065] The engine employed to describe the engine control method was a diesel type of vehicle engine, that is to say running on diesel fuel. However, the engine control method can be implemented in other engine categories—high-pressure cleaning engine, concrete mixer engine, etc. The engine control method can also be implemented in engines running on other motor fuels, such as gasoline engines.

[0066] The reader will have understood that numerous modifications can be made without materially going beyond the novel teachings and advantages described herein. In consequence, for example all the modifications of this type are intended to be incorporated within the scope of the vehicle body as defined in the appended claims.

REFERENCES

- [0067] 1 motor vehicle
- [0068] 2 engine
- [0069] 3 exhaust line
- [0070] 4 oxidation catalytic converter
- [0071] 5 particulate filter

- [0072] 6 computer
- [0073] 7 combustion chambers
- [0074] 8 flowmeter
- [0075] 10 first segment
- [0076] 11 second segment
- [0077] 12 third segment
- [0078] 13 y-axis
- [0079] 14 x-axis

1-8. (canceled)

9. A method for controlling an engine including an oxidation catalytic converter, comprising:

if at least one pre-defined criterion is satisfied, calculating a maximum quantity of fuel to be post-injected based on a measured air flow rate and a limit operating temperature of the oxidation catalytic converter.

10. The method as claimed in claim 9, further comprising measuring the air flow rate in an exhaust line.

11. The method as claimed in claim 9, wherein the criterion is that the measured air flow rate is lower than an air flow rate setpoint.

12. The method as claimed in claim 9, further comprising: measuring an exhaust gas temperature in an exhaust line; ordering an increase in a quantity of fuel post-injected into the exhaust line if the measured exhaust temperature is lower than a temperature setpoint; and ordering a decrease in the quantity of fuel post-injected into the exhaust line if the measured exhaust gas temperature is higher than the temperature setpoint.

13. An engine comprising: an oxidation catalytic converter; and a computer that calculates a maximum quantity of fuel to be post-injected based on a measured air flow rate and a limit operating temperature of the oxidation catalytic converter.

14. The engine as claimed in claim 13, further comprising a flowmeter that measures air flow rate in the exhaust line.

15. The engine as claimed in claim 13, further comprising a temperature probe that measures exhaust gas temperature in the exhaust line, and wherein the computer is further configured to order an increase or decrease, respectively, in a quantity of fuel post-injected into the exhaust line if the measured exhaust temperature is lower or higher, respectively, than a temperature setpoint.

16. A motor vehicle, comprising an engine as claimed in claim 13.

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