DEVICE FOR TREATING EXHAUST GASES

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ABSTRACT
A device (1) for exhaust treatment of an internal combustion engine, in particular a diesel internal combustion engine, having a particle filter (4), is proposed that is to be realized with less expense than conventional systems and ensures reliable particle filter regeneration. This is obtained according to the invention by the fact that the device (1) comprises a catalytic burner (3), whereby the burner (3) is located between the internal combustion engine and the particle filter (4).
DEVICE FOR TREATING EXHAUST GASES

[0001] The invention concerns a device for exhaust treatment of an internal combustion engine, in particular a diesel internal combustion engine, having a particle filter according to the preamble of claim 1.

BACKGROUND OF THE INVENTION

[0002] In accordance with growing understanding, legal regulations that govern the emissions of motor vehicles are continuously tightened in order to protect human health and the environment. To meet these specifications, in addition to using fuels that have been modified accordingly, solid particles are removed from exhaust gas using filters, for example.

[0003] Diesel drives in particular produce large quantities of soot. It is suspected that diesel exhaust gas has carcinogenic potential. Numerous requirements for treatment of diesel exhaust gas have therefore been proposed. In general, these requirements consist of filter systems that retain the particulate constituents. An efficient filter effectively retains soot particles with a diameter of approximately 10 to 5000 nanometers in particular.

[0004] Due to the fact that the filter and/or its surface become coated, however, the particles retained by such filters bring about a reduction in mixture flow and, as a result, cause filtration resistance to increase. This resistance leads to increased fuel consumption up to the point of engine standstill, so that frequent regeneration must be provided. Regeneration generally takes place by means of nearly residue-free combustion of the stored soot. The temperatures of approximately 200°C present in diesel exhaust gas are usually inadequate for this purpose, so that additional system aids must be provided.

[0005] Without additional measures, soot oxidizes at temperatures starting at approximately 550 to 600°C. By combining the soot filter with an oxidation catalytic converter or by providing a catalytic coating on the filter, the lower temperature threshold for the soot oxidation can be reduced to approximately 250 to 350°C. These temperatures are still above the usual exhaust-gas temperatures for modern diesel engines, however, so that temperature-increasing measures are required for reliable filter regeneration.

[0006] To increase the exhaust-gas temperature, electric heating devices, microwave heating devices, or measures internal to the engine, for example, have been provided up to now, whereby they often make it necessary to provide additional batteries due to the high heat output required, they have a high associated system expense, or they cannot reliably ensure the necessary temperature increase, for example.

[0007] Burners have therefore been used in some commercial vehicles, for instance, whereby the filter is self-cleaned with a naked flame. The requirements for uniform distribution of temperature, ignition conditions, burning laws, etc. are very demanding, however, so that systems of this type are very expensive to realize. Furthermore, ignition and burning with a naked flame require that high safety requirements be placed on the entire system.

[0008] Accordingly, these exhaust-gas filter systems are relatively expensive overall, and/or they do not ensure a reliable temperature increase to regenerate the particle filter at any operating point.

ADVANTAGES OF THE INVENTION

[0009] In contrast, the object of the invention is to propose a device for exhaust treatment of an internal combustion engine, in particular a diesel internal combustion engine, having a particle filter that markedly reduces the system-related expense and simultaneously ensures reliable particle filter regeneration at any operating point, whereby no safety-related risks occur.

[0010] This object is attained by means of the characterizing features of claim 1 based on a device of the type initially described.

[0011] As a result of the measures named in the dependent claims, advantageous embodiments and further developments of the invention are possible.

[0012] Accordingly, a device according to the invention differs in that the device comprises a catalytic burner, whereby the burner is located between the internal combustion engine and the particle filter.

[0013] With the aid of such a device, fuel (HC) with oxygen (O₂) is converted in the catalytic converter to water (H₂O) and carbon dioxide (CO₂). The reaction heat that is released increases the exhaust-gas temperature to the regeneration temperature, so that regeneration of the particle filter takes place.

[0014] According to the invention, the furnishing of a fuel mixture that ignites and combusts well, as well as a device for igniting the mixture are advantageously eliminated. Safety-related risks associated with the ignition and combustion of the fuel mixture are eliminated. The catalytic material of the burner according to the invention ensures conversion of fuel even at exhaust-gas temperatures of approximately 200°C.

[0015] A fuel metering device is preferably located between the internal combustion engine and the catalytic burner, so that fuel is metered as necessary, i.e., fuel is metered into the exhaust-gas flow before the catalytic burner when the exhaust-gas back pressure has reached a specified threshold value, for example. Fuel metering is stopped, for example, when the filter is self-cleaned.

[0016] In a particular further development of the invention, the fuel metering device comprises a fuel dispersal unit, so that the furnished fuel is brought in contact relatively well with the catalytic material of the burner, whereby the metered fuel is completely converted and, as a result, the heat required for filter regeneration is released.

[0017] An open-loop control of the fuel metering device is advantageously provided, so that fuel metering takes place automatically, for example, at a specified back pressure of the exhaust gas, and it is switched off automatically when the filter is self-cleaned. Furthermore, a flexible adjustment of fuel metering is possible, e.g., depending on the exhaust-gas flow and/or its soot content.

[0018] Advantageously, the device according to the invention comprises a nitrous oxide oxidation unit, whereby it increasingly produces nitrogen dioxide (NO₂) in the exhaust-gas flow out of nitric oxide (NO) and oxygen (O₂). The reverse procedure takes place in the downstream installed particle filter, and the released oxygen atom burns the carbon of the soot even at lower exhaust-gas tempera-
tures, so that even more reliable particle filter regeneration is ensured. In the case of a diesel internal combustion engine, it must be kept in mind, however, that relatively low-sulphur diesel fuel is used, which prevents sustained damage to the nitrogen oxide oxidation unit.

[0019] The device advantageously comprises a coated particle filter, which ensures further reduction of the lower soot-oxidation temperature. Regeneration on a catalytically-coated wall takes place relatively slowly, so that, advantageously, complete conversion of the appropriate substances takes place.

[0020] In a particular further development of the invention, the device comprises a heating device. For example, an electric heating device is used to ensure reliable particle filter regeneration, even under the most difficult operating conditions, e.g., during cold start, overrun fuel cutoff, etc. Additionally, the catalytic burner can be brought to an optimal operating temperature relatively quickly.

[0021] The invention described hereinabove ensures reliable particle filter regeneration, even under the most difficult conditions to be encountered in the internal combustion engines of motor vehicles, particularly under rapid throttle changes, cold-start conditions, overrun fuel cutoff, or during operation at different rotational speeds.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] An exemplary embodiment of the invention is presented in the drawing and it is explained in greater detail hereinbelow with reference to the drawings.

[0023] FIG. 1 shows a schematic representation of a device for exhaust treatment according to the invention.

[0024] FIG. 2 shows a schematic representation of a further development of the device according to the invention with a nitrogen oxide oxidation unit and a heating device, and

[0025] FIG. 3 shows a schematic representation of a second further development of the device according to the invention with a coated particle filter.

[0026] FIG. 1 shows a device 1 for exhaust treatment, whereby exhaust gas 2 (with a temperature of approximately 200°C.) meets a catalytic burner 3 and then flows through a particle filter 4. Fuel is dispersed in front of the catalytic burner 3 by means of a fuel metering device 5, so that the exhaust gas 2 in the catalytic burner 3 is heated to approximately 600°C. due to the oxidation of fuel (HC) into water (H₂O) and carbon dioxide (CO₂) and the heat released as a result. At these exhaust-gas temperatures, the carbon (C) of the diesel soot reacts in the particle filter 4 with the rest of the oxygen (O₂) remaining in the exhaust gas 2, and this binds to form carbon dioxide (CO₂). Fuel (HC) is supplied to the device (1), e.g., after a specified exhaust-gas back pressure is reached, and it is metered in the exhaust-gas flow until the particle filter 4 has self-cleaned, whereby the end of the furnishing of fuel can also take place in pressure-controlled fashion.

[0027] A further development of the device 1 is shown in FIG. 2 whereby, compared with the device in FIG. 1, it differs in that is also has a heating device 6 located on the catalytic burner 3 and a nitrogen oxide oxidation unit 7 located between the catalytic burner 3 and the particle filter 4. For certain operating conditions of the engine of a vehicle, e.g., during cold starting or overrun fuel cutoff, an additional heating-up of the exhaust gas 2 can become necessary. Using the heating device 6, therefore—which is supplied with power by the electrical sources within the motor vehicle, for example, such as the battery or electric generator—reliable particle filter regeneration is ensured even under the most difficult operating conditions. Furthermore, the catalytic burner 3 can be heated specifically if necessary using the heating device 6, so that optimal oxidation of the furnished fuel is ensured.

[0028] Nitric oxide (NO) in the exhaust gas 2 is oxidized into nitrogen dioxide (NO₂) by means of the nitrogen oxide oxidation unit 7. Advantageously, continuous combustion of the soot residue takes place in the particle filter 4 starting at an exhaust-gas temperature of approximately 250°C. The catalytic burner is switched on only when this temperature has not been reached for an extended period of time.

[0029] The exemplary embodiment in FIG. 3 comprises—in comparison with the exemplary embodiment in FIG. 1—a coated particle filter 8 in place of the particle filter 4. The coated particle filter 8 hereby combines the nitrogen oxide oxidation unit 7 and the particle filter 4 in FIG. 2 into one component, so that nitric oxide (NO) is oxidized into nitrogen dioxide (NO₂) in the coated particle filter 8, which said nitrogen dioxide (NO₂) then oxidizes the soot according to this reaction equation: 2NO+O₂→2NO₂+CO₂→2NO+CO₂. A further nitrogen oxide treatment can take place downstream if necessary. Advantageously, the catalytic coating also lowers the temperature required for the direct oxidation of soot.

[0030] In the case of exhaust-gas filter systems according to the invention, the fuel for the catalytic burner 3 can be furnished preferably in gaseous form as well as liquid form. The supply of fuel can take place periodically as well as continuously.

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What is claimed is:

1. A device (1) for exhaust treatment of an internal combustion engine, in particular a diesel internal combustion engine, having a particle filter (4), wherein the device comprises a catalytic burner (3), whereby the burner (3) is located between the internal combustion engine and the particle filter (4).

2. The device (1) according to claim 1, wherein a fuel metering device (5) is located between the internal combustion engine and the burner (3).
3. The device (1) according to one of the aforementioned claims, wherein the fuel metering device (5) comprises a fuel dispersal unit.

4. The device (1) according to one of the aforementioned claims, wherein an open-loop control of the fuel metering device (5) is provided.

5. The device (1) according to one of the aforementioned claims, wherein the device (1) comprises a nitrogen oxide oxidation unit (7).

6. The device (1) according to one of the aforementioned claims, wherein the device (1) comprises a coated particle filter (8).

7. The device (1) according to one of the aforementioned claims, wherein the device (1) comprises a heating device (6).

8. A vehicle, wherein a device (1) according to one of the aforementioned claims is provided.

9. A method for exhaust treatment of an internal combustion engine, in particular a diesel internal combustion engine, having a particle filter (4), wherein a device (1) according to one of the aforementioned claims is used.

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