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(54) EXHAUST GAS PROCESSING SYSTEM FOR DIESEL ENGINE

(57) An exhausted gas processing system for a diesel engine is provided. The exhausted gas processing system includes: a low temperature heater, arranged at downstream of an exhaust pipe of the diesel engine; and a particulate trap, connected with the low temperature heater. The low temperature heater includes: a housing; a glow plug, fixed to the housing via a glow plug seat; a combustion chamber including an open end and a closed end, where a sidewall of the combustion chamber close to the closed end is connected to the glow plug seat and fixed in the housing via the glow plug seat; and an intake pipe, where fresh air is inputted through the intake pipe, an outlet end of the intake pipe is fixed to the sidewall of the combustion chamber, arranged between the glow plug seat and the open end, and extends into the combustion chamber. A centerline of the outlet end of the intake pipe is eccentrically arranged with respect to a centerline of the combustion chamber, so that fresh air inputted from the intake pipe flows along the sidewall of the combustion chamber.

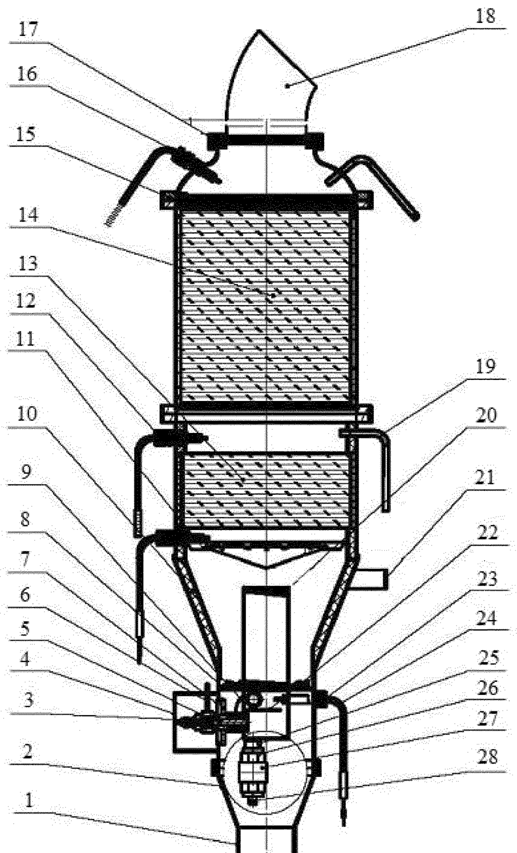

Figure 1

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Description

FIELD

[0001] The present disclosure relates to the field of exhausted gas processing of a diesel vehicle. Specifically, the present disclosure relates to an exhausted gas processing system and a regeneration method for heating and filtering the exhausted gas of a diesel vehicle, and regenerating a used particulate trap.

BACKGROUND

[0002] With the implementation of the Euro 5 emission standard, the diesel particulate filter (DPF) has become an indispensable technology for diesel vehicles. In recent years, with the increase of motor vehicles, the motor vehicles emission has gradually become the main source of air pollution in large cities of China. In the source of atmospheric PM2.5 in Beijing, the exhaust emission of motor vehicles accounts for up to 22%. Moreover, particulates emitted by motor vehicles are mainly derived from diesel vehicles. With the establishment of increasingly strict control regulations for diesel vehicle emission of China in recent years, the application of DPF will have a broad market prospect.

[0003] In diesel engines, the diesel fuel is burnt based on auto-ignition of different air/fuel mixtures. If the combustion is insufficient, particulates are generated due to oxygen deficiency. Such particulates primarily include carbon (carbon black), sulfates, and insufficiently combusted hydrocarbons. To filter out such particulates, diesel particulate filters have been disclosed in the conventional art.

[0004] In a case that a diesel particulate filter is used, the exhaust back pressure generally rises due to an increase in the filter load. Passive or active regeneration of the filter is necessary because an exhaust back pressure exceeding the allowable value is not tolerable for the engine manufacturer, and no maintenance cost due to filter evacuation is expected.

[0005] In general, an active diesel particulate filter system includes "electric regeneration system" or "combustor support system". With the system, the regeneration of the DPF may be manually triggered or may be triggered in response to open loop or closed loop control by monitoring the exhaust back pressure.

[0006] In the conventional art, the combustor is generally designed to include an ejector having a small opening, so that fuel is atomized in the combustion chamber. In the combustion chamber, the fuel is mixed with air necessary for combustion. A disadvantage of this design is that coking may quickly occur at the tiny atomizing opening of the nozzle due to combustion residues, disturbing the operation of the combustor. For example, combustion residues are formed in a case that the combustor is turned off.

[0007] In addition, the currently designed combustor structure is relatively complicated. The conventional combustor has a complicated manufacturing process and a high cost, and problems are prone to occur during the operation of the conventional combustor, for example, as discussed in Chinese Patent Application No. 201310019585.7. In addition, for some combustors, the DPF can only be regenerated in a case that the vehicle is parked or idling, and cannot be regenerated in a case that the vehicle accelerates or travels at a high speed, as discussed in Chinese Patent Application No. 200780021783.1.

[0008] Therefore, it is required in the art an exhausted gas processing system that is capable of heating gas exhausted from a diesel engine to reach the regeneration temperature of the diesel particulate filter, and achieving the regeneration of the particulate trap in a case that the vehicle travels at a high speed or even accelerates.

SUMMARY

[0009] In order to achieve the above object, the inventors of the present application propose a simple structure to realize fuel combustion and exhausted gas heating. In this structure, according to the principle of eccentric air intaking, the introduced fresh air forms a vortex in the combustion chamber, to intensively mix with the fuel gas, so as to improve the combustion efficiency. Then, the flame generated by the combustion is directly introduced into a mixing chamber of the particulate trap and intensively mixed with the gas exhausted from the exhaust pipe, so as to raise the temperature of the exhausted gas and realize the regeneration of the particulate trap.

[0010] In view of the foregoing problems, an exhausted gas processing system for a diesel engine is provided in the present disclosure, which is capable of heating and igniting the diesel and introduced fresh air rapidly in various complicated operating conditions, particularly in a low temperature condition. Thus the exhausted gas is rapidly heated to reach a temperature required for the regeneration of the particulate trap, so that the carbon particles accumulated in the particulate trap can be quickly removed through combustion in a short time period, thereby realizing real time online regeneration.

[0011] An exhausted gas processing system for a diesel engine is provided in a first aspect of the present disclosure. The exhausted gas processing system includes: a low temperature heater, arranged at downstream of an exhaust pipe of the diesel engine; and a particulate trap, connected with the low temperature heater, where the particulate trap is configured to trap particulates from engine exhausted gas. The low temperature heater includes: a housing that is in fluid communication with the exhaust pipe of the diesel engine; a glow plug, fixed to the housing via a glow plug seat and configured to introduce fuel, preheat the fuel, and ignite the fuel; a combustion chamber including an open end and a closed end, where a sidewall of the combustion chamber close to the closed end is connected to the glow plug seat and fixed in the housing via the glow plug seat, an end of the glow plug is aligned with an inner space of the combustion chamber; and an intake pipe, where fresh air is inputted through the intake pipe, an outlet end of the intake pipe is fixed to the sidewall of the combustion chamber, arranged between the glow plug seat and the open end, and extends into the combustion chamber, and where a centerline of the outlet end of the intake pipe is eccentrically arranged with respect to a centerline of the combustion chamber, so that fresh air inputted from the intake pipe flows along the sidewall of the combustion chamber.

[0012] The exhausted gas processing system according to the present disclosure can not only perform real time online regeneration of the particulate trap with accumulated soot, that is, the DPF, in a case that the vehicle is parked or at an idling speed, but also can perform real time online regeneration of the particulate trap with accumulated soot, that is, the DPF, in a case that the vehicle travels at a high speed or accelerates. More importantly, compared with conventional exhausted gas processing systems, the DPF online regeneration time for the exhausted gas processing system according to the present disclosure is significantly reduced, even accounting for only half of the regeneration time for the conventional exhausted gas processing systems.

[0013] In the exhausted gas processing system according to the first aspect, a rotating piece is further arranged at periphery of the sidewall of the combustion chamber, the rotating piece is arranged between the outlet end of the intake pipe and the open end of the combustion chamber, and configured to rotate gas exhausted from the exhaust pipe.

[0014] In the exhausted gas processing system according to the first aspect, the rotating piece is composed of an annular metal piece, trapezoidal or triangular cutouts are uniformly distributed on the rotating piece, and the metal piece cut along the cutout is bent or buckled in a direction of the open end of the combustion chamber for guiding flowing of the exhausted gas.

[0015] In the exhausted gas processing system according to the first aspect, a spiral heating wire is further provided at the open end of the combustion chamber, and configured to block and heat a portion of fuel droplets.

[0016] In the exhausted gas processing system according to the first aspect, the low temperature heater is in communication with a housing in which the particulate trap is mounted, the housing includes the particulate trap at the rear and a mixing chamber at the front, an outlet end of the housing extends into the mixing chamber, and the exhaust pipe of the diesel engine extends into the mixing chamber in an eccentric manner.

[0017] In the exhausted gas processing system according to the first aspect, a wall flow type honeycomb ceramic filter or an oxidation type catalyst is further provided between the low temperature heater and the particulate trap, and configured to remove hydrocarbons and a portion of particulates from the exhausted gas.

[0018] In the exhausted gas processing system according to the first aspect, the wall flow type honeycomb ceramic filter or the oxidation type catalyst is made of cordierite, silicon carbide or recrystallized silicon carbide.

[0019] Compared with the conventional art that the ignition is stable and the later installed DPF is regenerated only in a case that the vehicle is parked or idling, with the exhausted gas processing system according to the present disclosure, stable ignition and uniform regeneration of the blocked DPF can be achieved in a case that the vehicle accelerates or event travels at a high speed. Without being limited by certain theory, the flame generated in this way is strongly pushed into the exhausted gas, the flame cannot be blown out even if the exhaust speed is fast or increases, thereby achieving stable ignition and regeneration.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The present disclosure is described with reference to the drawings hereinafter. It should be understood that the drawings are only intended to explain and demonstrate principles of the disclosure by examples, rather than limiting the disclosure to the detailed solutions shown in the drawings. In the drawings:

Figure 1 is a schematic diagram of an exhausted gas processing system for a diesel engine according to an embodiment of the present disclosure;
Figure 2 is a perspective view of a rotating piece according to an embodiment of the present disclosure;
Figure 3 is a schematic view showing working principles of a wall flow type honeycomb ceramic filter according to an embodiment of the present disclosure; and
Figure 4 is a schematic view showing working principles of an oxidation type catalyst according to an embodiment of the present disclosure.

Reference numerals:

[0021] 1: straight pipe; 2: flange; 3: pad; 4: glow plug cover; 5: glow plug; 6: glow plug oil pipe; 7: glow plug seat; 8: rotating piece; 9: manifold; 10: outlet end cap; 11: baffle flow; 12: temperature sensor; 13: DOC; 14: DPF; 15: outlet end cap; 16: temperature sensor; 17: end cap flange; 18: tail pipe; 19: piezometric pipe; 20: heating wire; 21: differential pressure fixing frame; 22: blocking plate; 23: sensor joint; 24: temperature sensor; 25: elbow; 26: straight pipe joint; 27: check valve; 28: pagoda head.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] Hereinafter, an exhausted gas processing system according to the present disclosure is to be described in detail with reference to the drawings. It should be understood by those ordinarily skilled in the art that the various embodiments of the present disclosure described below are only used to enable those ordinarily skilled in the art to understand the present disclosure without any limitation. The scope of the present disclosure is defined by the claims.

[0023] Figure 1 shows a schematic diagram of an exhausted gas processing system 100 according to an embodiment of the present disclosure. The exhausted gas processing system 100 is installed at downstream of an exhaust pipe of a diesel engine for processing gas exhausted from the exhaust pipe, so as to remove nitrogen oxides and most of the particulates from the exhausted gas, such as removing more than 95% of the particulates. Different from most conventional processing systems in which only fuel is injected to promote combustion so as to regenerate the DPF, in the exhausted gas processing system 100 according to the present disclosure, an exhaust temperature of the diesel engine is raised by igniting fuel-air mixture and utilizing heat generated by combustion, thereby achieving reliable combustion and regeneration of the DPF under various operating conditions, especially in harsh environments, even under a condition in which the exhausted gas processing system 100 according to the present disclosure is used in extreme temperatures.

[0024] In an embodiment, housings of these components are all made of steel, preferably made of stainless steel. In this way, surfaces of these components can maintain bright, thereby reducing dust accumulation and corrosion. In another embodiment, the components are connected via flanges. This connection manner can facilitate the installation, removal and replacement of these components. Practically, these components may also be connected by other connection manners that are well known to those skilled in the art, such as welding.

[0025] A straight tube 1 is connected with an exhaust port (not shown) of the diesel engine, and is configured to receive and process gas exhausted from the engine. A component connected to the straight pipe 1 is a low temperature heater including an oil pipe, a gas pipe and a glow plug and so on. In an example, fuel from the oil inlet pipe and fresh air from the air inlet pipe are received and combusted by the low temperature heater. The fuel may be fuel from an engine, such as diesel. Alternatively, the fuel may be separately provided liquid or gas fuel, such as propane and ethanol.

[0026] The low temperature heater may be configured to perform heat transfer with gas exhausted from the engine exhaust pipe. For example, the low temperature heater may be directly arranged in a flow path of the exhausted gas, and is configured to heat the exhausted gas flowing into the housing to a relative high temperature, in which the efficiency of the oxidation type catalyst (DOC) arranged at the downstream can be enhanced and regeneration of the particulate trap 14 (DPF) can be set at the downstream. Alternatively, the low temperature heater can be further configured to preheat the exhaust system before starting the engine, so as to improve the efficiency of the exhaust system when the engine is started, thereby reducing emissions of a cold start.

[0027] A low temperature heater according to an embodiment is to be described in detail with reference to Figure 1 hereinafter. The low temperature heater includes: a housing, a glow plug, a combustion chamber, and an intake pipe. The housing is in fluid communication with an exhaust pipe of a diesel engine. The glow plug is fixed to the housing via a glow plug seat, and is configured to introduce fuel, preheat the fuel, and ignite the fuel. The combustion chamber includes an open end and a closed end, a sidewall of the combustion chamber close to the closed end is connected to the glow plug seat and fixed in the housing via the glow plug seat, and an end of the glow plug is aligned with an inner space of the combustion chamber. Fresh air is inputted from the intake pipe. An outlet end of the intake pipe is fixed to the sidewall of the combustion chamber, is arranged between the glow plug seat and the open end, and extends into the combustion chamber. A centerline of the outlet end of the intake pipe is eccentrically arranged with respect to a centerline of the combustion chamber, so that fresh air introduced from the intake pipe flows along the sidewall of the combustion chamber.

[0028] For example, the housing may be made of the stainless steel material and may have a straight tube cylinder shape. The housing is configured to be in fluid communication with an exhaust pipe of the diesel engine (not shown) through a connecting flange 4, and accommodate and heat gas exhausted from the exhaust pipe.

[0029] The glow plug 5 is connected to a sidewall of the housing via the glow plug seat 7, and is covered with a square or circular glow plug cover 4, to protect the glow plug 5. The glow plug 5 may be an electric spark plug commonly used in diesel vehicles or a high temperature ignition rod, for igniting fuel from an oil inlet pipe, for example. In a case that the glow plug is the high temperature ignition rod, the glow plug may be a high temperature silicon nitride rod or a boron nitride rod containing a high temperature heating wire, such as a tungsten wire. However, the present disclosure is not limited to the above example, as long as the glow plug can generate a high temperature and ignite the fuel. Preferably, a fuel passage (not shown) is provided inside the glow plug 5, so that the fuel enters the fuel passage via the glow plug oil pipe 6, and the fuel is heated to facilitate subsequent combustion.

[0030] The combustion chamber has a tubular shape and is connected and fixed to the housing via the glow plug seat 7. The combustion chamber includes a closed end and an open end. The open end faces an exhaust direction of the diesel engine, for outputting a hot airflow generated by the combustion of the fuel. The closed end, that is, the combustion chamber bottom plate, is configured to guide the generated hot airflow to flow toward the direction of the open end, and block the generated hot airflow from flowing toward an opposite direction of the exhaust direction, so as to improve the thermal efficiency. In an embodiment, the combustion chamber is made of a high temperature resistant metal, such as the stainless steel.

[0031] An intake component is provided at the closed end of the combustion chamber, namely an intake component consisting of a pagoda head 28, a check valve 27, a straight pipe joint 26 and an elbow 25. Due to the check valve, the gas can only be inputted into the combustion chamber from the outside (for example, via a gas pump), and cannot be outputted from the combustion chamber, thereby ensuring the stability of the air pressure in the combustion chamber.

[0032] The intake pipe may be a manifold 9. A first branch of the manifold 9 extends into the combustion chamber in an eccentric manner. An advantage of such an arrangement is that the fresh air inputted through the intake pipe flows along the sidewall due to the impact of the sidewall of the combustion chamber after entering the combustion chamber, thereby forming a swirl flow in the combustion chamber, facilitating intensive mixing with the fuel from the ignition plug, and facilitating driving a flame to swirl, so that the hot airflow generated by the flame is intensively mixed with gas exhausted from the engine. Practically, in an alternative embodiment, a first outlet of the manifold 9 may also be inserted into the combustion chamber in a manner of aligning with a center of the combustion chamber, thereby facilitating combustion and aid mixing. A second branch of the manifold 9 extends into the glow plug to deliver a portion of fresh air into the ignition plug for mixing with the fuel, so as to provide an initial combustion mixture. Generally, the ratio of the amount of fresh air inputted through the first branch (for example, by volume) to the amount of fresh air inputted through the second branch ranges from 9:1 to 1:1, for example, 8:1. 7:1, 6:1, 5:1, 4:1, 3:1 or 2:1, or any value in a range of 9:1 to 1:1. By changing the amount of fresh air outputted through the first outlet and the second outlet, a fuel-air ratio in the combustion chamber can be flexibly changed to achieve different combustion conditions. For example, in a case that the diesel engine is stopped or idling, the ratio may be appropriately increased, for example, 8:1. Because the exhausted gas amount at this time is relatively small, and the exhausted gas occupies a low proportion of the gas in the combustion chamber, thus a relatively small amount of fresh air can maintain the sufficient combustion of the fuel. In contrast, in a case that the diesel engine accelerates or operates at a high speed, the exhausted gas amount is relatively large, and the exhausted gas occupies a high proportion of the gas in the combustion chamber. In this case, more fresh air is required to be delivered into the ignition plug to achieve the sufficient combustion of the fuel.

[0033] In addition, in order to promote the mixing of the hot airflow and the exhausted gas, an annular rotating piece 8 is further sleeved on an outer peripheral wall of the combustion chamber close to the straight pipe, as shown in Figure 2. For example, the rotating piece 8 is made of the stainless steel material. Triangular or trapezoidal notches are equidistantly arranged in an annular portion of the rotating piece 8, and fins generating these notches are obliquely bent or buckled in the exhaust direction, thereby guiding the airflow to rotate clockwise or counterclockwise to form a swirling airflow, and thus further improving the mixing effect of the hot airflow and the exhausted gas.

[0034] In addition, a spiral heating wire 20 is further provided at the open end of the combustion chamber. The spiral heating wire is configured to block fuel droplets that have not been fully burned from being directly ejected out from the straight tube, and heat to vaporize the fuel droplets.

[0035] In order to monitor the gas temperature in the housing conveniently, a temperature sensor 24 is further provided on the sidewall of the housing, opposite to the glow plug 5. The temperature sensor 24 is fixed to the sidewall of the housing 11 via a sensor base 17. In an embodiment, two, three or four temperature sensors 24 are equidistantly arranged.

[0036] In order to further enhance the swirling effect, a semicircular or square blocking plate 22 is provided between the glow plug 5 and the straight tube on the sidewall of the combustion chamber, and is configured to block the air inputted through the manifold 9 from directly contacting with the glow plug 5. The air entering the combustion chamber through the manifold 9 is swirled due to the blocking plate 22, and then is mixed with the flame ejected from the outlet of the glow plug 5, thereby enhancing the combustion effect. In addition, the blocking plate 22 also blocks the flame ejected from the outlet of the glow plug 5 from directly entering the manifold 9.

[0037] In another embodiment, the gas exhausted from the engine enters the low temperature ignition apparatus through the intake pipe, and is discharged through a splitter and a flow collecting cover. The gas of the air pump enters through the intake pipe, flows through an igniter and an ignition cylinder, and carries the burning flame at the igniter to the flow collecting cover, to heat the gas from the engine. The gas from the engine mixes with the gas of the air pump, and thus a high temperature gas is formed and discharged. By providing the splitter and the flow collecting cover, the hot airflow generated by the combustion and the gas exhausted from the engine are firstly mixed to form a swirling airflow, and then intensive mixing is achieved through a small convergence, thereby facilitating the uniform regeneration of the DPF, effectively preventing the rupture of the DPF caused by uneven heating during the regeneration, and prolonging a service life of the DPF. In addition, the uniform mixing also greatly improves the thermal efficiency, reduces the fuel consumption during the regeneration process, and achieves further energy saving and emission reduction.

[0038] In another embodiment, the low temperature heater is in communication with a housing in which a particulate trap is mounted. The housing includes the particulate trap at the rear and a mixing chamber at the front, and an outlet end of the housing extends into the mixing chamber, and the exhaust pipe of the diesel engine extends into the mixing chamber in an eccentric manner. Thus, the exhausted gas entering the mixing chamber forms a swirling airflow, thereby facilitating intensively mixing with the hot airflow generated by the combustion, and thus achieving uniform regeneration of the DPF. In addition, an advantage of such arrangement is that the low temperature heater can form a curved fit with the exhaust pipe instead of a linear fit, thereby facilitating flexible installation and improving the adaption performance of the low temperature heater.

[0039] As one of the core components of the exhausted gas processing system 100, the particulate trap 14, that is, the DPF, may be a wall flow type honeycomb ceramic filter generally used in the art, such as a wall flow type honeycomb ceramic filter made of cordierite, silicon carbide or recrystallized silicon carbide. The advantage of the wall flow type honeycomb filter is that most of the particulates in the exhausted gas can be removed, for example more than 95% of the particulates, so that the highest discharge requirement for the particulates is met. The working principle of the wall flow type honeycomb ceramic filter is shown in Figure 3. Referring to Figure 3, the particulates are trapped in the honeycomb filter which is provided with holes separated from each other, and are removed by combustion after accumulating to a certain amount, thereby realizing the regeneration of the filter.

[0040] In an embodiment, preferably, a wall flow type honeycomb ceramic filter made of recrystallized silicon carbide, is used, such as a recrystallized silicon carbide honeycomb ceramic wall flow particulate filter (DPF) of "Huang Di" brand. The filter captures particulates in the diesel exhausted gas through a porous partition wall between interactive blocked honeycomb channels, and has an extremely strong capability to capture soot ultrafine nanoparticles. In addition, the filter has a large filtration area, a low pressure drop, a compact structure, excellent properties of high temperature resistance, corrosion resistance and thermal conduction, high mechanical strength, strong thermal shock resistance, and a long service life.

[0041] The main parameters of this filter are shown in Table 1 below:

Table 1: Main parameters of a wall flow type honeycomb ceramic filter made of recrystallized silicon carbide

Technical feature	Unit	
SiC content	%	>99
The number of honeycomb lattices in per square inch	cpsi	200~300
Side length of the honeycomb lattice	mm	1.20~1.45
Honeycomb wall thickness	mm	0.30~0.35
Porosity	%	42~60
median aperture	μm	9~20
Compressive strength	MPa	>13~18
Thermal expansion rate (40~800°C)	10^{-6}	4.30~4.40
Thermal conductivity(500°C)	W/mK	>14
Capturing rate	%	>98~99
Honeycomb volume density	Kg/L	~0.80
Filtration area	m^2/L	~0.75
permeability	m^2	$<5.0\times10^{-12}$
heat shock resistant parameter (ΔT)	°C	250

[0042] The filter is tested by Tianjin SwARC Automotive Research Laboratory Co., Ltd., according to the internationally approved VERT test specification. The pressure drop characteristics meet the requirements, the average of filtration efficiency for particle weight analysis is 96.50%, and the filter is authenticated by the Chinese Environment Protection

Product Authentication Mechanism.

[0043] Preferably, an oxidation type catalyst 13 is further arranged between the low temperature heater (or a spoiler) and the particulate trap, that is a DOC well known in the art (shown in Figure 4). The DOC is provided to remove hydrocarbons and a portion of particulates from the exhausted gas. For example, the DOC may be those commonly used DOC in current diesel engines.

[0044] In oxidation type catalysts used in automotive diesel engines, noble metals such as platinum (Pt) and palladium (Pd) are used as catalysts to reduce the content of soluble organic components (SOF) in particulate emissions, thereby reducing the emission of PM. In addition, HC and CO in the exhausted gas can be effectively reduced. The oxidation type catalyst is capable of removing 90% of the SOF, thereby reducing PM emissions by 40% to 50%. The processing efficiency for HC and CO can reach 88% and 68%, respectively. Catalytic oxidation technology has a good effect in removing SOF from diesel engine exhausted particles, that is, a catalytic converter is added in the diesel exhaust system, and SOF is converted into CO2 and H2O and removed, through an oxidation reaction under the catalytic function of noble metal catalysts such as platinum, rhodium and palladium, or rare earth catalysts, and generally, a removal efficiency for the SOF is up to 80%. In addition, harmful substances such as HC and CO in the exhausted gas can be removed. For example, substances, such as CO, HC, SOF, and PAH, in the exhausted gas of the diesel engine, are oxidized and converted by the DOC, the acquired products are mainly CO2 and H2O, so that the exhausted gas is partially purified.

First Embodiment: Combustion of a low temperature heater in an idling condition

[0045] The configuration of the low temperature heater is shown in Figure 1, which is not described here. The low temperature heater is line-mounted to the engine exhaust pipe. The engine is an engine of a diesel vehicle of Dong Feng Motor Corporation, with a displacement of 2.8 liters. A comparative example is the low temperature heater disclosed in Chinese Patent Application No. 200780021783.1.

[0046] First, the engine is started; the low temperature heater is preheated and ignited according to the program in the conditions of idling, accelerating and operating at a high speed; the ignition reliability of the flame in the idling condition is observed, that is, whether the ignition is stable is observed, and whether the flame is blown out by the exhausted gas is observed, and observation results are recorded.

[0047] Next, a used diesel particulate filter, that is, DPF (which accumulates a large amount of soot, but the DPF is intact) is installed at the outlet end of the low temperature heater, and a regeneration experiment is conducted based on the program. During the experiment, it is observed whether the combustion in the DPF is uniform and multiple temperatures are recorded. It is detected whether a crack occurs in the DPF when the experiment ends.

Second Embodiment: Combustion of a low temperature heater in a high speed and acceleration condition

[0048] The configuration of the low temperature heater is shown in Figure 1, which is not described here. The low temperature heater is line-mounted to the engine exhaust pipe. The engine is an engine of a diesel vehicle of Dong Feng Motor Corporation, with a displacement of 2.8 liters. A comparative example is the low temperature heater disclosed in Chinese Patent Application No. 200780021783.1.

[0049] First, the engine is started; the low temperature heater is preheated and ignited according to the program in the conditions of idling, accelerating and operating at a high speed, the ignition reliability of the flame in idling is observed, that is, it is observed whether the ignition is stable and whether the flame is blown out by the exhausted gas, and observation results are recorded.

[0050] Next, a used diesel particulate filter, that is, DPF (which accumulates a large amount of soot, but the DPF is intact) is installed at the outlet end of the low temperature heater, and a regeneration experiment is conducted based on the program. During the experiment, it is observed whether the combustion in the DPF is uniform and multiple temperatures are recorded. It is detected whether a crack occurs in the DPF when the experiment ends.

[0051] Finally, the regenerated DPF is weighed and an ash cleaning rate is calculated based on the DPF weight before regeneration. An average of multiple ash cleaning rates is calculated to characterize the regeneration degree.

[0052] Results of the first embodiment and second embodiment are shown in Table 2

Table 2: results of the first embodiment and second embodiment

	The present disclosure				Comparative example			
Index	Ignition Times	Combustion uniformity	crack	Average ash cleaning rate (%)	Ignite times	Combustion uniformity	crack	Avera ge ash cleani ng rate (%)
First Embodiment	5 / 5	uniform	no	92%	5 / 5	uniform	no	85%
Second Embodiment	5 / 5	uniform	no	89%	5 / 5	-	-	-

[0053] In the first embodiment and the second embodiment, the low temperature heater according to the present disclosure is stably ignited in both the first embodiment and the second embodiment, and the DPF in which the soot is accumulated can be stably regenerated, the ash cleaning rate reaches about 90%, thereby indicating that the regeneration effect of the DPF is good, and a case where the DPF is broken or cracks does not occur in either the first embodiment or the second embodiment.

[0054] Further, in a case of ensuring the regeneration of DPF of 90% or more, the low temperature heater according to the present disclosure can regenerate the DPF by consuming an average time of about 10 minutes, while in the comparative example, about 20 minutes or even up to 30 minutes are consumed to realize the regeneration of the DPF. In this way, with the system according to the present disclosure, the fuel consumption for system regeneration is significantly reduced, and the service life of the ignition rod is extended.

[0055] In contrast, in the comparative example, the average ash cleaning rate of the DPF is only about 85% in the idling state. Moreover, in the state of acceleration and operating at a high speed, a small flame is observed, and the temperature at the inlet end of the DPF is low, only about 300 °C, not meeting the temperature requirement of DPF regeneration, so the ash cleaning rate is almost zero. That is, the low temperature heater disclosed in the comparative example in this state cannot regenerate the DPF at all.

[0056] It can be seen from the above experimental data that the low temperature heater according to the present disclosure is superior to the low temperature heater of the comparative example in terms of ignition reliability or stability, DPF ash cleaning rate, etc., in any of the idling state, accelerating state or high speed operating state.

[0057] The above-described embodiments are only preferred embodiments of the present disclosure, and are intended to illustrate the present disclosure rather than limiting the present disclosure. Any modifications, equivalent substitutions and improvements made within the spirit of the present disclosure and the protection scope of the claims fall in the scope of protection of the present disclosure.

Claims

1. An exhausted gas processing system for a diesel engine, comprising:

a low temperature heater, arranged at downstream of an exhaust pipe of the diesel engine; and
a particulate trap, connected with the low temperature heater, wherein the particulate trap is configured to trap particulates from engine exhausted gas,
wherein the low temperature heater comprises:

a housing, in fluid communication with the exhaust pipe of the diesel engine;
a glow plug, fixed to the housing via a glow plug seat and configured to introduce fuel, preheat the fuel, and ignite the fuel;
a combustion chamber comprising an open end and a closed end, wherein a sidewall of the combustion chamber close to the closed end is connected to the glow plug seat and fixed in the housing via the glow plug seat, an end of the glow plug is aligned with an inner space of the combustion chamber; and
an intake pipe, wherein fresh air is inputted through the intake pipe, an outlet end of the intake pipe is fixed to the sidewall of the combustion chamber, arranged between the glow plug seat and the open end, and extends into the combustion chamber, and wherein a centerline of the outlet end of the intake pipe is eccentrically arranged with respect to a centerline of the combustion chamber, wherein the fresh air inputted from the intake pipe flows along the sidewall of the combustion chamber.

2. The exhausted gas processing system according to claim 1, wherein a rotating piece is further provided at periphery of the sidewall of the combustion chamber, the rotating piece is arranged between the outlet end of the intake pipe and the open end of the combustion chamber, and configured to rotate gas exhausted from the exhaust pipe.

3. The exhausted gas processing system according to claim 2, wherein the rotating piece is composed of an annular metal piece, trapezoidal or triangular cutouts are uniformly distributed on the rotating piece, and the metal piece cut along the cutout is bent or buckled in a direction of the open end of the combustion chamber for guiding flowing of the exhausted gas.

4. The exhausted gas processing system according to claim 1, wherein a spiral heating wire is further provided at the open end of the combustion chamber and configured to block and heat a portion of fuel droplets.

5. The exhausted gas processing system according to claim 1, wherein the low temperature heater is in communication with a housing in which the particulate trap is mounted, the housing comprises the particulate trap at the rear and a mixing chamber at the front, an outlet end of the housing extends into the mixing chamber, and the exhaust pipe of the diesel engine extends into the mixing chamber in an eccentric manner.

6. The exhausted gas processing system according to claim 1, wherein a wall flow type honeycomb ceramic filter or an oxidation type catalyst is further provided between the low temperature heater and the particulate trap, and configured to remove hydrocarbons and a portion of particulates from the exhausted gas.

7. The exhausted gas processing system according to claim 6, wherein the wall flow type honeycomb ceramic filter or the oxidation type catalyst is made of cordierite, silicon carbide or recrystallized silicon carbide.

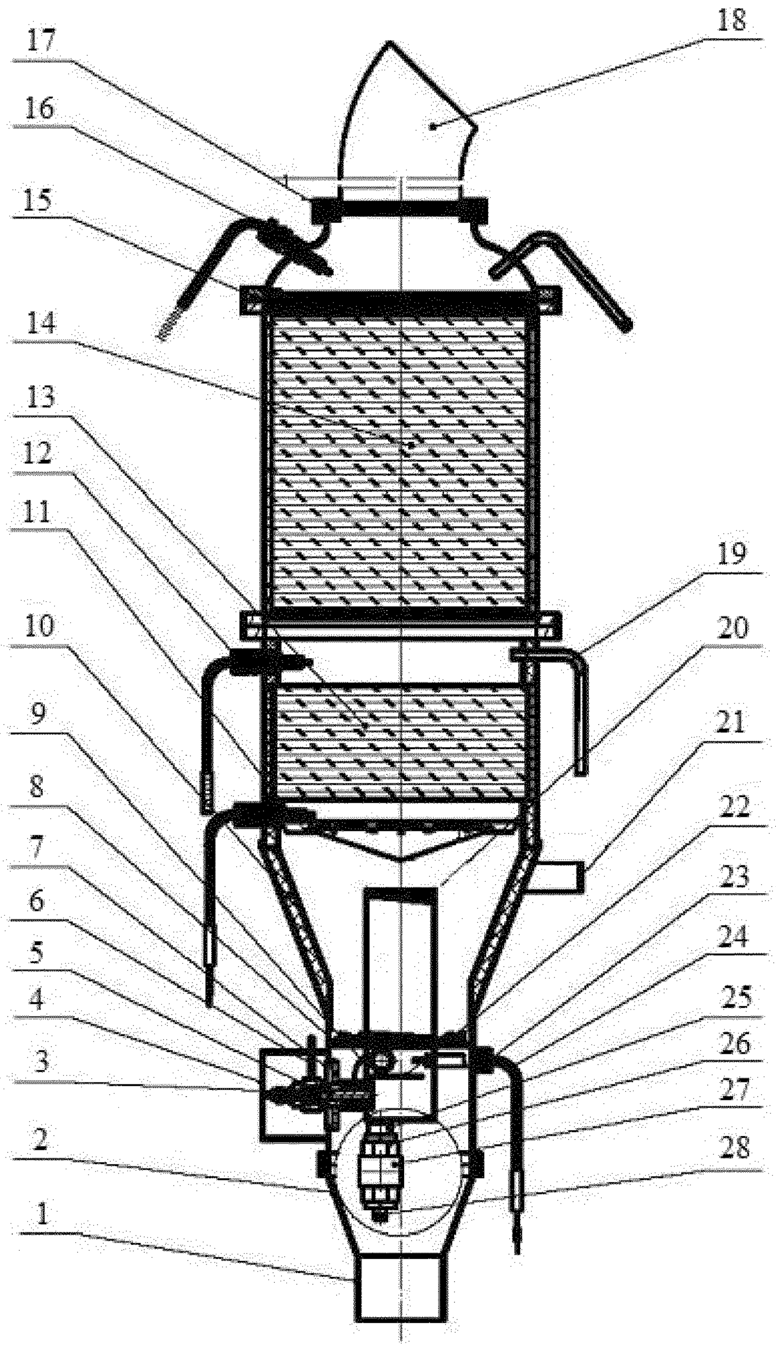

Figure 1

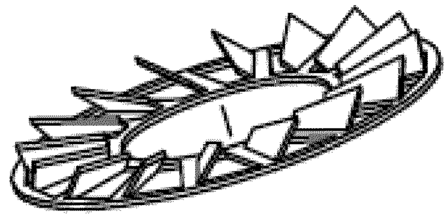

Figure 2

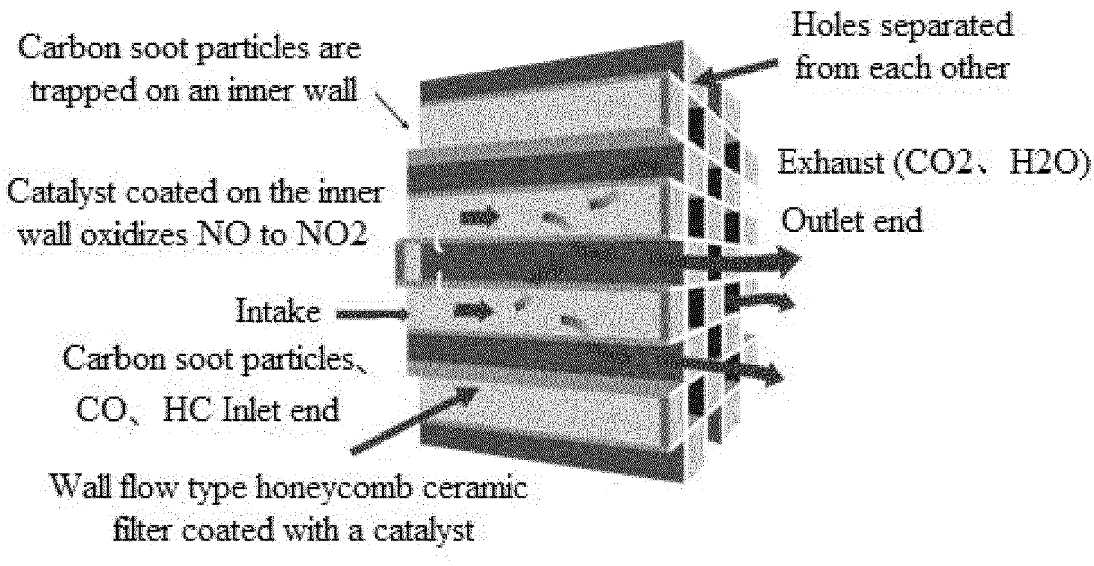

Figure 3

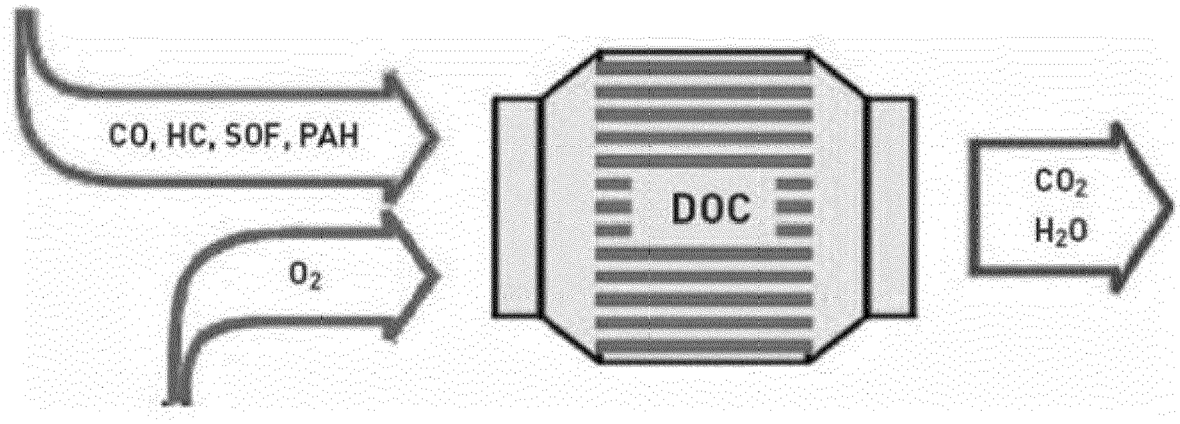

Figure 4

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 3575

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
E	EP 3 444 459 A1 (GUIZHOU HUANGDI DIESEL ENGINE CLEANER CO LTD [CN]) 20 February 2019 (2019-02-20) * paragraphs [0030], [0033], [0034]; claims 1,2,3; figure 2 * -----	1-3,5-7	INV. F01N3/10 F01N3/021 F01N3/025 F01N3/027
A	KR 100 828 157 B1 (TEMS CO LTD [KR]) 8 May 2008 (2008-05-08) * paragraphs [0041], [0042], [0043]; figures 3,4,5 * -----	1-7	
A	US 2011/197570 A1 (KALANTARIFIROOZABAD KEIVAN [CA] ET AL) 18 August 2011 (2011-08-18) * paragraph [0033]; figures 3,6 * -----	1-7	
A	US 2010/319330 A1 (HONG SOON CHUL [KR] ET AL) 23 December 2010 (2010-12-23) * paragraphs [0052] - [0068]; figure 4 * -----	1-7	TECHNICAL FIELDS SEARCHED (IPC)
A	KR 2012 0096734 A (INHA IND PARTNERSHIP INST [KR]; LEE CHANG EON [KR]) 31 August 2012 (2012-08-31) * abstract; figures 1-3 * -----	1-7	F01N

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 March 2019	Blanc, Sébastien

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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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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08-03-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3444459 A1	20-02-2019	NONE	
KR 100828157 B1	08-05-2008	NONE	
US 2011197570 A1	18-08-2011	NONE	
US 2010319330 A1	23-12-2010	CN 101929371 A	29-12-2010
		KR 100929611 B1	03-12-2009
		US 2010319330 A1	23-12-2010
		WO 2010147261 A1	23-12-2010
KR 20120096734 A	31-08-2012	NONE	

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- CN 201310019585 **[0007]**
- CN 200780021783 **[0007] [0045] [0048]**