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- (71) **Applicant (for all designated States except US):** **GM GLOBAL TECHNOLOGY OPERATIONS, INC.** [US/US]; 300 Renaissance Center, P.O. Box 300, Detroit, MI 48265-3000 (US).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** **VERNASSA, Roberto** [IT/IT]; Via G. Leopardi 8, I-10088 Volpiano (TO) (IT). **CIANFLONE, Francesco** [IT/IT]; Via Gozzi 5, I-10121 Torino (IT).
- (74) **Agent:** **SPITZFADEN, Ralf**; Adam Opel GmbH, Patentrecht A0-02, 65423 Rüsselsheim (DE).

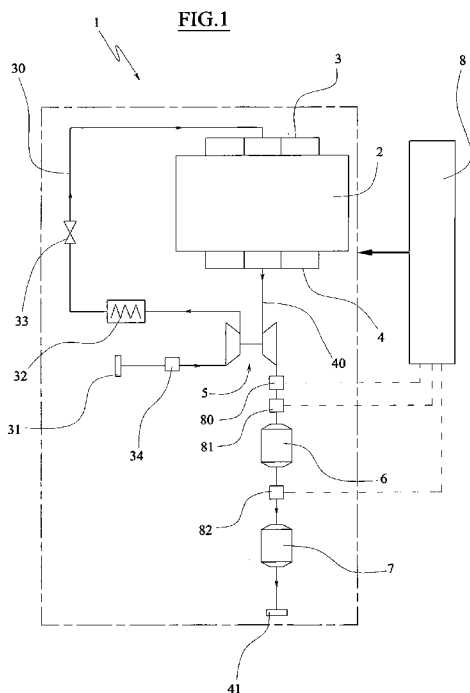
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[Continued on next page]

(54) **Title:** METHOD FOR CALCULATING AN EFFICIENCY INDEX OF A DIESEL OXIDATION CATALYST



(57) **Abstract:** A method and a control system for diagnosing a diesel combustion catalyst (6) which is located in an exhaust line (40) within a diesel engine system (1); the method comprising: providing an unburned fuel mass flow through the diesel oxidation catalyst (6), determining the oxidation heat release rate which is related to the exothermic oxidation reactions of the unburned fuel into the diesel oxidation catalyst (6), integrating the determined oxidation heat release rate on a time interval, integrating the unburned fuel mass flow on the same time interval, dividing the integrated value of oxidation heat release rate and the integrated value of unburned fuel mass flow for determining an efficiency index (DOI) of the diesel oxidation catalyst (6).

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**METHOD FOR CALCULATING AN EFFICIENCY INDEX OF A
DIESEL OXIDATION CATALYST**

5

TECHNICAL FIELD

The present invention relates to diagnosing a diesel oxidation catalyst within a diesel engine system.

10

BACKGROUND OF THE INVENTION

A diesel engine system generally comprises one or more combustion chambers which are individually defined by a reciprocating piston inside a cylinder.

The cylinder is provided with electrically controllable injection means for injecting fuel inside the combustion chamber. The cylinder is also provided with one or more intake valves for cyclically opening the combustion chamber towards an intake line for receiving fresh airflow, and with one or more exhaust valves for cyclically opening the combustion chamber towards an exhaust line for discharging the exhaust gases.

The exhaust line comprises a diesel oxidation catalyst (DOC) which is conventionally provided for reducing the toxicity of emissions from diesel engine.

In order to accomplish tighter emission legislation, most of the diesel engine systems are also equipped with a diesel particulate

25

filter (DPF), which is located in the exhaust line downstream the DOC for capturing and removing diesel particulate matter (soot) from the exhaust gas flow.

The diesel oxidation catalyst (DOC) is especially provided for oxidizing hydrocarbons (HC) and carbon monoxides (CO), which are formed in the combustion process of the engine and are contained in the exhaust gas flow.

More particularly, the diesel oxidation catalyst uses excess oxygen (O_2) in the exhaust gas flow for oxidizing carbon monoxide to carbon dioxide (CO_2), and for oxidizing hydrocarbons to water (H_2O) and carbon dioxide (CO_2).

Such oxidations are exothermic reactions, which increase the catalyst temperature as well as the temperature of the exhaust gas flow downstream the catalyst.

The total heat rate within an active diesel particulate catalyst is determined by two main factors.

The first main factor is represented by the heat exchange rate which is related to the conventional processes between exhaust gases, diesel oxidation catalyst and environment.

The second main factor is represented by the oxidation heat release rate which is related to the exothermic oxidation reactions into the diesel oxidation catalyst.

This second main factor is a key parameter in establishing the diesel oxidation catalyst efficiency.

During its operative life, diesel oxidation catalysts gradually

reduce their efficiency.

Modern diesel engine systems are provided with a diagnostic system suitable for determining an efficiency index of the diesel oxidation catalyst.

5 Such diagnostic system generally comprise two sensors for measuring the exhaust gas temperature upstream and downstream the diesel oxidation catalyst.

A microprocessor based controller applies said temperature measures to a computer code for calculating the actual oxidation heat release
10 rate, which is related to the exothermic oxidation reactions in the diesel oxidation catalyst.

The controller further comprises a computer code for implementing a physical model of the diesel oxidation catalyst, by means of which the oxidation heat release rate is estimated as a function of the
15 exhaust gas temperature upstream the catalyst.

Such a model is calibrated on a fresh diesel oxidation catalyst, in order to estimate the nominal oxidation heat release rate which is theoretically produced by a new catalyst.

The efficiency index is then calculated dividing the actual
20 (measured) heat release rate by the estimated (nominal) heat release oxidation rate.

As a matter of fact, such efficiency index establishes the rate at which the exothermic reactions occur in the diesel oxidation catalyst as expected by a fresh catalyst.

25 Therefore, when the efficiency index is below a certain threshold,

the diagnostic system warns that the diesel oxidation catalyst is faulty and must be replaced.

A drawback of the above mentioned diagnostic device is that the effectiveness of the index is strongly dependent on the DOC physical
5 model error.

Another drawback is that such a physical model is generally very complex, so that it is difficult to calibrate and requires a powerful hardware to be implemented.

Aim of the present invention is to solve, or at least to
10 positively reduce, the above mentioned drawbacks with a simple, rational and inexpensive solution.

The aims are attained by the characteristics of the invention as reported in independent claims. The dependent claims delineate preferred and/or especially advantageous aspects of the invention.

15 **DISCLOSURE OF THE INVENTION**

The invention provides a method for diagnosing a diesel oxidation catalyst located in an exhaust line within a diesel engine system.

The method comprises:

- 20 - providing an unburned fuel mass flow through the diesel oxidation catalyst,
- determining the oxidation heat release rate which is related to the exothermic oxidation reactions of the unburned fuel in the diesel oxidation catalyst,
- 25 - integrating the determined oxidation heat release rate on a time

interval,

- integrating the unburned fuel mass flow over the same time interval,

- dividing the integrated value of oxidation heat release rate and the integrated value of unburned fuel mass flow, for determining an efficiency (or aging) index of the diesel oxidation catalyst.

As a matter of fact, the efficiency index according to the invention represents the actual fuel ratio that the diesel oxidation catalyst is able to oxidize.

The diagnostic method do not requires estimation of the nominal heat release oxidation rate.

Therefore, the diagnostic method avoids complicated physical model for calculating the nominal heat release of the diesel oxidation catalyst as well as long calibration time, and leads to cost and time saving.

According to the invention, the diagnostic method can be performed at any time during the engine system functioning, provided that a large amount of fuel is injected into the engine system for reaching the diesel oxidation catalyst unburnt.

In this case, the diagnostic method is referred as intrusive diagnosis.

Such an intrusive diagnosis has the advantage of being frequently feasible, but it has the disadvantage of increasing the fuel consumption.

Alternatively, the diagnostic method according to the invention can

be performed during the DPF regeneration process, when a large amount of fuel is already injected in the combustion chambers for reaching the diesel oxidation catalyst unburnt.

The regeneration process is for removing the particulate matter which is trapped in the diesel particulate filter (DPF) downstream the diesel oxidation catalyst.

The regeneration is achieved by heating the DPF to a temperature at which the accumulated particulate matter burns off, leaving the filter clean again.

10 It is known to heat the filter by means of a temperature increase of the exhaust gases entering the DPF.

This temperature increase is obtained with a dedicated combustion mode, by means of which an amount of fuel is injected into a combustion chamber of the engine when the piston has passed its top
15 dead center position.

Such late-injected fuel can get a first temperature increase due to fuel combustion inside combustion chamber, and a second temperature increase due to fuel oxidation inside the catalyst (DOC) of the exhaust line.

20 Conventionally, the second temperature increase is achieved by the so called Post-Injections which are late fuel injections that do not burn inside the combustion chamber.

The post-injected fuel is ejected unburnt from the combustion chamber and is channeled by exhaust line towards the diesel oxidation
25 catalyst (DOC).

Performing the diagnostic method during the regeneration of the DPF has the advantage of not requiring a dedicated fuel injection.

In this case, the diagnostic method is referred as non intrusive diagnosis.

5 The invention further provides a control system for a diesel engine system, which comprises a microprocessor based controller for performing the diagnostic method according to the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of a diesel engine system and engine controller in accordance with one embodiment of the present invention;

15 Figure 2 is a schematic illustration of a non-active diesel oxidation catalyst thermal model;

Figure 3 is a schematic illustration of a flow chart of a closed loop mechanism for estimating the oxidation heat release.

DESCRIPTION OF THE PREFERRED EMBODIMENT

20 A preferred embodiment of the present invention is applied to a turbocharged diesel engine system, which is generally labeled 1 in figure 1.

The diesel engine system 1 comprises engine 2 having intake manifold 3 and exhaust manifold 4, each of which comprises a plurality of runners corresponding in number to the number of individual
25 combustion chambers of the engine 2.

Intake manifold 3 is located at the end of an intake line 30, while the exhaust manifold 4 is located at the beginning of an exhaust line 40.

Intake line 30 comprises an inlet 31 for aspirating air at substantially atmospheric pressure. Downstream the inlet 31, a well known turbocharger 5 is located in the intake line 30, for compressing the airflow and for providing it to an intercooler 32. Further downstream, the intake line 30 comprises an intake throttle valve 33 which is electrically controllable for varying the intake restriction.

The exhaust gases are expelled from individual combustion chambers of the engine 2 to the corresponding plurality of runners and into the exhaust manifold 4.

Exhaust line 40 channels the exhaust gases from the exhaust manifold 4 to drive the turbine of turbocharger 5 and thereafter to atmosphere through an outlet 41.

Between turbocharger 5 and the outlet 41, the exhaust line 40 comprises a diesel oxidation catalyst 6 (DOC) provided for oxidizing residual hydrocarbons and carbon oxides which are produced by the fuel combustion inside the engine 2, and which are contained in the exhaust gas flow.

Downstream the diesel oxidation catalyst 6, a diesel particulate filter 7 (DPF) is located in the exhaust line 40 for capturing and removing diesel particulate matter (soot) from the exhaust gas flow, before it reaches the outlet 41.

Integral to the diesel engine system 1 is a control system, which generally comprises sensing means for providing respective measures of a plurality of engine operating parameters, and a microprocessor based controller 8 (ECM), for applying the engine operating parameter
5 measures to engine control routines.

In this case, the control system comprises a mass flow sensors 80 for measuring the exhaust gas mass flow upstream the diesel oxidation catalyst 6, a first temperature sensors 81 for measuring the exhaust gas temperature upstream the diesel oxidation catalyst 6, a second
10 temperature sensor 82 for measuring the exhaust gas temperature downstream the diesel oxidation catalyst 6.

The ECM comprises a computer code for using such mass flow and temperature measures for determining the oxidation heat release rate, which is related to the exothermic oxidation reactions in the diesel
15 oxidation catalyst 6.

Oxidation heat release rate can be obtained by using any conventional routine method.

Preferably, oxidation heat release rate is determined by using the method which is described hereinafter.

20 The method is based on the assumption that the main factors which contribute to the total heat exchange rate in an active diesel oxidation catalyst are:

heat exchange rate which is related to the conventional convective processes between exhaust gases, diesel oxidation catalyst
25 and environment; and

oxidation heat release rate which is related to the exothermic oxidation reactions into the diesel oxidation catalyst.

The method approach is to estimate the conventional convective heat exchange rate with a thermal model of the inert part of DOC, and to subtract such contribute from the total heat exchange rate, for
5 estimating the oxidation heat release rate.

According to the method approach, the ECM initially determines the oxidation heat release rate by using a thermal model of a non-active (inert) diesel oxidation catalyst, wherein no oxidation reaction
10 takes place and only conventional convective exchange have to be modeled.

The non-active diesel oxidation catalyst model is illustrated in figure 2.

The significant model inputs are identified as the exhaust gas mass flow rate into the diesel oxidation catalyst \dot{m}_m , the exhaust gas
15 temperature T_m upstream the diesel oxidation catalyst, and the catalyst substrate thermal state, which can be represented by the mean catalyst temperature T_{cat} . The significant model output is identified as the estimated exhaust gas temperature $T_{out,est}$ downstream
20 the diesel oxidation catalyst.

The following algebraic and differential modeling equations describe the non-active diesel oxidation catalyst:

$$(1) \frac{dQ_{in}}{dt} + \frac{dQ_{out}}{dt} + \frac{dQ_{exch}}{dt} = 0$$

$$(2) C \frac{dT_{cat}}{dt} = \frac{dQ_{exch}}{dt}$$

where:

$\frac{dQ_{in}}{dt}$ = input heat rate upstream the diesel oxidation catalyst;

$\frac{dQ_{out}}{dt}$ = output heat rate downstream the diesel oxidation catalyst;

$\frac{dQ_{exch}}{dt}$ = conventional convective heat exchange rate between exhaust

5 gases, diesel oxidation catalyst and environment;

C = diesel oxidation catalyst heat capacity.

The total heat exchange Q_{exch} can be expressed as the addition of two main thermal exchange contributions, according to the following equation:

$$10 \quad Q_{exch} = Q_{exch1} + Q_{exch2}$$

where:

Q_{exch1} = convective heat exchange between exhaust gas and catalyst,

Q_{exch2} = convective heat exchange between catalyst and external environment.

15 The convective heat exchange Q_{exch1} is a function of the exhaust gas mass flow \dot{m}_{in} upstream the catalyst, the exhaust gas temperature T_{in} upstream the catalyst, and the catalyst temperature T_{cat} :

$$(3) \quad Q_{exch1} = k_1 \dot{m}_{in} (T_{in} - T_{cat}).$$

20 The convective heat exchange Q_{exch2} is a function of the catalyst temperature T_{cat} and the external environment (ambient) temperature T_{amb} :

$$(4) \quad Q_{exch2} = k_2 (T_{amb} - T_{cat}).$$

The input heat rate and the output heat rate are defined according to

the following equations:

$$(5) \quad \frac{dQ_{in}}{dt} = \dot{m}_{in} C_p T_{in}$$

$$(6) \quad \frac{dQ_{out}}{dt} = -\dot{m}_{out} C_p T_{out,est}$$

where:

- 5 \dot{m}_{in} = exhaust gas mass flow upstream the diesel oxidation catalyst,
 \dot{m}_{out} = exhaust gas mass flow downstream the diesel oxidation catalyst,
 T_{in} = exhaust gas temperature upstream the diesel oxidation catalyst,
 $T_{out,est}$ = estimated exhaust gas temperature downstream the DOC,
 C_p = exhaust gas specific heat.
- 10 The exhaust gas mass flow \dot{m}_{in} and the gas temperature T_{in} are measured by means of the respective sensors 80 and 81. The exhaust gas mass flow \dot{m}_{out} downstream the catalyst can be assumed equal to the exhaust gas mass flow \dot{m}_{in} upstream the catalyst.

Therefore, the equations (1), (2), (3), (4), (5) and (6) define a non
 15 linear dynamic system, whose standard equation formulation is the following:

$$\begin{cases} \frac{dx}{dt} = f(x, u_1 \dots u_n) \\ y = g(x, u_1 \dots u_n) \end{cases}$$

where u_i are the input variables, x is the status variable of the system and y is the output variable.

- 20 In the present case, the input variables u_i are represented by the exhaust gas temperature T_{in} and the exhaust gas mass flow \dot{m}_{in} upstream the catalyst, the status variable x of the system is represented by the catalyst temperature T_{cat} , and the output variable y is

represented by the estimated exhaust gas temperature $T_{out,est}$ downstream the diesel oxidation catalyst.

Such non linear dynamic system can be solved by the ECM using a known discrete time methods, in order to estimate the exhaust gas temperature $T_{out,est}$.

The non-active DOC model can be calibrated using identification techniques in order to minimize the differences between the estimated exhaust gas temperature $T_{out,est}$ and the real exhaust gas temperature $T_{out,meas}$ measured by sensor 82, when the diesel oxidation catalyst 6 is in non-active state.

As illustrated in figure 3, when the DOC goes in active state, the error caused by the missing oxidation heat release in the preceding model is compensated by feeding back the estimated exhaust gas temperature $T_{out,est}$ and calculating the oxidation heat release rate $\frac{dQ_{oxi}}{dt}$ according to the following equation:

$$\frac{dQ_{oxi}}{dt} = K(T_{out,meas} - T_{out,est}).$$

The diesel oxidation model is then corrected according to the new equation (2):

$$(2') \quad C \frac{dT_{cat}}{dt} = \frac{dQ_{exch}}{dt} + \frac{dQ_{oxi}}{dt} = \frac{dQ_{exch}}{dt} + K(T_{out,meas} - T_{out,est}).$$

Therefore, a corrected exhaust gas temperature $T_{out,est}^*$ is obtained by solving the non linear dynamic system defined by the equations (1), (2'), (3), (4), (5) and (6).

Finally, the corrected exhaust gas temperature $T_{out,est}^*$ is subtracted

from the measured outlet temperature $T_{out,meas}$ and then multiplied by the predetermined proportional factor K in order to obtain a corrected value for $\frac{dQ_{oxi}}{dt}$, which is the desired heat exchange rate related to the exothermic oxidation reactions.

5 According to the invention, the oxidation heat release rate is used for performing a diagnostic method of the diesel oxidation catalyst 6.

The diagnostic method comprises providing an unburned fuel mass flow through the diesel oxidation catalyst 6, in order to promote the
10 oxidation reactions therein.

Such unburned fuel mass flow is provided by the ECM with a dedicated injection pattern, by means of which one or more post-injections are injected into the combustion chamber after the piston has passed its top dead center (TDC).

15 Post-injections start sufficiently far from TDC for the fuel to not burn into the combustion chamber, typically after the exhaust valves opening.

Therefore, the post-injected fuel is ejected unburnt from the combustion chamber and is channeled by the exhaust line 40 towards
20 the diesel oxidation catalyst 6.

According to the invention, the ECM can provide such post-injections at any time during the engine system functioning, for instance during engine overrun or in engine steady state.

In this case, the diagnostic method is referred as intrusive
25 diagnosis.

Alternatively, the ECM can provide such post-injections during the DPF regeneration process, for contemporaneously heating the exhaust gas flow to a temperature at which the particulate matter accumulated in the DPF burns off.

5 In this case, the diagnostic method is referred as non intrusive diagnosis.

In both cases, the unburned fuel mass flow is determined by the ECM using a preset map which correlates the amount of post-injected fuel to a plurality of engine operating parameters, for example engine
10 speed and engine load.

During post-injections, the diagnostic method comprises determining the oxidation heat release rate, which is related to the exothermic oxidation of the unburned fuel flow into the diesel oxidation catalyst.

15 As explained above, the ECM determines the oxidation heat release rate by using the exhaust gas mass flow upstream the DOC, the exhaust gas temperature upstream the DOC, and the exhaust gas temperature downstream the DOC, which are respectively measured by the sensors 80-82.

20 Finally, the diagnostic method comprises determining a diesel oxidation catalyst efficiency index *DOI*, according to the following equation:

$$DOI = \frac{\int_{ta}^{tb} \frac{dQ_{oxi}}{dt} dt}{\int_{ta}^{tb} \frac{dQ_{fuel}}{dt} dt}$$

where:

$\frac{dQ_{oxi}}{dt}$ = oxidation heat release rate in the DOC during the diagnosis;

$\frac{dQ_{fuel}}{dt}$ = unburned fuel mass flow through the DOC during the diagnosis;

$\int_{ta}^{tb} \frac{dQ_{oxi}}{dt} dt$ = integral of the oxidation heat release rate on a preset

5 time interval (ta, tb) ;

$\int_{ta}^{tb} \frac{dQ_{fuel}}{dt} dt$ = integral of the unburned fuel rate on the same preset

time interval (ta, tb) ;

ta is the time at which exhaust gas temperature downstream DOC reaches a certain value $T_{out,a}$;

10 tb is the time at which exhaust gas temperature downstream DOC reaches a certain value $T_{out,b}$ which is higher than $T_{out,a}$;

According to a preferred embodiment of the invention, $T_{out,a}$ is comprised between 250°C and 350°C, while $T_{out,b}$ is comprised between 450°C and 550°C. Preferably, $T_{out,a}$ is equal to 300°C and $T_{out,b}$ is equal

15 to 500°C.

The integrals have been introduced in order to get the maximum index sensitivity, especially for diagnosing the DOC during the DPF regeneration.

As a matter of fact, $\int_{ta}^{tb} \frac{dQ_{oxi}}{dt} dt$ represents the heat which is

20 produced by the oxidation reactions in the DOC, for raising the

exhaust gas temperature downstream the DOC from $T_{out,a}$ to $T_{out,b}$.

$$\int_{t_a}^{t_b} \frac{dQ_{fuel}}{dt} dt$$

represents the amount of unburned fuel which is passed

through the DOC, for raising the exhaust gas temperature downstream the DOC from $T_{out,a}$ to $T_{out,b}$.

5 Therefore, the diesel oxidation index *DOI* is correlated to the DOC efficiency.

According to the invention, the *DOI* can be compared with a preset threshold, beneath which the ECM warns that the DOC is faulty and must be replaced.

10 ECM can use the diesel oxidation index *DOI* also for controlling the after-treatment of the exhaust gas.

By way of example, *DOI* can be useful for assisting DPF regeneration, feed gas generation for an SCR systems (DOC must be able to increase NO_2 concentration upstream of an SCR system), and ammonia slip
15 prevention downstream an SCR system (DOC must have proper HC, CO, NO_x conversion capability).

While the present invention has been described with respect to certain preferred embodiments and particular applications, it is understood that the description set forth herein above is to be taken
20 by way of example and not of limitation. Those skilled in the art will recognize various modifications to the particular embodiments are within the scope of the appended claims. Therefore, it is intended that the invention not be limited to the disclosed embodiments, but that it has the full scope permitted by the language

of the following claims.

CLAIMS

1. Method for diagnosing a diesel combustion catalyst (6) which is located in an exhaust line (40) within a diesel engine system (1), wherein the method comprises:

- 5 - providing an unburned fuel mass flow ($\frac{dQ_{fuel}}{dt}$) through the diesel oxidation catalyst (6),
- determining the oxidation heat release rate ($\frac{dQ_{oxi}}{dt}$) which is related to the exothermic oxidation reactions of the unburned fuel into the diesel oxidation catalyst (6),
- 10 - integrating the determined oxidation heat release rate ($\frac{dQ_{oxi}}{dt}$) on a time interval (ta, tb),
- integrating the unburned fuel mass flow ($\frac{dQ_{fuel}}{dt}$) on the same time interval,
- dividing the integrated value of oxidation heat release rate and
- 15 the integrated value of unburned fuel mass flow for determining an efficiency index (DOI) of the diesel oxidation catalyst (6).

2. Method according to claim 1, characterized in that the method further comprises comparing the efficiency index (DOI) with a preset threshold, beneath which the diesel oxidation catalyst (6) is

20 considered faulty.

3. Method according to claim 1, characterized in that the lower limit (ta) of the time interval is the time at which exhaust gas downstream DOC reaches a first temperature ($T_{out,a}$), and the upper limit (tb) of the time interval is the time at which exhaust gas

downstream DOC reaches a second temperature ($T_{out,b}$) which is higher than the first temperature ($T_{out,a}$).

4. Method according to claim 3, characterized in that the first temperature ($T_{out,a}$) is between 250°C and 350°C and the second temperature ($T_{out,b}$) is between 450°C and 550°C.

5. Method according to claim 1, characterized in that determining the oxidation heat release rate ($\frac{dQ_{oxi}}{dt}$) comprises:

- measuring a plurality of engine operating parameters,
- measuring the exhaust gas temperature ($T_{out,meas}$) downstream the diesel oxidation catalyst (6),

- providing a thermal model of a diesel oxidation catalyst for estimating the exhaust gas temperature ($T_{out,est}$) downstream the diesel oxidation catalyst (6), on the base of the engine operating parameter measures,

- implementing the thermal model of the diesel oxidation catalyst in a closed loop mechanism, wherein the error between the measured exhaust gas temperature ($T_{out,meas}$) and the estimated exhaust gas temperature ($T_{out,est}$) downstream the diesel oxidation catalyst (6), is used for estimating the oxidation heat release rate ($\frac{dQ_{oxi}}{dt}$).

6. Method according to claim 5, characterized in that such a plurality of engine operating parameters comprises the exhaust gas mass flow rate (\dot{m}_m) upstream the diesel oxidation catalyst (6), and the exhaust gas temperature (T_m) upstream the diesel oxidation catalyst (6).

7. Method according to claim 1, characterized in that a diesel

particulate filter (7) is located in the exhaust line (40) downstream the diesel oxidation catalyst (6), and that the unburned fuel mass flow is provided as post-injected fuel during a diesel particulate filter regeneration.

5 **8.** Control system for a diesel engine system comprising an exhaust line (40), a diesel oxidation catalyst (6) located in the exhaust line (40), and means for providing an unburned fuel flow through the diesel oxidation catalyst (6), characterised in that the control system comprises a microprocessor based controller (8) for performing
10 the method according to anyone of the preceding claims.

9. Control system according to claim 8, characterized in that it comprises sensor means (82) for measuring the exhaust gas temperature ($T_{out,est}$) downstream the diesel oxidation catalyst (6).

10. Control system according to claim 8, characterized in that it
15 comprises sensor means (81) for measuring the exhaust gas temperature (T_{in}) upstream the diesel oxidation catalyst (6).

11. Control system according to claim 8, characterized in that it comprises sensor means (80) for measuring the exhaust gas mass flow (\dot{m}_m) upstream the diesel oxidation catalyst (6).

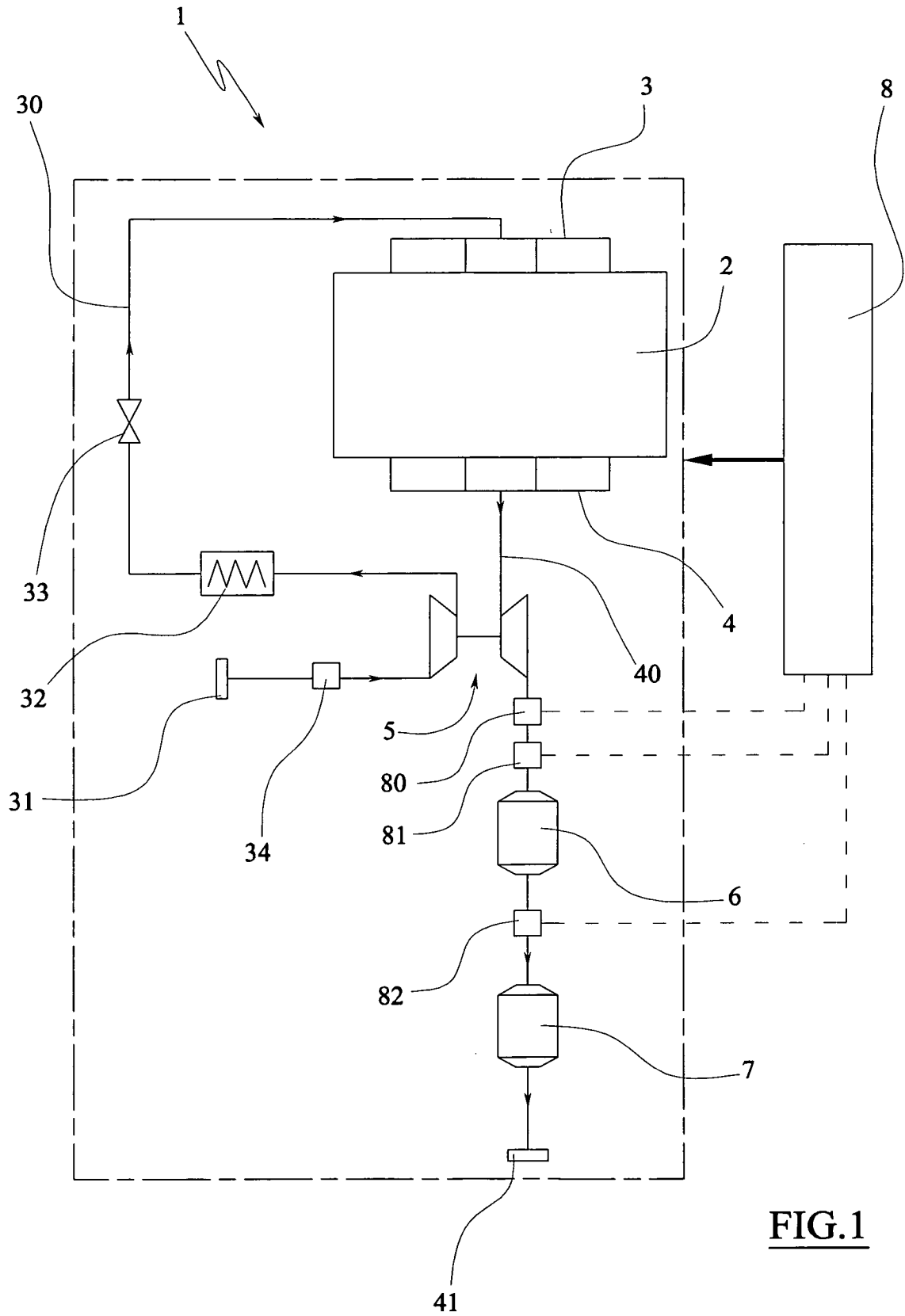


FIG. 1

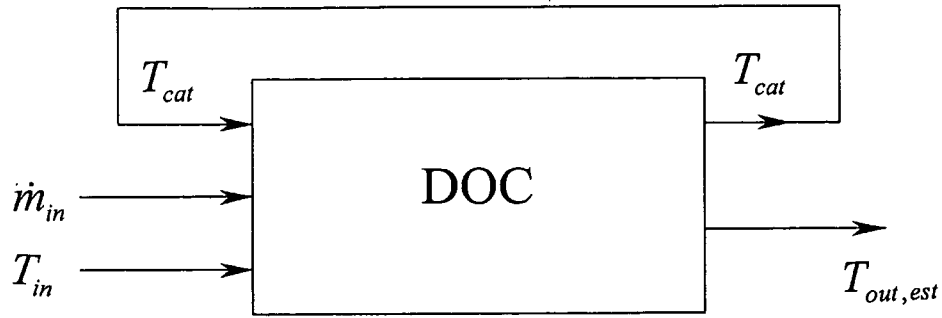


FIG.2

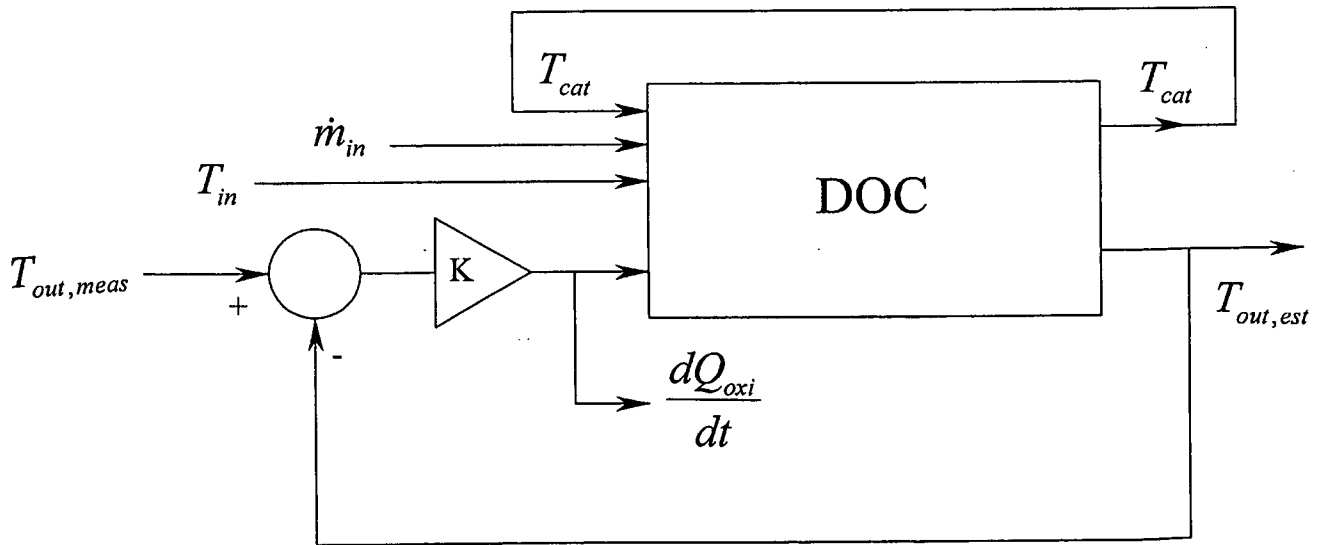


FIG.3

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2010/001954

A. CLASSIFICATION OF SUBJECT MATTER

INV. F01N11/00 F02D41/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F01N F02D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 096 117 A1 (MAGNETI MARELLI SPA [IT] MAGNETI MARELLI POWERTRAIN SPA [IT]) 2 May 2001 (2001-05-02) the whole document -----	1-11
X	US 2002/197721 A1 (KINUGAWA MASUMI [JP] ET AL) 26 December 2002 (2002-12-26) abstract; figures 1,2,3 paragraphs [0001], [0013] - [0015], [0042] - [0044], [0050] - [0051], [0055], [0059] - [0061], [0070] - [0072], [0084] - [0085], [0090], [0096] - [0107] -----	1-11
A	US 2006/225492 A1 (PFISTER TOBIAS [DE]) 12 October 2006 (2006-10-12) the whole document ----- -/--	1-11

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Date of the actual completion of the international search

31 May 2010

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Mineau, Christophe

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/001954

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