A method for controlling regeneration of a particle filter by electrically heating the particle filter. According to the method, the regeneration is triggered by a calculator according to a loading level and temperature of the particle filter. The calculator simultaneously uses parameters relating to the operation of the vehicle so as to take into account the fuel consumption driven by the electrical heating of the filter.
METHOD FOR CONTROLLING THE REGENERATION OF AN ELECTROSTATIC PARTICLE FILTER

[0001] The invention relates to a method for controlling the regeneration of an electrostatic particulate filter fitted to the exhaust pipe of the internal combustion engine of a motor vehicle.

[0002] The regeneration is carried out by electrical heating of the particulate filter. It is triggered according to operating parameters of the motor vehicle which are sent to a computer.

[0003] Among the known systems for eliminating the soot particles emitted by internal combustion engines and in particular diesel engines, mention can be made of particulate filters inserted in the exhaust pipes of the engines. These particulate filters are arranged to trap the soot particles contained in the exhaust gases.

[0004] Electronically-managed regeneration systems periodically burn the particles trapped in the particulate filters and prevent clogging of the filters.

[0005] It is desirable for the regeneration of a particulate filter not to adversely affect the performance and to leave the smallest possible impact on the fuel costs of the engine.

[0006] In fact, the soot particles burn at temperatures of the order of 500 to 600°C. However, such heat levels are only rarely reached by the exhaust gases of a diesel automobile engine since for example in town the temperature of the exhaust gases varies between 150° and 250°C. This is why there is a need to have appropriate means for heating the soot directly without relying on the gases.

[0007] Various regeneration systems have been proposed, in particular, electrical resistance heating systems, raising the temperature of the exhaust gases to a value which is sufficient to bring about the combustion of the particles in the particulate filter.

[0008] The activation of such assisted regeneration systems is electronically managed by a control computer which determines, on the basis of a certain number of parameters, the moment of regeneration. However, the electrical power required by the electrical equipment, such as an electrical heating element, is supplied directly by the engine via the alternator. The regeneration of the particulate filter can therefore cause an overconsumption of fuel or, if the alternator cannot supply the instantaneous power, a discharging of the battery.

[0009] The object of the present invention consists in limiting the fuel consumption due to an electrical heating system used for the regeneration of a particulate filter.

[0010] For this purpose, the invention proposes that the regeneration control computer receive parameters for determining the fuel consumption linked to the production of electricity for the means of heating necessary for regeneration.

[0011] According to other features of the invention, the parameters derived from the vehicle are, for example, the pedal positions, the vehicle speed, and the gear engaged.

[0012] Other features and advantages of the invention will emerge from the reading of the description of embodiments with reference to the attached drawings.

[0013] FIG. 1 illustrates a schematic view of an internal combustion engine fitted with a particulate filter, using the method according to the invention.

[0014] FIG. 2 illustrates a flowchart of the method according to the invention.

[0015] Identical or similar elements are designated by the same reference numbers.

[0016] FIG. 1 illustrates a non-limiting manner the use of the proposed regeneration principle.

[0017] An internal combustion engine 1 is designed to be fitted to a vehicle such as an automobile. It is, for example, a turbocharged diesel engine with four cylinders in line and direct fuel injection. The engine 1 is fitted with an exhaust pipe 5 provided with a device for filtering out soot particles. The engine 1 is fed with air by an intake circuit 2.

[0018] Suitable sensors and, in particular, a flow sensor 8, are fitted to the intake circuit 2 to supply to a control computer 3, parameters relating to, for example, the pressure feeding the engine 1. The injection of the fuel into the cylinders is provided by electromagnetic injectors, not illustrated, discharging into the combustion chambers and electronically managed by the control computer 3 from a pressurized fuel system 4, of the high pressure common rail type. Leaving the engine 1, the exhaust gases evacuated through the pipe 5, pass through a particulate filter 6.

[0019] Various sensors 7, such as pressure and temperature sensors, installed upstream and downstream of the particulate filter 6, supply corresponding parameters to the control computer 3. It is also intended to fit the exhaust pipe with an oxidizing catalyst unit 10 treating the unburned hydrocarbon HC and carbon monoxide CO emissions. A portion of the exhaust gases is returned to the intake by means of a recycling system 11 including a valve 12 of which the opening is electronically managed by the control computer 3. The turbocharger comprises, conventionally, a turbine 13 and a compressor 14.

[0020] The control computer 3 comprises, in a limiting manner, a microprocessor or central processing unit CPU, at least one random access memory, at least one read only memory, at least one analog to digital converter and at least one input/output interface. The microprocessor of the control computer 3 comprises electronic circuits and suitable software programs, designed in particular for the various electronically managed actuators.

[0021] The computer 3 controls the pressure of the fuel in the common rail 4 and the opening of the injectors using the parameters sent by the various sensors, and in particular the weight of intake air, the engine speed as well as formulae and stored calibrations for reaching the desired levels of consumption and performance. The opening of the injectors is more particularly defined by the moment when injection starts and the opening time of the injectors, time which for a given fuel pressure corresponds to a quantity of fuel injected and therefore to a richness of the mixture filling the combustion chambers.

[0022] The computer 3 is also arranged to provide the control of the operation of the exhaust system, and in particular the particulate filter 6. The triggering of the regeneration of the particulate filter 6 is controlled by the computer 3 which also determines its continuation or its interruption.

[0023] As stated above, the regeneration phase consists essentially of directly increasing the temperature of the soot, so as to burn the trapped particles. The temperature increase is started, for example, by electrical heating means such as metal wires.

[0024] In accordance with the invention, the computer 3 takes into account various parameters, relating to the particulate filter 6 itself and the vehicle, for triggering the regeneration, for example, the temperatures of the engine coolant, the gases upstream and downstream of the particulate filter 6, the vehicle speed, the weight of soot which has accumulated in the particulate filter 6 and the distance traveled since the last regeneration.
In accordance with the invention, the computer 3 also receives other parameters relating to the fuel consumption due to the production of electricity for operating the heating system. The latter parameters can comprise the pedal position Pf, the vehicle speed V, the gear engaged H, the engine speed N, and the engine torque M.

In this manner, a compromise can be found for carrying out the regeneration while avoiding overconsumption of fuel or discharging of the battery.

In FIG. 2 is illustrated a flowchart of the proposed particulate filter regeneration control method.

At stage 10, the computer reads various parameters such as the level of loading of the particulate filter A, the vehicle speed V, the gas pedal position Pf, the engine torque M, the engine speed N, the gear engaged H, and the temperature T of the particulate filter.

At stage 11, after the computer 3 has read as a parameter the level of loading of the particulate filter A, a first check is carried out on the level of the loading of the filter 6.

If the level of loading A is lower than a preset threshold called S1, S1 is higher than a threshold below which regeneration is not necessary, called Sm, the next stage is stage 17, and there is no regeneration.

If the level of the loading A is higher than S1, the next stage is stage 12.

At stage 12, a second check is carried out on the brake pedal position Pf.

If the brake pedal position Pf is active, read as Pf ≥ 1, the next stage is 14 is the regeneration. The regeneration is activated by means of the electrical energy recovered by regenerative braking. Regenerative braking takes place when the vehicle mode is driving with braking: the alternator recovers the kinetic energy of the vehicle as electrical energy to feed the heating means.

If the brake pedal position is inactive, read as Pf ≤ 0, then the next stage is stage 13 where another check is carried out on the loading of the particulate filter. The level of loading A is then compared with a second preset threshold, called S2 (high back-pressure which requires a regeneration to be carried out without waiting for the driver to brake). This threshold S2 is higher than S1 and is lower than a threshold at which regeneration becomes compulsory, called Smax.

If the level of loading A is higher than S2, the next stage is stage 15. This stage 15 consists of the computer 3 selecting the values of various parameters affecting the fuel consumption, for example, the vehicle speed V, the gas pedal position Pf, the engine torque M, the engine speed N, the gear engaged H, and the temperature T of the particulate filter.

To determine whether there is an overconsumption of fuel, initially, the efficiency F of the engine is calculated using the selected parameters.

The values of the various parameters enable the computer 3 to make a comparison between the efficiency G of the engine which would be obtained with a regeneration and the efficiency F of the engine obtained without regeneration.

To do that, a map of the efficiency G of the engine obtained with a regeneration is stored by the computer 3. For example, for an internal combustion engine, a map of the efficiency G is illustrated based on the following parameters: the engine torque M and the engine speed N. The values read by the computer 3 are used to determine the efficiency F of the engine from the stored map. The efficiency F of the engine is compared with the efficiency of the engine obtained with a regeneration G. If the regeneration improves the efficiency of the engine, it is started, and the next stage is stage 14.

If not, the level of loading of the particulate filter A is compared with the Smax threshold at stage 18.

If the level of loading A is lower than Smax, the regeneration is not carried out, this is stage 17.

If the level of loading A is higher than Smax, the regeneration is then started immediately.

1. (canceled)

12. A method for controlling regeneration of a particulate filter by electrically heating the particulate filter, according to which the regeneration is triggered by a computer on the basis of a level of loading and temperature of the particulate filter, wherein the computer uses simultaneously parameters linked to an operation of the vehicle so as to take into account fuel consumption caused by electrical heating of the particulate filter.

13. The method for controlling regeneration of a particulate filter as claimed in claim 12, wherein the parameters include a brake pedal position.

14. The method for controlling regeneration of a particulate filter as claimed in claim 12, wherein the computer activates the regeneration of the particulate filter:

- if the level of loading is higher than a first preset threshold;
- and if the brake pedal position is active.

15. The method for controlling regeneration of a particulate filter as claimed in claim 14, wherein the first preset threshold is higher than a threshold below which regeneration is not necessary.

16. The method for controlling regeneration of a particulate filter as claimed in claim 14, wherein the computer activates the regeneration of the particulate filter:

- if the level of loading is higher than a second preset threshold which is higher than the first preset threshold;
- and if the brake pedal position is active;
- and if an efficiency of the engine, calculated using selected parameters, is lower than an efficiency of the engine that would be obtained with a regeneration of the particulate filter.

17. The method for controlling regeneration of a particulate filter as claimed in claim 16, where the second preset threshold is lower than a threshold at which regeneration is compulsory.

18. The method for controlling regeneration of a particulate filter as claimed in claim 16, wherein the parameters include a gear engaged.

19. The method for controlling regeneration of a particulate filter as claimed in claim 16, wherein the parameters include a gas pedal position.

20. The method for controlling regeneration of a particulate filter as claimed in claim 16, wherein the parameters include vehicle speed.

21. The method for controlling regeneration of a particulate filter as claimed in claim 16, wherein the parameters include engine speed.

22. The method for controlling regeneration of a particulate filter as claimed in claim 16, wherein the parameters include engine torque.