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Process for eliminating particulates in exhaust gas
Verfahren zum Entfernen von Teilchen aus Abgas
Procédé pour éliminer des particules des gaz d'échappement

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Description

BACKGROUND OF THE INVENTION

Field of Invention.

[0001] The present invention is related to a method for eliminating particulates contained in exhaust gas to eliminate and decompose floating particulates (SPM) contained in exhaust gas generated from diesels for ships, surface transportation vehicles and overland fixed uses.

Background Art

[0002] In the past, DPF (Diesel Particulate Filter) using a honeycomb-shaped filter made of ceramics, etc. has been proposed for decomposing floating particulates (SPM, hereinafter called as “Particulates”) contained in exhaust gas generated from diesels for ships, surface transportation vehicles and overland fixed use, wherein the particulates are captured by DPF, and DPF which had captured a great amount of the particulate is burned to eliminate the particulates for the regeneration of the filter since the exhaust resistance increases when the accumulation of the captured particulates became heavy.

[0003] As the regeneration method, a method to improve exhaust temperature by throttling, and a method to burn the un-burned component of the captured particulates after elevating the exhaust gas temperature by means of heating using a heater, supplemental burning, etc. are known.

[0004] However, there is a problem as follows in the decomposing method of the particulates in the past.

1) Due to the repetition of thermal impact in the regeneration, damage to the honeycomb-shaped ceramics filter may occur.
2) Due to generation of abnormal burning, the thermal resistance and the thermal shock resistance of the filter material deteriorate, thus causing damage to the filter.
3) Since utility cost, such as for heating by a heater, for supplemental burning, and for required fuels, may be further required, there is a requirement to reduce the cost for such treatment.
4) When the burning is not sufficient, pressure loss increases to unable the system to use, consequently requiring exchange of the filter itself.

[0005] Considering the problems as described above, it is an object of the present invention to provide a method to eliminate particulates contained in exhaust gas, which requires no heating means, such as a heater, and enable to decompose the particulates in exhaust gas at a low temperature.

[0006] US-A-4 631 076 discloses various arrangements for dispersing a catalyst solution to the exhaust gas in a filter chamber at a position upstream of a filter element mounted within the filter chamber for collecting carbon particles constituting the black fume. A catalyst solution dispersing device in the form of a spray nozzle is disposed within the filter chamber within the exhaust gas stream upstream of the filter element and is directed toward the filter element in order to spray the catalyst solution onto the carbon particles collected in the filter element.

SUMMARY OF THE INVENTION

[0007] The present invention provides a method for eliminating particulates contained in exhaust gas as defined in claim 1. Preferred embodiments of the method are defined in the dependent claims.

[0008] The process for eliminating particulates in exhaust gas according to the present invention is characterized in that the process is constituted by a step to capture the particulates, a step to attach a catalyst solution onto the surface of the captured particulates and a step to burn and decompose the particulates.

[0009] Constituting the process for eliminating particulates in exhaust gas as described above, which captures the particulates in exhaust gas ejected from the motors, attaches a catalyst solution onto the surface of the captured particulates and then burns and decomposes the particulates while covering the particulates with the catalyst solution, it enables to eliminate the particulates in the exhaust gas at a low temperature.

[0010] Preferably, in the process described above, the catalyst solution is sprayed onto the surface of the particulates being attached onto the surface of the capturing means and is attached to the surface of the captured particulates.

[0011] Constituting the process as described above, wherein the catalyst solution is sprayed onto the surface of the particulates being attached onto the surface of the capturing means to attach the catalyst solution onto the surface of the captured particulates, it enables to eliminate the particulates in the exhaust gas at a low temperature.

[0012] Preferably, in the process described above, the capturing means whereinto the particulates having been attached onto the surface thereof is soaked into the catalyst solution to attach the catalyst solution onto the surface of the captured particulates.

[0013] Constituting the process as described above, wherein the capturing means whereinto the particulates having been attached onto the surface thereof is soaked into the catalyst solution to attach the catalyst solution onto the surface of the captured particulates, it enables to eliminate the particulates in the exhaust gas at a low temperature.
BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Various other objects, features, and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood with reference to the following detailed description of the method of the present invention and of preferred embodiments suitable for carrying out this method when considered in connection with the accompanying drawings, in which:

Fig. 1 shows an example for the filter used in the present invention, and Fig. 1(A) is an asquint view of a discoid-shaped filter, and Fig. 1(B) and 1(C) are an asquint view of a cylinder-shaped filter, respectively.

Fig. 2 is a schematic for showing the particulate eliminating device according to the first embodiment for the present invention.

Fig. 3 is a diagram for showing the result of combustion tests on suite and tar comprising the particulates.

Fig. 4 is a schematic for showing the constitution of the filter.

Fig. 5 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the second embodiment for the present invention.

Fig. 6 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the third embodiment for the present invention.

Fig. 7 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the third embodiment for the present invention, which is equipped with a plurality of nozzles.

Fig. 8 is a schematic for showing the vertical type device for eliminating particulates contained in exhaust gas according to the third embodiment for the present invention.

Fig. 9 is a schematic for showing the soaking type device for eliminating particulates contained in exhaust gas according to the third embodiment for the present invention.

Fig. 10 is a schematic for showing filter of which cross section assumes convexo-concave form according to the third embodiment for the present invention.

Fig. 11 is a schematic for showing the discoid-shaped filter according to the third embodiment for the present invention.

Fig. 12 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the fourth embodiment for the present invention.

Fig. 13 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the fifth embodiment for the present invention.

Fig. 14 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the sixth embodiment for the present invention.

Fig. 15 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the seventh embodiment for the present invention.

Fig. 16 is a schematic for showing the device for eliminating particulates contained in exhaust gas according to the eighth embodiment for the present invention.

Fig. 17 shows various types of mounting manners for the filter, and Fig. 17(A) shows single filter mode with either a rotatable cylinder-shaped filter or a fixed type filter, Fig. 17 (B) shows the switchable type filter wherein three filters are arranged in parallel by means of tubing and are used in turn by switching from one to another, and Fig. 17 (C) shows unit type filter constituted by a plurality of filters.

Fig. 18 is a schematic for showing the exhaust gas cleaning up system according to the ninth embodiment for the present invention.

Fig. 19 is a schematic for showing the exhaust gas cleaning up system according to the tenth embodiment for the present invention.

Fig. 20 is a schematic for showing the exhaust gas cleaning up system according to the eleventh embodiment for the present invention.

Fig. 21 is a schematic for showing the exhaust gas cleaning up system according to the twelfth embodiment for the present invention.

Fig. 22 is a schematic for showing the exhaust gas cleaning up system according to the thirteenth embodiment for the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] Now, the embodiments for carrying out the present invention are explained in the following, however, it should be noted that the scope of the present invention should not be limited to the description in the following embodiments.

[0016] The particulate eliminating device for carrying out the present invention is a device to eliminate particulates in exhaust gas expelled from motors, such as diesel engine, gasification furnace, etc. and is constituted by equipping thereon with a capturing means to capture the particulates and a catalyst attaching means to attach the catalyst solution onto the surface of the particulates being captured in the capturing means, thereby burning and decomposing the particulates having been not burned in the exhaust gas while covering the whole particulates being captured with the catalyst solution.

[0017] As the capturing means to capture the particulates, a discoid-shaped filter or a cylinder-shaped filter can be given as examples, however, any filter having a shape capable of capturing the particulates in the exhaust gas and being attached with the catalyst solution,
for example, honeycomb-shaped filter, can be used without limitation.

[First Embodiment]

[0018] Now, as an embodiment for the present invention, a device for eliminating particulates in exhaust gas using a discoid-shaped filter 11 as shown in Fig. 1(A) is explained.

[0019] Fig. 2 is a schematic for the device to eliminate particulates in exhaust gas according to the first embodiment.

[0020] The device for eliminating particulates according to this embodiment is constituted by a discoid-shaped filter 11 having an axial core in vertical axis direction, the part of which filter is rotatably set in the interior of the flue 21, a capturing zone 22 to capture the particulates contained in the exhaust gas 10 in the flue 21, a catalyst carrying zone 24 to spray in the outside of the flue the catalyst solution 12 fed from a catalyst storing tank 23, a catalyst by spraying the alkaline catalyst solution onto the surface of the captured particulates on the filter so as to cover the surface of the particulates with the alkaline catalyst solution to facilitate the absorption and carrying of the alkaline catalyst solution onto the filter, thereby allowing to make the combustion space uniform and enable the catalytic combustion at a lower temperature (300°C) than the burning temperature of higher than 400°C when using a conventional heater.

[0021] In the catalyst storing tank 23, an alkali metal catalyst solution, either K₂CO₃ or seawater, is fed from a storing tank 26, stored therein and stirred by a stirring means 27.

[0022] The remain of the catalyst solution 12 sprayed at the catalyst carrying zone 24 is recovered into the catalyst storing tank 23, and the remaining catalyst solution may contains non-burned carbon as the non-burned carbon may sometime drop into the remaining catalyst solution at the time of recovering.

[0023] The device according to this embodiment captures particulates in exhaust gas 10 on the surface of a filter 11 at the particulate capturing zone 22, sprays the catalyst solution 12 onto the captured particulates so as to cover the surface of the particulates with the catalyst solution in the catalyst carrying zone 24, dries the catalyst while rotating the filter 11 and burns the particulates again in the combustion zone 25 in the flue to decompose the non-burned particulates, such as suite and tar, at a low temperature as high as 300°C and to make the exhaust gas to clean gas 28.

[0024] Combustion test results of the suite and tar comprising the particulates are presented in Fig. 3. In Fig. 3, the whole weight (mg) of the suite and tar is presented on the vertical axis and the elapsed time (h) is presented on the horizontal axis.

[0025] In Fig. 3, the solid line represents the result obtained for the device operating according to the present invention, which shows the decomposing effect by spraying the catalyst, K₂CO₃, at 300°C. From the figure, it is understood that the weight of the suite and tar are decreasing along with the time elapse. On the other hand, the broken line represents the result obtained for the conventional device with no catalyst spray, where the reduction rate in the weight of the suite and tar is found to be low in comparison with that obtained by the device operating according to the present invention.

[0026] In the present invention, the catalyst is defined as the one at least containing one of alkali metals and alkaline earth metals, such Na and K including potassium carbonate and sodium carbonate. Seawater is also usable as an alkaline catalyst. Also, at least one of the alkali metal or the alkaline earth metal can be contained in seawater to use as the catalyst.

[0027] The device of the first embodiment for the present invention allows to uniformly distribute the catalyst by spraying the alkaline catalyst solution onto the surface of the captured particulates on the filter so as to cover the surface of the particulates with the alkaline catalyst solution to facilitate the absorption and carrying of the alkaline catalyst solution onto the filter, thereby allowing to make the combustion space uniform and enable the catalytic combustion at a lower temperature (300°C) than the burning temperature of higher than 400°C when using a conventional heater.
efficiency of the particulates may be further improved owing to combination effect of the catalytic action given by the catalyst contacting to the particulates and the catalytic action given by the alkaline catalyst attached to the particulates.

Now, the mechanism and the effect of the catalyst specified in the present invention to eliminate the particulates are presented in Fig. 4(B). As shown in Fig. 4, the particulates 10a contained in the exhaust gas are attached to the surface of the filter 11 at first. Then, after spraying the catalyst solution 12, the catalyst solution 12 covers the surface of the particulates. Along with the covering with the catalyst solution 12 onto the particulates 10a, the catalyst solution is penetrating into the fine pores on the particulates 10a. After drying the filter, the catalyst solution having covered the surface of the particulates 10a is also dried and the component having the catalytic activity remains onto the surface of the particulates in a state being uniformly distributed. In addition, the catalyst solution penetrated into the inner part of the particulate is also dried, thereby allowing the component having the catalytic activity uniformly remain in the inner part of the particulate. Consequently, the catalytic reaction may take place not only on the surface of the particulates but also in the inner part of the particulates, thereby allowing complete burning of the particulates.

The device operating according to the present invention can decompose and treat the particulates contained in exhaust gas generated from motors irrespective of the type of the motors.

For example, non-burned portion of floating particulates (SPM) contained in exhaust gas generated from motors, such as diesel engines for ships, for surface transportation vehicles and for overland fixed use, can be decomposed and treated at a low temperature. Furthermore, the device operating according to the present invention can decompose and treat not only particulates in exhaust gas ejected from motors but also particulates contained in exhaust gas generated from various incinerators, such as urban garbage incinerators, industrial waste and sludge incinerators, thermal decomposition furnaces or fusing furnaces, for example.

For the present invention, as the catalyst attaching means to attach the catalyst solution onto the surface of the particulates, as described above, a soaking means to soak the capturing means having captured the particulates in the catalyst solution is given other than a spraying means to spray the catalyst solution onto the filter 11 having captured the particulates.

In the present embodiment, a device for eliminating particulate in exhaust gas using a discoid-shaped filter and carrying a catalyst by using a soaking means is described.

Fig. 5 is a schematic for showing the device for eliminating particulates in exhaust gas according to the second embodiment.

As shown in Fig. 5, the device for eliminating particulates contained in exhaust gas according to the present embodiment is constituted by a discoid-shaped filter 11 having the axial core in the orthogonal direction to the vertical axis, a capturing zone 22 to capture the particulates contained in the exhaust gas 10 in the flue, wherein a part of the filter 11 is rotatably set in the flue 21 for the exhaust gas, a catalyst carrying zone 24, wherein the filter 11 having captured particulates is rotated and the filter 11 is soaked in the catalyst storing tank 23 on outside the flue, and a burning zone 25, where the catalyst being carried is fed again into the flue 21 and burned at the temperature of combustion gas.

The storing tank 23 may contain unburned carbon being attached to the surface of the filter, since the filter is soaked in the catalyst carrying zone 25.

Description on the mechanism to decompose the particulates is same as the mechanism in the first embodiment.

This soaking type device is suitable for exhaust gas treatment for overland-fixed motors, and it is required to equip a quake-preventing means to the device when applying it for motors for ships and surface transportation vehicles.

[Third Embodiment]

In the present invention, there is no limitation in the filter structure, and a discoid-shaped filter as shown in Fig. 1(A), a cylinder-shaped filter as shown in Figs. 1(B) and 1(C), etc. can be given as the examples.

Now, the device for eliminating particulates contained in exhaust gas according to the present embodiment, wherein a cylinder-shaped filter is used and the catalyst is carried onto the filter by employing a spraying means, is explained in the following.

Figs. 6(A) and 6(B) are schematics for showing the device for eliminating particulates contained in exhaust gas according to the third embodiment.

As shown in Fig. 6, the device for eliminating particulates contained in exhaust gas according to the present embodiment is constituted by a capturing means to capture the particulates being cylinder-shaped and an external direction filtration type filter 41A, whereto the particulates contained in the exhaust gas 10 are attached from outside the cylinder-shaped filter 41A, and a catalyst attaching means equipped with an ejecting nozzle 42A on the external side thereof to attach the catalyst solution onto the surface of the particulates, and sprays the catalyst solution 12 onto the surface of the filter 41A while rotating the cylinder-shaped filter 41A and then burns the unburned particulates contained in the exhaust gas after drying the sprayed filter.

In Fig. 6(B), the marked number 43 represents a rotation unit to rotate the filter 41A.

The device for eliminating particulates according to the present embodiment, wherein an external di-
The device for eliminating particulates according to the present embodiment captures the particulates contained in the exhaust gas 10 in the particulate capturing zone 45 to the surface of the filter 41A, sprays the alkaline catalyst solution 12 in the catalyst carrying zone 46 onto the captured particulates so as to cover the surface of the particulates, dries the sprayed catalyst while rotating the filter 41A and burns the particulates in the burning zone 48, thereby allowing to decompose the unburned portion, such as suite and tar, of the particulates at a low temperature as high as 300°C and to eject the exhaust gas as clean gas 28.

As to the spraying method for the catalyst, any of continuous spray, sprays at prefixed intervals and sprays depending upon the attached amount of the particulates to be detected by means of using a sensor can be employed.

In the present embodiment, as shown in Fig. 7, a plurality of the spray nozzles 42A may be arranged along with the axial direction of the cylinder-shaped filter 41A.

In the present embodiment, as shown in Fig. 8, the cylinder-shaped filter may be fixed in vertical direction by adjusting the position of rotation axis of the filter to the vertical axis to make the spray flow from the nozzle 41A downdraft and to reduce the number of the nozzles to be set.

Alternatively, instead of spraying the catalyst solution to the filter, the device may be prepared in a type of soaking filter as shown in Fig. 9.

Such soaking type may be suitable for the device of which filter 61 has a cross section in convexo-concave form comprising the convexo 61a and the concave 61b as shown in Fig. 10 and the device comprising a filter in a complex shape, such as small cylinder in group type filter 63, wherein a plurality of gas-permeable cylinders 41a are vertically set on the surface of a cylindrical tube 62 as shown in Fig. 11.

In the present embodiment, as shown in Fig. 8, the rotating particulates contained in exhaust gas uses a fixed rotation unit 44 by means of using a rotation unit 43, is constituted by a capturing zone 45 to capture the particulates contained in the exhaust gas 10, a catalyst carrying zone 46 to spray the catalyst solution 12 onto the surface of the particulates, dries the sprayed catalyst while rotating the filter 41A and burns the particulates in the burning zone 48, thereby allowing to decompose the unburned portion, such as suite and tar, of the particulates at a low temperature as high as 300°C and to eject the exhaust gas as clean gas 28.

As shown in Fig. 12, the device for eliminating particulates contained in exhaust gas according to the fourth embodiment is equipped with a capturing means to capture the particulates being an internal filtration type cylinder-shaped filter 41B, ejects the particulates contained in the exhaust gas 10 from the internal side of the cylinder-shaped filter 41B via the gas ejecting tube 50, having therein an ejecting nozzle 42B for the catalyst attaching means to attach the catalyst solution onto the surface of the particulates, sprays the catalyst solution 12 onto the surface of the filter 41B while rotating the cylinder-shaped filter 41B and then burns the unburned particulates in the exhaust gas following to drying the sprayed catalyst.

The device for eliminating particulates according to the present embodiment, wherein an internal direction filtration type cylinder-shaped filter 41B having the axial core in a direction orthogonal to the vertical axis direction is used and the filter 41B is rotatably set in the exhaust gas treating unit 44 by means of using a rotation unit 43, is constituted by a capturing zone 45 to capture the particulates contained in the exhaust gas 10, a catalyst carrying zone 46 to spray the catalyst solution 12 onto the catalyst storing tank 23 onto the rotating filter 41B having captured the particulates, a drying zone 47 to dry the carried catalyst and a burning zone 48 to burn the unburned particulate portion in combination with heat generated by the exhaust gas 10 and the catalytic effect.

The device for eliminating particulates according to the present embodiment captures the particulates contained in the exhaust gas 10 in the particulate capturing zone 45 to the surface of the filter 41B, ejects the particulates contained in the exhaust gas 10 from the internal side of the cylinder-shaped filter 41B via the gas ejecting tube 50, having therein an ejecting nozzle 42B for the catalyst attaching means to attach the catalyst solution onto the surface of the particulates, dries the sprayed catalyst while rotating the filter 41B and burns the particulates in the burning zone 48, thereby allowing to decompose the unburned portion, such as suite and tar, of the particulates at a low temperature as high as 300°C and to eject the exhaust gas as clean gas 28.

In the present embodiment, the device for eliminating particulates contained in exhaust gas as shown in Fig. 1(C), which uses the internal direction filtration type cylinder-shaped filter and operates the carrying of the catalyst by using the spraying means, is explained.

Figs. 12(A) and 12(B) are schematics for showing the device for eliminating particulates contained in exhaust gas according to the fourth embodiment.

As shown in Fig. 12, the device for eliminating particulates contained in exhaust gas according to the present embodiment is equipped with a capturing means to capture the particulates containing a catalyst solution, and that is constituted by a capturing zone 45 to capture the particulates contained in the exhaust gas 10, a catalyst carrying zone 46 to spray the catalyst solution 12 onto the internal side of the filter 41B while rotating the cylinder-shaped filter 41B and then burns the unburned particulates in the exhaust gas following to drying the sprayed catalyst.

In the present embodiment, the device for eliminating particulates contained in exhaust gas as shown in Fig. 1(C), which uses the internal direction filtration type cylinder-shaped filter and operates the carrying of the catalyst by using the spraying means, is explained.

In the present embodiment, the device for eliminating particulates contained in exhaust gas uses a fixed filter, which is different from the one using a rotatable filter, and performs the carrying of a catalyst by using a
spraying means.

In the present embodiment, the device for eliminating particulates contained in exhaust gas according to the present embodiment.

As shown in Fig. 13, the device for eliminating particulates contained in exhaust gas according to the present embodiment has a capturing means to capture the particulates which is a fixed pier-shaped filter 71, attaches the particulates in the exhaust gas 10 onto the outside of the filter 71, has a catalyst attaching means equipped with four spray nozzles 72 A-D on the exterior circumference of the catalyst attaching means to attach the catalyst solution 12 onto the surface of the particulates and burns the unburned particulates in the exhaust gas following to drying of the catalyst.

Although the pier-shaped filter is used for the fixed filter in the present embodiment, there is no limitation in the shape to be used. A cylinder-shaped and a polygon-shaped filter are also usable, which may be sprayed with the catalyst solution 12 in turn while switching the exhaust gas to be covered.

In the present embodiment, the device for eliminating particulates contained in exhaust gas using a fixed filter and performing the carrying of a catalyst by using the spraying means is provided.

As shown in Fig. 14, the device for eliminating particulates contained in exhaust gas according to the present embodiment has a capturing means to capture the particulates which is a fixed pier-shaped filter 81, attaches the particulates in the exhaust gas 10 onto the outside of the filter 81, sprays the catalyst solution 12 onto the surface of the particulates being captured on the filter 81 by using the spraying nozzle (not shown in Fig.) and burns the unburned particulates portion in the exhaust gas following to drying of the sprayed catalyst.

The filter 81 to capture the particulates in the exhaust gas according to the present embodiment is a honeycomb-shaped filter having a checkered pattern on the end surface thereof, which is constituted by alternatively closing the end with a choke 82.

As a method to attach the catalyst, it is not limited to said spraying method, and any methods capable of appropriately carrying the catalyst onto the filter, such as a method to soak the internal part of the filter with the catalyst solution, may be employed without limitation.

In the present embodiment, the device for eliminating particulates contained in exhaust gas using a fixed filter and performing the carrying of a catalyst by using a spraying means is provided.

In the present embodiment, the device for eliminating particulates contained in exhaust gas according to the seventh embodiment. particulates contained in exhaust gas according to the present embodiment has a capturing means to capture the particulates which is a laminated filter 91 having a canaliform structure by folding a plate-shaped filter, attaches the particulates in the exhaust gas 10 onto the surface of the filter 91, sprays the catalyst solution 12 onto the surface of the particulates being captured on the filter 91 by using spraying nozzles (not shown in Fig.) and burns the unburned particulates portion in the exhaust gas following to drying of the sprayed catalyst. The marked number 92 represents a choke.

In the device according to this embodiment, the laminated type filter 91 may be constituted by laminating plate-shaped filters in multilayer and alternatively closing the both end sides with chokes 92.

Since the parts of the end sides of the laminated filter 91 of the present embodiment other than the parts closed with the chokes are opened, the unburned particulates attached to the surface of the filter can be cleaned up and eliminated easily.

In the present embodiment, the device for eliminating particulates contained in exhaust gas using a fixed filter and performing the carrying of a catalyst by using a spraying means is provided.

As shown in Fig. 16, the device for eliminating particulates contained in exhaust gas according to the eighth embodiment. As shown in Fig. 17, the device for eliminating particulates contained in exhaust gas according to the present embodiment has a capturing means to capture the particulates which is a filter 95 constituted by setting a plurality of doughnut-shaped discoid filters in hollow 93 in the internal cylinder 94, attaches the particulates in the exhaust gas 10 onto the surface of the filter 95, sprays the catalyst solution 12 onto the surface of the particulates being captured on the filter 95 by using spraying nozzles (not shown in Fig.) and burns the unburned particulates in the exhaust gas following to drying of the sprayed catalyst.

Although the discoid-shaped and cylinder-shaped filters or fixed type filter are exemplified above as the filter apparatus to be used in this embodiment, there is no limitation for the filters, and any types of filters which can efficiently capture the particulates contained in exhaust gas may be used.

There are various methods for installing the filter, and an example for the installation is shown in Fig. 17. Fig. 17 (A) shows an independent and either rotating or fixed type filter being in a cylindrical shape.

Fig. 17(B) shows a filter system constituted by three filters arranged in parallel by means of tubing to perform absorption of the particulates onto the filter, dry-
ing of the filter and burning of the particulates in turn by switching the filters to be used from one to another.

[0082] Fig. 17(C) shows an unit type filter comprising a plurality of filters.

[0083] Now, an example for an exhaust gas cleaning system equipped with the various devices for eliminating particulates in exhaust gas described above is explained hereinbelow, however, it should be noted that the scope of the present invention shall not be limited to the following description.

[Ninth Embodiment]

[0084] Fig. 18 is a schematic for showing the exhaust gas cleaning up system according to the present embodiment.

[0085] As shown in Fig. 18, the exhaust gas cleaning up system of this embodiment is a system to clean up exhaust gas ejected from motors and is constituted by mounting a particulate eliminating device 102, which is located in the exhaust gas feeding path from motors, large diesel engines 101 for ships, to decompose and treat floating particulates contained in the exhaust gas 10 and a denitrification device 103 equipped at the downstream side of the particulate eliminating device 102 to eliminate the particulates and hazardous substance, such as nitrogen oxide, thereby allowing to eject clean gas 104 from a chimney 105.

[Tenth Embodiment]

[0086] Fig. 19 is a schematic for showing the exhaust gas cleaning up system according to the tenth embodiment for the present invention.

[0087] As shown in Fig. 19, the exhaust gas cleaning up system of the present embodiment is a system to clean up the exhaust gas ejected from motors and is constituted by mounting a particulate eliminating device 102, which is located in the exhaust gas feeding path from motors, large diesel engines 101 for ships, to decompose and treat floating particulates contained in the exhaust gas 10, and the system is constituted as an exhaust gas recycling system (EGR) to recycle and circulate the part of the exhaust gas, approximately 30% more or less, which is ejected from an engine 101 to a diesel engine 101.

[0088] Although exhaust gas is a factor to down the combustion temperature, this system of the present embodiment allows to eject clean exhaust gas from which particulates have been eliminated, thereby allowing to reduce the amount of nitrogen oxides in total produced in exhaust gas over a long time.

[0089] In particular, the present system is suitably applied for diesel engines to be used for surface transport vehicles other than for ships.

[Eleventh Embodiment]

[0090] Fig. 20 is a schematic for showing the exhaust gas cleaning up system according to the eleventh embodiment.

[0091] As shown in Fig. 20, the exhaust gas cleaning up system of this embodiment is a system to clean up exhaust gas ejected from motors, such as motors for surface transportation vehicles including motortrucks, buses, roller cars, forklifts and shoveling cars and overland-fixed motors including compressors and generators, and is constituted by mounting a particulate eliminating device 102, which is located in the exhaust gas feeding path from a diesel engines 101 as a motor, to decompose and treat floating particulates contained in the exhaust gas 10 and a denitrification device 103 equipped at the downstream side of the particulate eliminating device 102 to eliminate the particulates and hazardous substance, such as nitrogen oxide, thereby allowing to eject clean gas 104 to the outdoor.

[Twelfth Embodiment]

[0092] Fig. 21 is a schematic for showing the exhaust gas cleaning up system according to the twelfth embodiment.

[0093] As shown in Fig. 21, the exhaust gas cleaning up system of this embodiment is corresponding to the cogeneration system and is constituted by mounting a particulate eliminating device 102, which is located in the exhaust gas feeding path from a diesel engine generator 111 outputting electricity. In the present system, a denitrification device 103 is equipped at the downstream side of the particulate eliminating device 102 to eliminate the particulates and hazardous substance, such as nitrogen oxide, thereby allowing to eject clean gas 104 to the outdoor. And, the system recovers heat as hot water by using a heat-recovering boiler 112 at ejecting the clean gas 104 and is aiming at improving energy utilization efficiency.

[0094] Consequently, the system according to the present embodiment enables to constitute a system capable of decomposing and treating the unburned portion of the floating particulates (SPM) contained in the exhaust gas ejected from motors, such as diesel engines for ships, surface transportation vehicles and overland fixed use, at a low temperature.

[Thirteenth Embodiment]

[0095] Fig. 22 is a schematic for showing the exhaust gas cleaning up system according to the thirteenth embodiment.

[0096] As shown in Fig. 22, the exhaust gas cleaning up system according to the present embodiment is a system to clean up exhaust gas ejected from a gasification furnace and is constituted with a particulate eliminating device 102, which is mounted in the smoke feeding path from the gasification furnace 121, to decompose and treat the floating particulates contained in the exhaust gas 10 and a denitrification device 103 equipped at the
downstream side of the particulate eliminating device 102, thereby eliminating the particulates and hazardous substance, such as nitrogen oxides, to eject cleaned up gas 104 through a chimney 105.

As described above, the exhaust gas cleaning up system operating according to the present invention allows to decompose and eliminate particulates contained in exhaust gas ejected not only from motors but also from various incinerators, such as urban garbage incinerators, industrial waste incinerators and sludge incinerators, thermal decomposition furnaces or fusion furnaces, for example.

Claims

1. A method for eliminating particulates contained in exhaust gas, preferably in exhaust gas ejected from a motor, comprising the steps of:
   - capturing the particulates contained in the exhaust gas;
   - attaching a catalyst onto the captured particulates by applying a catalyst solution in a state of solution onto the captured particulates so as to cover the surface of the captured particulates with the catalyst solution;
   - penetrating the catalyst solution into fine pores of the captured particulates;
   - drying the catalyst solution on the captured particulates; and
   - burning and decomposing the captured particulates.

2. The method according to claim 1, wherein the catalyst solution is applied onto the captured particles outside of the flow of the exhaust gas.

3. The method according to claim 1 or 2, wherein the catalyst is applied onto the particulates by spraying the catalyst solution onto the captured particles.

4. The method according to claim 1 or 2, wherein the catalyst is applied onto the particulates by soaking the captured particulates in the catalyst solution.

5. The method according to claim 1, 2, 3 or 4, wherein the catalyst solution contains at least one of alkali metals, alkaline earth metals, seawater, and seawater containing at least one of the alkali metals and the alkaline earth metals.

Revendications

1. Procédé d’élimination de particules contenus dans des gaz d’échappement, de préférence dans des gaz d’échappement éjectés d’un moteur, comprenant les étapes consistent à :
   - capturer les particules contenues dans les gaz d’échappement ;
   - attacher un catalyseur sur les particules capturées en appliquant une solution de catalyseur à un état de solution sur les particules capturées de façon à couvrir la surface des particules capturées par la solution de catalyseur ;
   - faire pénétrer la solution de catalyseur dans de fins pores des particules capturées ;
   - sécher la solution de catalyseur sur les particules capturées ;
   - et brûler et décomposer les particules capturées.

2. Procédé selon la revendication 1, dans lequel la solution de catalyseur est appliquée sur les particules
capturées à l’extérieur de l’écoulement des gaz d’échappement.

3. Procédé selon la revendication 1 ou 2, dans lequel le catalyseur est appliqué sur les particules par pulvérisation de la solution de catalyseur sur les particules capturées.

4. Procédé selon la revendication 1 ou 2, dans lequel le catalyseur est appliqué sur les particules en trempant les particules capturées dans la solution de catalyseur.

5. Procédé selon la revendication 1, 2, 3 ou 4, dans lequel la solution de catalyseur contient au moins l’un des métaux alcalins, des métaux alcalino-terreux, de l’eau de mer et de l’eau de mer contenant au moins des métaux alcalins et des métaux alcalino-terreux.
FIG. 3

- Combustion test results of the suite and tar (300°C non catalyst)
- Combustion test results of the suite and tar (300°C K₂CO₃ Catalyst)

Whole weight (mg) of the suite and tar

Time (h)
FIG. 8
FIG. 9
FIG. 11 A

FIG. 11 B
FIG. 18
FIG. 20
FIG. 22