A method for mutual adaptation of a delivery module and a metering module of an exhaust emissions control system that has an exhaust gas conduit and a control module, the delivery module having a reservoir that has a venting valve and contains a uric acid solution that is conveyed via a delivery pump to a pressure regulating valve; and in the metering module, an air stream being compressed with the aid of a pump, conveyed to a pressure accumulator, and conveyed via a regulating valve, together with the uric acid solution, out of the pressure regulating valve to a metering valve, and being conveyed from there to an atomizer unit disposed in the exhaust gas conduit, the value of a reference pressure based on the pressure forming in the exhaust gas conduit being stored in the control module. A method for mutual adaptation of a delivery module and a metering module of an exhaust emissions control system having a control module, a respective parameter or characteristic curve being created for the delivery module and for the metering module and being introduced into the respective module as a machine-readable code. An apparatus for mutual adaptation of a delivery module and metering module for an exhaust emissions control system having an exhaust gas conduit and a control module, the value of a reference pressure based on the pressure forming in the exhaust gas conduit in the context of a calibration cycle being stored in the control module. A mutual adaptation of any arbitrary metering and delivery modules can thereby be implemented in a simple and economical fashion.
METHOD AND APPARATUS FOR AN EXHAUST EMISSIONS CONTROL SYSTEM

FIELD OF THE INVENTION

[0001] The present invention relates to a method for mutual adaptation of a delivery module and a metering module of an exhaust emissions control system that has an exhaust gas conduit and a control module, the delivery module having a reservoir that has a venting valve and contains an aqueous solution that is conveyed via a delivery pump to a pressure regulating valve; and in the metering module, an air stream being compressed with the aid of a pump, conveyed to a pressure accumulator, and conveyed via a regulating valve, together with the aqueous solution, out of the pressure regulating valve to a metering valve, and being conveyed from there to an atomizer unit disposed in the exhaust gas conduit.

[0002] The present invention further relates to an apparatus for mutual adaptation of a delivery module and metering module for an exhaust emissions control system having an exhaust gas conduit and a control module.

BACKGROUND INFORMATION

[0003] Appropriate exhaust gas treatment is necessary in connection with future regulatory stipulations regarding emissions of nitrogen oxides from motor vehicles. The so-called selective catalytic reduction (SCR) method, among others, is to be used to decrease the NOx emissions of combustion engines, in particular diesel engines. In this method, a defined quantity of the reducing agent urea or urea-water solution (UWS) is added to the exhaust gas.

[0004] German Patent Application No. DE 101 39 142, for example, describes an exhaust emissions control system of an internal combustion engine in which an SCR converter, which reduces nitrogen oxides contained in the exhaust gas to nitrogen using ammonia as reagent, is used to decrease NOx emissions. The ammonia is obtained, in a hydrolytic converter located upstream from the SCR converter, from a urea-water solution (UWS). The hydrolytic converter converts the urea contained in the UWS into ammonia and carbon dioxide. In a second step, the ammonia reduces the nitrogen oxides to nitrogen, water being produced as a byproduct. The exact mechanism has been 'amply' described in the technical literature (cf. Weissweller in CIT (72), pp. 441-449, 2000). The UWS is provided in a reagent tank.

[0005] An exhaust emissions control system of this kind is usually constructed in modular fashion, being made up of a delivery module and a metering module for the UWS. For reasons of production logistics, it may happen in some circumstances that the delivery module and metering module are installed at different sites. For example, the delivery module may be installed by the vehicle manufacturer, but the metering module by the engine manufacturer. This complicates the process of compensating for production tolerances, which was previously still possible by applying a corresponding characteristic curve in the control unit. For logistical reasons, this can be accomplished only with greater effort. At the present state of development, therefore, paired modules are still supplied, the delivery module and metering module having previously been matched to one another.

[0006] It is therefore an object of the present invention to provide a method and apparatus with which mutual adaptation of any arbitrary metering and delivery modules can be achieved in simple and economical fashion.

SUMMARY OF THE INVENTION

[0007] An object relevant to the method is achieved in that for mutual adaptation of a delivery module and a metering module of an exhaust emissions control system that has an exhaust gas conduit and a control module, the value of a reference pressure based on the pressure forming in the exhaust gas conduit is stored in a control module. The delivery module has, in that context, a reservoir that has a venting valve and contains an aqueous solution that is conveyed via a delivery pump to a pressure regulating valve. In the metering module, an air stream is compressed with the aid of a pump, conveyed to a pressure accumulator, and conveyed via a regulating valve, together with the aqueous solution, out of the pressure regulating valve to a metering valve and from there to an atomizer unit disposed in the exhaust gas conduit. The pressure value stored in the control module is dependent on the air flow, the spray tube embodiment, and the various vehicle applications, and is a tolerance metric for the properties of the various modules, including the regulating valves, metering valves, and pressure regulating valves contained therein.

[0008] Deviations from the target value result in pressure values deviating from the target pressure value, from which values a working point for an optimum reduction in nitrogen oxides can be calculated.

[0009] Upon startup of the exhaust emissions control system, firstly the metering module is activated, the delivery module not being activated. As a result, the pressure conditions and mass flows depend exclusively on the properties of the metering module, the atomizer unit, and the exhaust gas conduit, and are not influenced by the properties of the delivery module.

[0010] Because, in a further step, the metering valve is opened and the reference pressure is stored in the control module once steady-state pressure conditions have been established, that pressure also does not depend on the properties of the delivery module.

[0011] In order to release any residual pressure in the reservoir that would interfere with the calibration operation, a variant method provides for the venting valve to be opened upon startup and to be closed again before the metering valve is opened.

[0012] As operation of the exhaust emissions control system proceeds, provision is made in a preferred embodiment for the adaptation of the delivery module and metering module to be accomplished as necessary and/or cyclically at specific time intervals. A recalibration as necessary may be required, for example, if an elevated nitrogen oxide content is detected with a sensor in the exhaust section. This allows a long-term and reliable reduction in nitrogen oxides from the exhaust gas during continuous operation. Any drift of the optimum working point as a result of aging of the components can thereby be compensated for.

[0013] An alternative method provides that for mutual adaptation of a delivery module and a metering module of an exhaust emissions control system having a control module,
a respective parameter or characteristic curve is created for the delivery module and for the metering module, and is introduced into the respective module as a machine-readable code. The individual properties of the modules, for example as a consequence of production tolerances, can be measured, and the modules can be correspondingly characterized. Upon startup, the method provides for the machine-readable code to be read and to be stored in the control module, for example in a nonvolatile memory (EEPROM or the like). The optimum working points for the various valves can then be calculated on the basis of the stored codes.

[0014] An object relevant to the apparatus is achieved in that the value of a reference pressure based on the pressure forming in the exhaust gas conduit in the context of a calibration cycle is stored in the control module, with the result that a calculation of the optimum working point, and thus an optimum adaptation of the delivery and metering modules, can be effected.

[0015] For the apparatus, the preferred embodiment provides for the above-described method sequence according to the present invention to be represented in the control module as hardware and/or software. The method sequence, constituting a subprogram, can be integrated particularly easily into the control module, or alternatively into a higher-level engine control software program. Necessary modifications in the method sequence for further optimization of nitrogen oxide values in the exhaust gas can thereby be implemented particularly quickly.

BRIEF DESCRIPTION OF THE DRAWING

[0016] FIG. 1 schematically depicts an exhaust emissions control system.

DETAILED DESCRIPTION

[0017] FIG. 1 shows a delivery module 10 and a metering module 20 of an exhaust emissions control system according to the existing art, having an exhaust gas conduit 30 and a control module 40.

[0018] Delivery module 10 is made up of a reservoir 11 that has a venting valve 11.1 and contains a uric acid solution (UWS) 12 which is conveyed via a delivery pump 13 to a metering valve 14. A pressure regulating valve 15 connected to the delivery side of pump 13 opens when the system pressure is too high, and then returns UWS to reservoir 11. In metering module 20, an air stream 26 is compressed with the aid of a pump 25, conveyed to a pressure accumulator 24, and conveyed via a regulating valve 23, together with the uric acid solution from delivery pump 13, to a metering valve 22. From there the air-UWS mixture is conveyed to an atomizer unit 21 disposed in exhaust gas conduit 30. In exhaust gas conduit 30, an exhaust gas stream 31 is conveyed in a first chamber to an oxidation catalytic converter 32. The air-UWS mixture is then injected into exhaust gas stream 31 by atomizer unit 21. The reaction that breaks down the nitrogen oxides then takes place in a second chamber that constitutes a SCR converter 33. A pressure sensor 34 on the SCR converter measures the pressure, and transmits the value to control module 40.

[0019] The method for mutual adaptation of delivery module 10 and metering module 20 provides for the value of a reference pressure based on the pressure forming in exhaust gas conduit 30 to be stored in control module 40. For that purpose, upon startup of exhaust emissions control system 1, firstly metering module 20 is activated by switching on pump 25. Delivery pump 13 of delivery module 10 is not activated. The result is that the pressure in pressure accumulator 24 can build up. Predetermined volume and pressure conditions for the downstream metering valve 22 are established with regulating valve 23.

[0020] In a further step, metering valve 22 is opened and air is blown out of regulating valve 23 through atomizer unit 21 into SCR converter 33. The pressure in SCR converter 33 is measured with pressure sensor 34. Once steady-state pressure conditions are established at pressure sensor 34, the pressure value is stored in control module 40 as the reference pressure.

[0021] After this calibration, delivery module 10 is switched on by activating delivery pump 13, causing exhaust emissions control system 1 to transition into the normal operating state.

[0022] An alternative embodiment provides that upon startup, venting valve 11.1 is opened and is closed again before metering valve 22 is opened, so that any residual pressure in reservoir 11 can be released before the calibration operation.

[0023] As the operation of exhaust emissions control system 1 proceeds, provision is made for the adaptation of delivery module 10 and metering module 20 to be accomplished as necessary and/or cyclically at specific time intervals.

[0024] A recalibration as necessary may be required, for example, if an elevated nitrogen oxide content is detected with a sensor in the exhaust section. This allows a long-term and reliable reduction in nitrogen oxides from the exhaust gas.

[0025] The apparatus provides for the value of the reference pressure based on the pressure forming in exhaust gas conduit 30 to be stored in a memory in control module 40. The above-described method sequence for adapting delivery module 10 and metering module 20 is preferably represented in control module 40 as hardware and/or software. Alternatively, the method sequence can also be stored in a higher-level engine control software program.

[0026] An alternative method provides that for mutual adaptation of delivery module 10 and metering module 20 of exhaust emissions control system 1, a respective parameter or characteristic curve is created for delivery module 10 and for metering module 20, and is introduced into the respective module as a machine-readable code. The individual properties of the modules, for example as a consequence of production tolerances, can be measured, and the modules can be correspondingly characterized.

[0027] Upon startup, the method provides for the machine-readable code to be read and to be stored in the control module, for example in a nonvolatile memory (EEPROM or the like). The optimum working points for the various valves can then be calculated on the basis of the stored codes.

[0028] With the method presented and with the corresponding apparatus, a mutual adaptation of any arbitrary metering and delivery modules can be implemented in
simple and economical fashion. This makes possible optimum nitrogen oxide reduction. It is additionally advantageous in this context that not only is equalization upon initial startup of the internal combustion performed, but also a recalibration, for example, to compensate for aging drift.

What is claimed is:

1. A method for mutual adaptation of a delivery module and a metering module of an exhaust emissions control system that has an exhaust gas conduit and a control module, the delivery module having a reservoir that has a venting valve and contains a uric acid solution, the method comprising:

   conveying the uric acid solution via a delivery pump to a pressure regulating valve;
   in the metering module, compressing an air stream by a pump, conveying the compressed air stream to a pressure accumulator, and conveying the compressed air stream via a regulating valve, together with the uric acid solution, out of the pressure regulating valve to a metering valve, and further conveying from the metering valve to an atomizer unit situated in the exhaust gas conduit; and
   storing, in the control module, a value of a reference pressure based on a pressure forming in the exhaust gas conduit.

2. The method according to claim 1, wherein upon startup of the exhaust emissions control system, firstly the metering module is activated, the delivery module not being activated.

3. The method according to claim 1, further comprising, in a further step, opening the metering valve and storing the reference pressure in the control module once steady-state pressure conditions have been established.

4. The method according to claim 1, further comprising, upon startup, opening the venting valve, and closing the venting valve again before the metering valve is opened.

5. The method according to claim 1, wherein as operation of the exhaust emissions control system proceeds, the adaptation of the delivery module and the metering module is accomplished at least one of (a) as necessary and (b) cyclically.

6. An apparatus for mutual adaptation of a delivery module and a metering module for an exhaust emissions control system having an exhaust gas conduit and a control module, the apparatus comprising:

   means for storing, in the control module, a value of a reference pressure based on a pressure forming in the exhaust gas conduit in the context of a calibration cycle.

7. The apparatus according to claim 6, wherein the control module is implemented in at least one of hardware and software.

8. A method for mutual adaptation of a delivery module and a metering module of an exhaust emissions control system having a control module, the method comprising:

   creating one of a respective parameter and characteristic curve for the delivery module and for the metering module; and
   introducing the one of the respective parameter and characteristic curve into a respective one of the delivery and metering modules as a machine-readable code.

9. The method according to claim 8, further comprising, upon startup, reading the machine-readable code and storing the code in the control module.

* * * * *