(19) Europäisches Patentamt
European Patent Office
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(11) **EP 4 585 792 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.07.2025 Bulletin 2025/29

(21) Application number: **24472001.7**

(22) Date of filing: **10.01.2024**

(51) International Patent Classification (IPC):
F01N 3/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F01N 3/0237; F01N 3/021; F01N 2900/14; F01N 2900/1602; F01N 2900/1606

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) METHOD FOR CLEANING COMPONENTS OF EXHAUST GAS TREATMENT SYSTEMS

(57) The method for cleaning components of treated gas systems according to the invention is used for catalytic converters or filter elements for exhaust gases for gasoline and diesel vehicles, such as, for example, diesel particulate filters (DPF) and catalytic converters of the type CAT, COD, SCR. The method comprises the steps of analysis and pre-assessment of said treated component (1), and the subsequent cleaning thereof using an oxyhydrogen burner (2) heating entirely said treated component (1). The process is controlled by means of an exhaust gas extraction system comprising a fan (5) capable of measuring and regulating the gas flow.

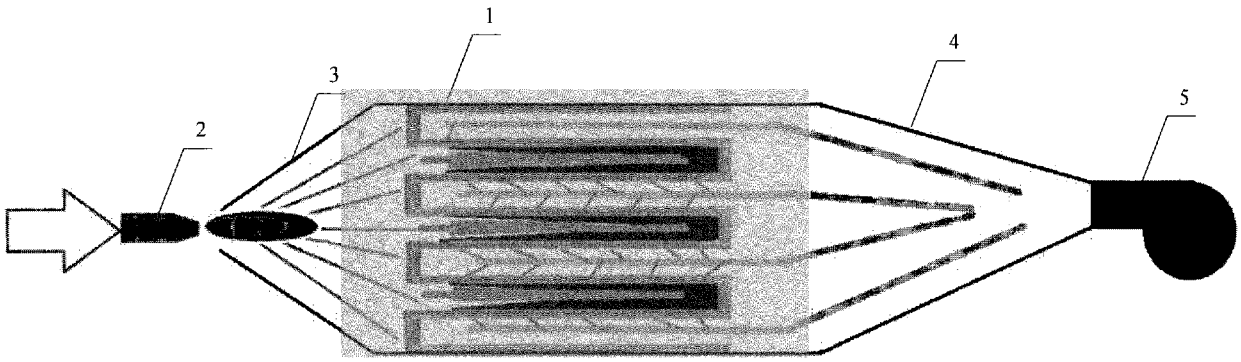

Fig. 1

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a method for cleaning components of exhaust gas treatment systems, which finds application in the industry, and in particular, in the automotive industry for maintenance and cleaning of treated gas systems of vehicles with internal combustion engines.

BACKGROUND OF THE INVENTION

[0002] Systems and methods for cleaning components of exhaust gas treatment systems of vehicles with internal combustion engines are known in the prior art, wherein diagnostics is first performed for determining the degree of clogging of the component to be treated. The component to be treated is then flushed by heating a cleaning agent to a high temperature of about 85 °C and injecting jets in a direction opposite to the direction of discharging the exhaust gases passing through the treated component. The different ranges of the change of the pressure level, as well as the repeated reversal of the injection streams, are a part of the procedure for removing ash deposits and soot particles on the surfaces of the treated component.

[0003] The described method does not provide for a sufficiently effective cleaning of the treated component, since uncleaned areas remain in the treated component after cleaning and mainly soot gets cleaned.

[0004] Other methods for cleaning components of exhaust gas treatment systems, such as baking or blowing-out, are known, but they are slow, very energy-intensive and inefficient.

SUMMARY OF THE INVENTION

[0005] An object of the invention is to create an optimized method for more efficient cleaning of components of exhaust gas treatment systems

[0006] This object is solved by creating a method for cleaning components of exhaust gas treatment systems having a housing with a front side and a back side between which channels are formed, comprising in sequence the steps of:

- positioning of said component on a stand;
- provision of a pure oxyhydrogen gas mixture obtained from electrolysis of water in an electrolyser;
- feeding said pure oxyhydrogen gas mixture from the electrolyser to an oxyhydrogen burner, around which a first hollow member is mounted; said member is made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is positioned opposite the front side of the processed component and the oxyhydrogen burner is mounted at said narrow opening;
- concentrated burning-out of said pure oxyhydrogen gas mixture, by means of said oxyhydrogen burner and feeding a flame towards the front side of said component, followed by radial heating of the entire front side surface of said processed component at a flame temperature from 850 °C to 1200 °C;
- heat transfer from the front side of said component along the entire length of the channels by means of a controlled suction by a suction system comprising an additional hollow member made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is disposed opposite the back side of said processed component, and said suction system with a controllable variable flow fan is mounted at said narrow opening;
- gradual burning-out of accumulated deposits along the entire length of said channels until the temperature of the exhaust gases drops below 400 °C, wherein the following occurs throughout the whole process:
- real-time monitoring of changes in the temperature of the processed component and of the gases evolved by means of temperature sensors located along said processed component and at the exhaust outlet, and
- controlling the combustion rate, temperature and extraction of exhaust gases and deposits via the suction system.

[0007] Components of processed exhaust gas treatment systems may be catalytic converters or filter elements for exhaust gases.

[0008] Typically, the channels of the processed exhaust gas treatment systems are made of a porous substrate material.

[0009] Preferably, the temperature of the processed component is additionally monitored in real time using a thermal camera and/or an infrared thermometer positioned against the front or back side of said treated component. This allows for better monitoring and control of the heating process of said processed component.

[0010] In a preferred embodiment of the invention, when necessary, the combustion temperature and/or the exhaust gas extraction velocity are varied by the suction system after real-time sensing of the temperature of the processed component and/or the temperature of the gases discharged by means of said temperature sensors, infrared thermometer and/or thermal camera.

[0011] In a preferred embodiment of the invention, said oxyhydrogen burner comprises a supply pipeline and at least four nozzles mounted on the front side of the burner housing, first, second, third, and fourth nozzles, respectively, each nozzle being positioned at an angle relative to the adjacent nozzle thereof as follows: the angle between the first and second nozzle - βab = 0° to 3°, the angle between the third and fourth nozzle βcd = 0° to 3°, the

angle between the first and third nozzle βas = 1° to 12°, and the angle between the second and fourth nozzle -βbd = 1° to 12°, wherein said supply pipeline is connected to the back side of the housing.

[0012] In a preferred embodiment of the invention, the degree of gas permeability through said processed component is measured using a measuring stand prior to positioning thereof on a stand and after burning-out the accumulated deposits.

[0013] In a preferred embodiment of the invention, a scale is used for measuring the total weight of said processed component prior to positioning thereof on a stand and after burning-out the accumulated deposits.

[0014] In a preferred embodiment of the invention, a visual inspection is carried-out for physical damages to said processed component prior to positioning thereof on a stand and after burning-out the accumulated deposits.

[0015] In a preferred embodiment of the invention, after the procedure of burning-out of the accumulated deposits in said processed component, accelerated blow-out using a compressor system and collection of coarse particles of deposits on said processed component is carried-out.

[0016] The use of oxyhydrogen alone for cleaning by burning-out carbon compounds (deposits) in the processed component, which are residuals of combustion processes, is the only way for complete elimination thereof. The elimination of carbon by-products from the combustion of carbon-containing fuels cannot be obtained with other similar fuels because of the various types of gases.

[0017] The method according to the invention provides a more optimized cleaning of components of processed components of exhaust gas treatment systems by allowing for complete burning-out of accumulated contaminants over the entire area and in the full depth of the processed component. The method allows for removal of soot deposits, Eolis, AD BLUE, oil and other deposits.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In more detail, the invention is explained by preferred embodiments, given as nonlimiting examples of the scope of the invention, with reference to the enclosed figures, wherein:

Figure 1 is a diagram of a processed component of a processed exhaust gas treatment systems at the time of cleaning using the method according to the invention.

DETAILED DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

[0019] The method for cleaning components of processed exhaust gas treatment systems according to the invention is used for components 1, having a housing with a front side and a back side between which channels are formed that are made of a porous substrate material. Said components 1 are catalytic converters or filter elements for exhaust gases for gasoline and diesel vehicles, such as diesel particulate filters (DPF) and catalytic converter (CAT) of the types diesel oxidation catalyst (DOC), selective catalytic reduction (SCR) or similar.

[0020] At the beginning and at the end of the cleaning process of the diesel particulate filter, validation of the readings can be performed by measuring the weight, the degree of permeability and the presence of physical damages on the diesel particulate filter. The validation is performed by entering the results into an analysis and pre-assessment module, which is a memory device, a database, a processor and a data input means, for example, a computer.

[0021] According to an exemplary embodiment of the invention, the method is used for cleaning a diesel particulate filter, and comprises analysis and pre-assessment steps first, and namely:

- performing a visual inspection for physical damages to the honeycomb and housing of the diesel particulate filter prior to cleaning using a stethoscope camera and a simple visual contact by an operator. If the presence of oil or metal shavings (usually caused by a faulty turbine) is detected, this is described in a findings report as the condition of the filter prior to the cleaning procedure, and the information is entered into the analysis and pre-assessment module;
- measuring using a scale of the total weight of the diesel particulate filter before cleaning thereof. The measured values are entered into an analysis and pre-assessment module in a findings report as the condition of the filter prior to the cleaning procedure;
- measuring using a bench of the degree of permeability of gases through the diesel particulate filter before cleaning thereof. This permeability is measured in bars and accounts for the pressure the gases created as they pass through the diesel particulate filter. The measured values are entered into an analysis and pre-assessment module in a findings report as the condition of the filter prior to the cleaning procedure.

[0022] After completing the analysis and pre-assessment, the cleaning of the diesel particulate filter is carried-out. The process is performed using a cleaning module that comprises the following members:

- an oxyhydrogen burner 2 for heating of the diesel particulate filter and burning out of the deposits therein;
- an electrolyser providing the oxyhydrogen gas mixture required for cleaning the diesel particulate filter. The electrolyser is a device that separates water into hydrogen and oxygen in the form of a stoichiometric mixture using electricity. For the needs of a standard installation, electrolysers with an adjustable volume of gas mixture generation from 1 to 2.5 m3/h are used. The electrolyser is active in the cleaning pro-

cess in the part of burning out (removal) of deposits on the filter filtering/active surfaces. The electrolyser in combination with the burner according to the disclosure provide high efficiency, environmental friendliness and economy of the filter cleaning process;

- 3D installation stand for positioning the filter to be cleaned;
- 3D position stand for fixing the burner for burning-out oxyhydrogen and fixing the position thereof relative to the filter treatment surface;
- A system of temperature sensors giving real-time information on the filter cleaning process, and allowing for monitoring changes in burning-out temperature or adjusting the exhaust suction rate;
- Thermally resistant hollow members 3, 4, of the cone type, for concentrating the generated heat relative to the cleaned filter surface. These hollow members 3, 4 are made of special high-temperature, mouldable materials, such as mixtures of silica, ceramics and other substances capable of withstanding temperatures above 1350 °C, which are used, for example, in foundry processes/furnaces;
- Exhaust gas extraction system comprising a fan 5, capable of measuring and regulating the gas flow, which is designed specifically for hot gas mixtures above 800° C. The system adapts to the cleaning process and allows for uniform cleaning in depth, as well as protects the treated material from thermal overheating. It is also used for cooling the filter after cleaning;
- Thermal camera for process monitoring.

[0023] Optionally, the cleaning module can also comprise additional members for achieving higher environmental standards, as well as for achieving additional functionalities in the filter treatment process, such as:

- A mechanical filter for treatment of exhaust gases in the process of processing the diesel particulate filter during the thermal cleaning thereof. The mechanical filter is installed downstream the fan 5;
- A water filter for capturing the exhaust gases in processes of cleaning greased parts. The water filter is installed downstream the fan and upstream the mechanical filter;
- A compressor system with various sets of attachments for mounting on the treated diesel particulate filter, and a corresponding mechanical filter for capturing any coarser particles that have become detached but cannot pass through the ceramic walls of the treated diesel particulate filter. The process is accelerated blow-out and collection of the separated particles, which is carried-out periodically.

[0024] The process of cleaning the diesel particulate filter comprises the following sequential steps:

- when necessary, cleaning of grease on the diesel particulate filter using a water filter;
- positioning of said component 1 on a stand;
- provision of a pure oxyhydrogen gas mixture obtained from electrolysis of water in an electrolyser;
- feeding said pure oxyhydrogen gas mixture from the electrolyser to an oxyhydrogen burner 2, around which a first hollow member 3 is mounted, said member is made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is positioned opposite the front side of the diesel particulate filter, and the oxyhydrogen burner is mounted at said narrow opening. The burner 2 may be of various types appropriate for the process, for example, it may comprise a supply pipeline and at least four nozzles mounted on the front side of the burner 2 housing, first, second, third, and fourth nozzles, respectively, each nozzle being positioned at an angle relative to the adjacent nozzle thereof as follows: the angle between the first and second nozzle - β_{ab} = 0° to 3°, the angle between the third and fourth nozzle - β_{cd} = 0° to 3°, the angle between the first and third nozzle - β_{ac} = 1° to 12°, and the angle between the second and fourth nozzle - β_{bd} = 1° to 12°, wherein said supply pipeline is connected to the back side of the housing.
- concentrated burning-out of said pure oxyhydrogen gas mixture, by means of said oxyhydrogen burner 2 and feeding a flame towards the front side of said component 1, followed by radial heating of the entire front side surface of the diesel particulate filter at a flame temperature from 850 °C to 1200 °C;
- heat transfer from the front side of said component 1 along the entire length of the channels by means of a controlled extraction by a suction system with a fan 5, comprising an additional hollow member 4 made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is disposed opposite the back side of said component 1, and a suction system with a controllable variable flow fan 5 is mounted at said narrow opening;
- gradual burning-out of accumulated deposits along the entire length of said channels until the temperature of the exhaust gases drops below 400 °C,
- carrying-out accelerated blow-out using a compressor system and collection of coarse particles of deposits on said component 1;
- measuring using a bench of the degree of permeability of gases through said component 1 after cleaning thereof;
- measuring using a scale of the total weight of said component 1 after cleaning thereof;
- performing a visual inspection for physical damages to the honeycomb and housing of said component 1 after cleaning thereof using a stethoscope camera and simple visual contact by an operator;

- when necessary, after measuring using a scale of the total weight of said component 1, or measuring using a bench of the degree of permeability of gases through said component 1, the process of burning-out of deposits on said component 1 is continued. If the weight and the degree of permeability of gases are found to correspond to the factory-specified parameters for said component 1, the burning-out process is terminated.

[0025] Throughout the process of cleaning of said component 1, heating may be interrupted for accelerated blow-out using a compressor system and collection of coarse particles from deposits on said component 1.

[0026] Throughout the process of cleaning of said component 1, the following is carried-out:

- real-time monitoring of changes in the temperature of said component 1 and of the gases evolved by means of temperature sensors located along said component 1, for example, on the outside surface of the wall thereof, and at the exhaust outlet, and/or an infrared thermometer positioned opposite the front or back side of said treated component 1, and/or a thermal camera located in the vicinity of said diesel particulate filter, and
- controlling the combustion rate, temperature and the extraction of the exhaust gases and deposits through the suction system after real-time reading of the temperature of said component 1 and/or the temperature of the discharged gases by means of said temperature sensors, infrared thermometer and/or thermal camera, thereby monitoring the optimum temperature for burning-out of the deposits on said component 1 and controlling the temperature so that it is not higher than a certain threshold, which would compromise the integrity of said component 1.

[0027] Upon completion of the cleaning procedure, data on the total weight and the degree of permeability of said component 1 is again measured, and a visual inspection is performed for physical damages thereto. The measured data are recorded in the 'after procedure' findings report in the analysis and pre-assessment module.

Claims

1. A method for cleaning components of exhaust gas treatment systems having a housing with a front side and a back side between which channels are formed, comprising in sequence the steps of:

    - positioning of said component (1) on a stand;
    - provision of a pure oxyhydrogen gas mixture obtained from electrolysis of water in an electrolyser;
    - feeding said pure oxyhydrogen gas mixture from the electrolyser to an oxyhydrogen burner (2), around which a first hollow member (3) is mounted, said member is made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is positioned opposite the front side of said processed component (1), and the oxyhydrogen burner (2) is mounted at said narrow opening;
    - concentrated burning-out of said pure oxyhydrogen gas mixture, by means of said oxyhydrogen burner (2) and feeding a flame towards the front side of said processed component (1), followed by radial heating of the entire front side surface of said processed component (1) at a flame temperature from 850 °C to 1200 °C;
    - heat transfer from the front side of said processed component (1) along the entire length of the channels by means of a controlled suction by a suction system comprising an additional hollow member (4) made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is disposed opposite the back side of said processed component (1), and said suction system with a controllable variable flow fan (5) is mounted at said narrow opening;
    - gradual burning-out of accumulated deposits along the entire length of said channels until the temperature of the exhaust gases drops below 400 °C,

    wherein the following occurs throughout the whole process:

    - real-time monitoring of changes in the temperature of said processed component (1) and of the gases evolved by means of temperature sensors located along said processed component (1) and at the exhaust outlet, and
    - controlling the combustion rate, temperature and extraction of exhaust gases and deposits via the suction system (5).

2. A method for cleaning components of exhaust gas treatment systems according to claim 1, **characterized in that** the components of exhaust gas systems are catalytic converters or filter members for exhaust gases.

3. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the channels of said components (1) of exhaust gas systems are made of a porous substrate material.

4. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the temperature of said processed component (1) is additionally monitored in real time using a thermal camera and/or an infrared thermometer positioned opposite the front or back side of said processed component (1).

5. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the combustion temperature and/or the exhaust gas extraction velocity is varied by the suction system (5) after real-time sensing of the temperature of said processed component (1) and/or the temperature of the gases discharged by means of said temperature sensors, infrared thermometer and/or thermal camera.

6. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** said oxyhydrogen burner (2) comprises a supply pipeline and at least four nozzles mounted on the front side of the burner (2) housing, first, second, third, and fourth nozzles, respectively, each nozzle being positioned at an angle relative to the adjacent nozzle thereof as follows: the angle between the first and second nozzle - β_{ab} = 0° to 3°, the angle between the third and fourth nozzle - β_{cd} = 0° to 3°, the angle between the first and third nozzle - β_{ac} = 1° to 12°, and the angle between the second and fourth nozzle - β_{bd} = 1° to 12°, wherein said supply pipeline is connected to the back side of said housing.

7. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the degree of gas permeability through said processed component (1) is measured using a measuring stand prior to positioning thereof on a stand and after burning-out the accumulated deposits.

8. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** a scale is used for measuring the total weight of said treated component (1) prior to positioning thereof on a stand and after burning-out the accumulated deposits.

9. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** a visual inspection is carried-out for physical damages to said processed component (1) prior to positioning thereof on a stand and after burning-out the accumulated deposits.

10. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** after the procedure of burning-out of the accumulated deposits in said processed component (1), accelerated blow-out using a compressor system and collection of coarse particles of deposits on said processed component (1) is carried-out.

Amended claims in accordance with Rule 137(2) EPC.

1. A method for cleaning components of exhaust gas treatment systems by a cleaning module, said components having a housing with a front side and a back side between which channels are formed, comprising in sequence the steps of:

- analysing and pre-assessment of the condition of the component;
- positioning of said component (1) on a stand;
- provision of a pure oxyhydrogen gas mixture obtained from electrolysis of water in an electrolyser;
- feeding said pure oxyhydrogen gas mixture from the electrolyser to an oxyhydrogen burner (2), around which a first hollow member (3) is mounted, said member is made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is positioned opposite the front side of said processed component (1), and the oxyhydrogen burner (2) is mounted at said narrow opening;
- concentrated burning-out of said pure oxyhydrogen gas mixture, by means of said oxyhydrogen burner (2) and feeding a flame towards the front side of said processed component (1), followed by radial heating of the entire front side surface of said processed component (1) at a flame temperature from 850 °C to 1200 °C;
- heat transfer from the front side of said processed component (1) along the entire length of the channels by means of a controlled suction by a suction system comprising an additional hollow member (4) made of a high temperature-resistant material having the shape of a truncated cone having a wide opening and a narrow opening, wherein said wide opening is disposed opposite the back side of said processed component (1), and said suction system with a controllable variable flow fan (5) is mounted at said narrow opening;
- gradual burning-out of accumulated deposits along the entire length of said channels until the temperature of the exhaust gases drops below 400 °C, wherein the following occurs throughout the whole process:
- controlling the combustion rate, temperature

and extraction of exhaust gases and deposits via the suction system (5) while real-time monitoring of changes in the temperature of said processed component (1) and of the gases evolved by means of temperature sensors located along said processed component (1) and at the exhaust outlet, so that the temperature for burning-out of deposits on said component (1) is below a threshold, compromising the integrity of the component.

2. A method for cleaning components of exhaust gas treatment systems according to claim 1, **characterized in that** the components of exhaust gas systems are catalytic converters or filter members for exhaust gases.

3. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the channels of said components (1) of exhaust gas systems are made of a porous substrate material.

4. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the temperature of said processed component (1) is additionally monitored in real time using a thermal camera and/or an infrared thermometer positioned opposite the front or back side of said processed component (1).

5. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the combustion temperature and/or the exhaust gas extraction velocity is varied by the suction system (5) after real-time sensing of the temperature of said processed component (1) and/or the temperature of the gases discharged by means of said temperature sensors, infrared thermometer and/or thermal camera.

6. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** said oxyhydrogen burner (2) comprises a supply pipeline and at least four nozzles mounted on the front side of the burner (2) housing, first, second, third, and fourth nozzles, respectively, each nozzle being positioned at an angle relative to the adjacent nozzle thereof as follows: the angle between the first and second nozzle - β_{ab} = 0° to 3°, the angle between the third and fourth nozzle - β_{cd} = 0° to 3°, the angle between the first and third nozzle - β_{ac} = 1° to 12°, and the angle between the second and fourth nozzle - β_{bd} = 1° to 12°, wherein said supply pipeline is connected to the back side of said housing.

7. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** the degree of gas permeability through said processed component (1) is measured using a measuring stand prior to positioning thereof on a stand and after burning-out the accumulated deposits.

8. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** a scale is used for measuring the total weight of said treated component (1) prior to positioning thereof on a stand and after burning-out the accumulated deposits.

9. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** a visual inspection is carried-out for physical damages to said processed component (1) prior to positioning thereof on a stand and after burning-out the accumulated deposits.

10. A method for cleaning components of exhaust gas treatment systems according to any one of the preceding claims, **characterized in that** after the procedure of burning-out of the accumulated deposits in said processed component (1), accelerated blow-out using a compressor system and collection of coarse particles of deposits on said processed component (1) is carried-out.

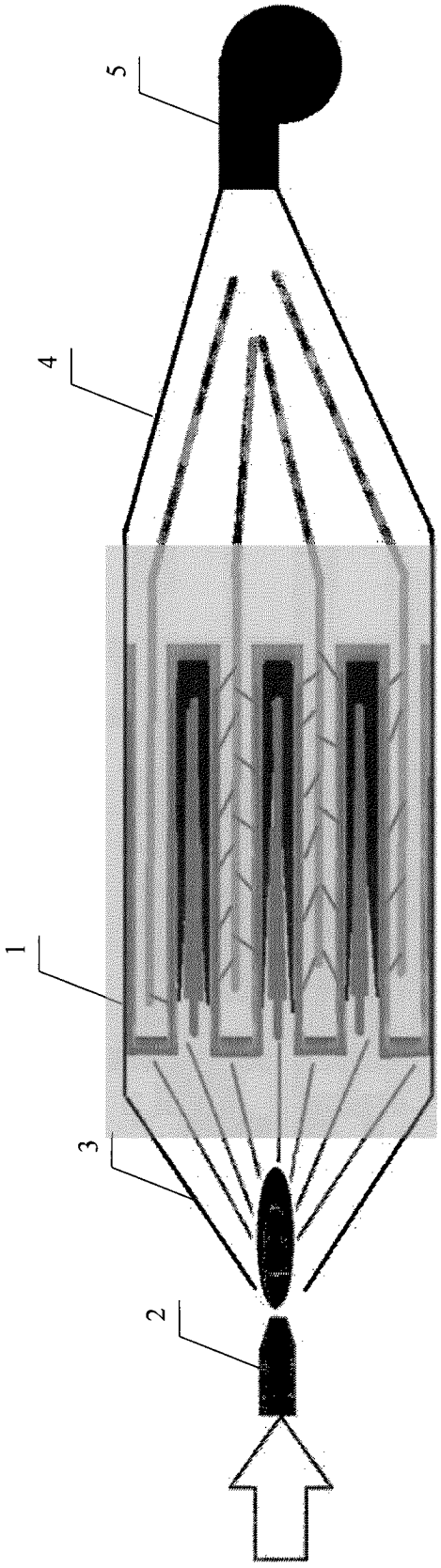

Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 24 47 2001

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 110 107 380 A (HUNAN GAINTOP TECH CORPORATION LIMITED) 9 August 2019 (2019-08-09) * paragraphs [0013] - [0015]; claims 1-5; figures 1-2 *	1-10	INV. F01N3
A	US 2016/047284 A1 (TURGEON LUKE J [US] ET AL) 18 February 2016 (2016-02-18) * paragraphs [0014] - [0025]; claims 1-3; figures 1-2 *	1-10	
A	US 2010/307339 A1 (TADROUS TED N [CA] ET AL) 9 December 2010 (2010-12-09) * paragraph [0043]; claims 1-6; figures 1-3 *	1-10	
			TECHNICAL FIELDS SEARCHED (IPC) F01N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 March 2024	Seifert, Marco

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 47 2001

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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29-03-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 110107380 A	09-08-2019	NONE	
US 2016047284 A1	18-02-2016	NONE	
US 2010307339 A1	09-12-2010	US 2010307339 A1	09-12-2010
		WO 2010144391 A1	16-12-2010

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82