INJECTOR CLEANING SYSTEM BASED ON PRESSURE DECAY

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ABSTRACT

An injector cleaning system for use with an exhaust treatment device is disclosed. The injector cleaning system may have a supply of injection fluid and an injector configured to receive and inject the injection fluid. The injector cleaning system may also have a pressure sensor associated with the injector to generate a signal indicative of the pressure of the injection fluid supplied to the injector. The injector cleaning system may further have a controller in communication with the injector and the pressure sensor. The controller may be configured to determine a pressure decay rate of injection fluid supplied to the injector during a normal injection event based on the signal. The controller may be further configured to compare the determined pressure decay rate to an expected pressure decay rate, and supply cleaning fluid to the injector based on the comparison.
INJECTOR CLEANING SYSTEM BASED ON PRESSURE DECAY

TECHNICAL FIELD

[0001] The present disclosure is directed to an injector cleaning system and, more particularly, to an injector cleaning system that cleans an injector based on a pressure decay.

BACKGROUND

[0002] Engines, including diesel engines, gasoline engines, gaseous fuel powered engines, and other engines known in the art exhaust a complex mixture of air pollutants. These air pollutants include solid material known as particulate matter or soot. Due to increased attention on the environment, exhaust emission standards have become more stringent and the amount of particulate matter emitted from an engine is regulated depending on the type of engine, size of engine, and/or class of engine.

[0003] One method implemented by engine manufacturers to comply with the regulation of particulate matter exhausted to the environment has been to remove the particulate matter from the exhaust flow of an engine with a device called a particulate trap or diesel particulate filter. A particulate trap is a filter designed to trap particulate matter and typically consists of a wire mesh or ceramic honeycomb medium. However, the use of the particulate trap for extended periods of time may cause the particulate matter to build up in the medium, thereby reducing functionality of the filter and subsequent engine performance.

[0004] The collected particulate matter may be removed from the filter through a process called regeneration. To initiate regeneration of the filter, the temperature of the particulate matter trapped within the filter must be elevated to a combustion threshold, at which the particulate matter is burned away. One way to elevate the temperature of the particulate matter is to inject a catalytic such as diesel fuel into the exhaust flow of the engine and ignite the injected fuel.

[0005] After the regeneration event, the supply of fuel is shut off. However, some fuel may remain within the fuel injector or the fuel lines that direct fuel to the injector. This remaining fuel, when subjected to the harsh conditions of the exhaust stream, may coke or be partially burned, leaving behind a solid residue that can restrict or even block the fuel injector. In addition, it may be possible for particulate matter from the exhaust flow to enter and block the injector. For these reasons, it may be necessary to periodically clean or purge the injector of fuel and/or any built up residue or particulate matter between regeneration events.

[0006] One method of cleaning a fuel injector is described in U.S. Pat. No. 4,977,872 (the '872 patent) issued to Hartopp on Dec. 18, 1990. Specifically, the '872 patent discloses an injector cleaning/testing apparatus arranged to enable electrically actuated injectors to be cleaned and tested while in situ on an engine. The apparatus is connected to the fuel supply system of the engine, which feeds fuel and a cleaning fluid to each of the engine’s injectors. During a cleaning cycle, the injectors are connected for normal operation by the vehicle injector controls, and cleaning fluid is therefore injected into the engine so that it runs normally, the cleaning fluid also acting as fuel for the engine as well as cleaning the injectors by its passage therethrough.

[0007] Prior to or after a cleaning cycle, each fuel injector is individually tested to ascertain whether flow characteristics of the fuel injector are as required or if the cleaning operation was successful. To test the injectors, fuel is pumped to the injectors and the pressure of the fuel supply is measured. One of the injectors is then energized and opened for a predetermined time of, say 2-3 seconds. During this time interval, fuel is passed through the injector and a pressure drop occurs in the fuel line to the injector. A pressure sensor records the pressure drop over this time interval and signals the pressure drop to an electronic calculating means. The calculating means compares the recorded pressure drop with a calibrated amount to give an output signal indicating the flow rate through the selected injector. The tests determine for the operator which, if any, of the injectors is defective or inadequately cleaned.

[0008] Although the apparatus of the '872 patent may allow for testing and cleaning of injectors and does so in situ, it still may be limited. Specifically, because the apparatus only tests injector performance when manually triggered to do so, there may be situations when the injectors could be unknowingly operating sub-optimally such as between standard scheduled diagnostic/service events. In addition, because the apparatus only checks the quality of a cleaning based on a technician’s desire to do so, the quality checks may be periodically skipped or omitted altogether, thereby allowing for a malfunctioning injector to continue performing poorly. Further, because the apparatus of the '872 patent provides only a single level of cleaning, severely clogged injectors may be treated the same as injectors having only a slight restriction. For this reason, some injectors may be cleaned inadequately, while cleaning fluid may be unnecessarily wasted on other injectors.

[0009] The apparatus of the '872 patent may also be expensive and interruptive. That is, because the cleaning event may be triggered at any time, it may be periodically triggered when no clogging of the injectors exists. Unnecessary cleanings waste cleaning fluid, thereby increasing operational cost of the system. And, because cleaning causes isolation of the tested injector, engine operation may be interrupted each time a cleaning is initiated.

[0010] The cleaning system of the present disclosure solves one or more of the problems set forth above.

SUMMARY OF THE INVENTION

[0011] One aspect of the present disclosure is directed to an injector cleaning system. The injector cleaning system may include a supply of injection fluid and an injector configured to receive and inject the injection fluid. The injector cleaning system may also include a pressure sensor associated with the injector to generate a signal indicative of the pressure of the injection fluid supplied to the injector. The injector cleaning system may further include a controller in communication with the pressure sensor. The controller may be configured to determine a pressure decay rate of injection fluid supplied to the injector during a normal injection event based on the signal. The controller may be further configured to compare the determined pressure decay rate to an expected pressure decay rate, and supply cleaning fluid to the injector based on the comparison.

[0012] In another aspect the present disclosure is directed to a method of cleaning an injector. The method may include pressurizing an injection fluid and directing the injection fluid to an injector for subsequent injection. The method may also include sensing a pressure decay rate of the injection fluid during a normal injection event and comparing the sensed
pressure decay rate to an expected pressure decay rate. The method may further include supplying cleaning fluid to the injector based on the comparison.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a schematic and diagrammatic illustration of an exemplary disclosed power unit; and

[0014] FIG. 2 is a flowchart depicting an exemplary method of operating the power unit of FIG. 1.

DETAILED DESCRIPTION

[0015] FIG. 1 illustrates a power unit 10 having a common rail fuel system 12, an injector cleaning system 13 and an auxiliary regeneration device 14. For the purposes of this disclosure, power unit 10 is depicted and described as a four-stroke diesel engine. One skilled in the art will recognize, however, that power unit 10 may be any other type of internal combustion engine such as, for example, a gasoline or a gaseous fuel-powered engine. Power unit 10 may include an engine block 16 that at least partially defines a plurality of combustion chambers (not shown), and a crankshaft 18 rotatable within engine block 16.

[0016] Fuel system 12 may be a common rail fuel system that may include components that cooperate to deliver injections of pressurized fuel into each of the combustion chambers. Specifically, common rail fuel system 12 may include a tank 20 configured to hold a supply of fuel, and a fuel pumping arrangement 22 configured to pressurize the fuel and direct the pressurized fuel to a plurality of fuel injectors (not shown) by way of a common rail 24. It is further contemplated that fuel system 12 may be a unit injector fuel system that is mechanically or hydraulically actuated, or any other applicable fuel system known in the art.

[0017] Fuel pumping arrangement 22 may include one or more pumping devices that function to increase the pressure of the fuel and direct one or more pressurized streams of fuel to common rail 24. Fuel pumping arrangement 22 may be operably connected to power unit 10 and driven by crankshaft 18, via a gear train 26. It is contemplated, however, that fuel pumping arrangement 22 may alternatively be driven electrically, hydraulically, pneumatically, or in any other appropriate manner. Fuel pumping arrangement 22 may be connected to common rail 24 by way of a fuel line 32. One or more filtering elements 34, such as a primary filter and a secondary filter, may be disposed within fuel line 32 in series relation to remove debris and/or water from the fuel pressurized by fuel pumping arrangement 22.

[0018] Auxiliary regeneration device 14 may be associated with an exhaust treatment device 46. In particular, as exhaust from power unit 10 flows through housing 47 of exhaust treatment device 46, particulate matter may be removed from the exhaust flow by a wire mesh or ceramic honeycomb filtration media 48. Over time, the particulate matter may build up in filtration media 48 and, if left unchecked, the particulate matter buildup could be significant enough to restrict, or even block the flow of exhaust through exhaust treatment device 46, allowing for backpressure within the power unit 10 to increase. An increase in the backpressure of power unit 10 could reduce the power unit’s ability to draw in fresh air, resulting in decreased performance, increased exhaust temperatures, and poor fuel consumption.

[0019] Auxiliary regeneration device 14 may include components that cooperate to periodically reduce the buildup of particulate matter within filtration media 48. These components may include a housing 50, an injector 52, an igniter 54 and a combustion canister 56. Fuel from common rail fuel system 12 may flow to fuel injector 52, situated in housing 50. From injector 52, fuel may be injected into combustion canister 56 and ignited by igniter 54 in order to raise the temperature of filtration media 48. It is contemplated that auxiliary regeneration device 14 may include additional or different components such as, for example, one or more pilot injectors, additional main injectors, a controller, a pressure sensor, a temperature sensor, a flow sensor, a flow blocking device and other components known in the art. It is further contemplated that a system other than fuel system 12 may provide injection fluid to regeneration device 14.

[0020] Injector 52 may be disposed within housing 50 and connected to fuel line 32 by way of a fluid passageway 57 and a main control valve 58. Injector 52 may be operable to inject an amount of pressurized fuel into combustion canister 56 at predetermined timings, fuel pressures and fuel flow rates. The timing of fuel injection may be synchronized with sensory input received from a temperature sensor (not shown), one or more pressure sensors (not shown), a timer (not shown), or any other similar sensory devices such that the injections of fuel substantially correspond with a buildup of particulate matter within filtration media 48. For example, fuel may be injected as a pressure of the exhaust flowing through exhaust treatment device 46 exceeds a predetermined pressure level or a pressure drop across filtration media 48 exceeds a predetermined differential value. Alternatively or additionally, fuel may be injected as the temperature of the exhaust flowing through exhaust treatment device 46 exceeds a predetermined value. It is contemplated that fuel may also be injected on a set periodic basis, in addition to or regardless of pressure and temperature conditions, if desired.

[0021] Main control valve 58 may include an electronically controlled valve element that is a solenoid movable against a spring bias in response to a commanded flow rate from a first position, at which pressurized fuel may be directed to common rail 24, to a second position, at which fuel may be directed to auxiliary regeneration device 14. It is contemplated that main control valve 58 may alternatively be hydraulically or pneumatically actuated, if desired.

[0022] During a normal injection event, control valve 58 may open to direct pressurized fuel to flow through fuel injector 52 into combustion canister 56, and control valve 55 may close to end the injection event. After control valve 55 closes, fuel injector 52 may continue to provide fuel to combustion canister 56 until the pressure in fuel line 57 drops and fuel line 57 is substantially empty. This time period of pressure reduction (i.e. decay period) may vary depending on restriction through fuel injector 52. For the purposes of this disclosure, a normal injection event may be considered an event where a primary purpose of an injector is fulfilled. For example, in most situations, a normal injection event occurs when fuel is injected by a fuel injector for the purpose of combusting. In regeneration system 14, a normal injection event may be considered once in which fuel is injected by fuel injector 52 for the purpose of regenerating exhaust treatment device 48.

[0023] During a regeneration event, igniter 54 may facilitate ignition of fuel sprayed from injector 52 into combustion canister 56. For example, igniter 54 may embody a spark plug, and a spark developed across an electrode (not shown) of the spark plug may ignite the locally rich atmosphere.
creating a flame, which may be jetted or otherwise advanced toward the trapped particulate matter of filtration media 48. As a result, the temperature within exhaust treatment device 46 may rise to a level that causes ignition of the particulate matter, thereby regenerating exhaust treatment device 46.

[0024] After the regeneration event, the supply of fuel to injector 56 may be shut off. However, some fuel may remain within fuel injector 52 or fluid passageway 57. This remaining fuel, when subjected to the harsh conditions of the exhaust stream may cloy or be partially burned, leaving behind a solid residue that can restrict or even block fuel injector 52. In addition, it may be possible for particulate matter from the exhaust flow to enter and block injector 52. For this reason, it may be necessary to periodically clean or purge the injector of fuel and/or any built up residue or particulate matter between regeneration events.

[0025] Injector cleaning system 13 may be associated with auxiliary regeneration device 14 and incorporate components that may purge injector 52 based on the rate of pressure decay at the end of a normal injection event. The components of injector cleaning system 13 may include pressure sensor 60, a controller 62 and a cleaning solution reservoir 64. A purge passageway 66 may fluidly connect auxiliary regeneration device 14 to cleaning solution reservoir 64. A check valve 68 may be disposed within purge passageway 66 to ensure that fuel and other contaminants are blocked from flowing through purge passageway 66 to reservoir 64. The flow of cleaning fluid through purge passageway 66 may be controlled by way of a control valve 70 in response to a pressure measured by pressure sensor 60.

[0026] Pressure sensor 60 may be located upstream of fuel injector 52 and may generate a signal indicative of the pressure of the fuel and/or cleaning fluid supplied to injector 52. Controller 62 may communicate with pressure sensor 60 via communication line 72.

[0027] Controller 62 may include components such as for example, a memory, a secondary storage device, a processor and any other components for controlling injector cleaning system 13. Controller 62 may embody a single microprocessor or multiple microprocessors that include a means for cleaning injector 52 based on a sensed pressure decay rate. Numerous available microprocessors can be configured to perform the functions of controller 62. Various other known circuits may be associated with controller 62, including power supply circuitry, signal-conditioning circuitry, solenoid driver circuitry, temperature sensor circuitry, communication circuitry and other appropriate circuitry.

[0028] Controller 62 may include one or more maps stored within an internal memory of controller 62 and may reference these maps to determine an expected pressure decay rate associated with a normal injection (e.g. a regeneration event) and corresponding to one or more engine operating parameters. The maps may include, for example, tables, graphs, equations, collections of data, etc. For example, controller 62 may compare an observed pressure decay rate with a known acceptable pressure decay rate corresponding to a current operating temperature or engine rotational speed. Controller 62 may calculate a difference between the observed and expected pressure rates and, based on this difference, may determine an amount of restriction within the fuel injector 52. Controller 62 may also contain maps that relate the level of restriction within fuel injector 52 to an amount of cleaning fluid, pressure, flow rate and/or flow duration required to adequately clean clogged fuel injector 52.

[0029] Reservoir 64 may contain a pressurized cleaning fluid capable of flushing and/or dissolving exhaust particulate matter and/or coked fuel trapped within fuel injector 52 by way of fluid passageway 57. For example, reservoir 64 may be pressurized to approximately 150 psi with nitrogen gas and contain approximately eight to ten ounces of cleaning fluid for the purpose of removing debris as it passes through fuel injector 52. The cleaning fluid may, for example, be a low-sediment degreaser with an operating temperature range of about −40°C to 95°C. It is further contemplated that injector cleaning system 13 may be an air purge system that may, for example utilize an auxiliary air pump to inject air at approximately 30 psi through fuel injector 52.

[0030] FIG. 2 illustrates an exemplary method of operating injector cleaning system 13. FIG. 2 will be discussed in detail in the following section.

INDUSTRIAL APPLICABILITY

[0031] The injector cleaning system of the present disclosure may be applicable to a variety of injectors and in particular, injectors associated with regeneration devices. The cleaning method of the present disclosure may determine whether a restriction exists within an injector at the end of a normal injection event, quantify the level of restriction and provide multiple levels of cleaning, dependant upon an observed level of injector restriction. Furthermore, the injector cleaning system of the present disclosure may log a failure in the event of an unsuccessful cleaning routine. The operation of power unit 10 will now be explained.

[0032] Referring to FIG. 1, air and fuel may be drawn into the combustion chambers of power unit 10 for subsequent combustion. Specifically, fuel from common rail fuel system 12 may be injected into the combustion chambers of power unit 10, mixed with the air therein, and combusted by power unit 10 to produce a mechanical work output and an exhaust flow of hot gases. The exhaust flow may contain a complex mixture of air pollutants composed of gaseous and solid material, which can include particulate matter. As this particulate laden exhaust flow is directed from the combustion chambers through exhaust treatment device 46, particulate matter may be strained from the exhaust flow by filtration media 48. Over time, the particulate matter may build up in filtration media 48 and, if unchecked, the buildup could be sufficient enough to restrict, or even block the flow of exhaust through exhaust treatment device 46. As indicated above, the restriction of exhaust flow from power unit 10 may increase the backpressure of power unit 10 and reduce the unit’s ability to draw in fresh air, resulting in decreased performance of power unit 10, increased exhaust temperatures, and poor fuel consumption.

[0033] To prevent the undesired buildup of particulate matter within exhaust treatment device 46, filtration media 48 may be regenerated. Regeneration may be periodic or based on a triggering condition such as, for example, a lapsing time of engine operation, a pressure differential measured across filtration media 48, a temperature of the exhaust flowing from power unit 10, or any other condition known in the art.

[0034] To initiate regeneration, injector 52 may be caused to selectively pass fuel into exhaust treatment device 46 at a desired rate, pressure and/or timing (i.e. a normal injection event may be initiated). As an injection of fuel from injector 52 sprays into exhaust treatment device 46, air may be mixed with the fuel and the mixture may be ignited. The ignited flow of fuel and air may then raise the temperature of the particu-
late matter trapped within filtration media 48 to the combustion level of the entrapped particulate matter, burning away the particulate matter and, thereby, regenerating filtration media 48.

[0035] Between regeneration events, fuel injector 52 may be selectively purged of fuel and/or contaminants to ensure proper operation of fuel injector 52. Referring to FIG. 1 and FIG. 2, injector cleaning system 13 may perform a predetermined routine in response to a pressure decay rate at the conclusion of a regeneration event (e.g., a normal injection event). For example, control valve 58 may open to allow a finite amount of fuel to flow through fluid passageway 57, into injector 52, thereby initiating a regeneration combustion event within combustion canister 56 (step 1). At a predetermined time, control valve 58 may close to block further flow of fuel through fuel line 57 and injector 52, thereby ending the regeneration event. However, fuel within fuel line 57 may still be somewhat pressurized, and thus, the fuel may continue to flow through injector 52 until the pressure within fuel line 57 has diminished. During the interval in which fuel is forced from fuel line 57 and no additional fuel is supplied to fuel line 57, the pressure within fuel line 57 may decay at a rate corresponding to the rate at which fuel injector 52 injects fuel into combustion canister 56. The decay rates for each normal injection event may be relatively constant. However, if the flow of fuel through fuel injector 52 is restricted, the rate at which the pressure within fuel line 57 decays may decrease. The pressure in fluid passageway 57 may be measured by pressure sensor 60 during the pressure decay interval, and controller 62 may calculate a pressure decay rate based on the pressure measurements communicated via communication line 72 (step 2).

[0036] Controller 62 may compare the observed decay rate to an expected pressure decay rate (corresponding to a substantially clog-free injector) stored in one of its maps. In order to determine whether injector 52 is clogged, controller 62 may access a map that may include multiple maps indexed according to an engine operating parameter. Controller 62 may compare the observed pressure decay rate to an expected pressure decay rate stored in a map corresponding to a current engine operating parameter. If the observed pressure decay rate is comparable or greater than the expected pressure decay rate the regeneration event may proceed as normal. However, if the observed pressure decay rate is lower than the expected pressure decay rate, injector 52 may be at least partially clogged (step 3).

[0037] Following an observation of a lower than expected decay rate, controller 62 may open control valve 70, allowing the passage of cleaning solution from reservoir 64 into auxiliary regeneration device 14 for purging and/or combustion purposes (step 4). Controller 62 may calculate the magnitude of the injector restriction, based on the difference between the expected pressure decay rate and the observed pressure decay rate, in order to determine a quantity of cleaning fluid required to remove the clog, as well as the pressure, flow rate and/or duration of the fluid release. For example, controller 62 may trigger control valve 70 to release anywhere between about one half and three ounces of cleaning solution, based on the injector restriction amount. It is further contemplated that the pressure, flow rate and the duration of the injection of the cleaning fluid may be dependant upon the pressure decay rate. Alternately or additionally, controller 62 may direct the cleaning fluid to mix with fuel during the injector cleaning event. Furthermore, it is considered that pressurized fuel may be directed into fuel line 57 to drive the cleaning fluid into injector 52.

[0038] After the required amount of cleaning fluid has been released, control valve 70 may close. During the period in which cleaning fluid is being drained from fluid passageway 57 (also called a cleaning check period) and injected by fuel injector 52, pressure sensor 60 may again communicate the pressure within fluid passageway 57 to controller 62, and controller 62 may make a second comparison of the calculated pressure decay rate to the expected pressure decay rate (step 5). Alternatively or additionally, fuel may be injected during the cleaning check period (i.e., after the cleaning), with or without initiating combustion, for the purposes of detecting the resulting pressure decay rate.

[0039] When the second observed pressure decay rate exceeds the expected pressure decay rate, controller 62 may be allowed to initiate a subsequent purging event in a similar manner (step 6). However, if the pressure decay rate observed at the end of the second purging event still exceeds the expected pressure decay rate (step 7), controller 62 may log a fault indicating a severely clogged fuel injector 52 and may prevent initiation of additional purging events (step 8).

[0040] Several advantages may be associated with the injector cleaning system of the present disclosure. Specifically, the disclosed system may allow for the detection of a restricted injector following each normal injection event. That is, detection of a restriction may occur during every normal injection operation, without requiring additional or special injections. The injector cleaning system of the present disclosure may detect such a restriction within an injector without operator initiation and may continuously check for clogging, ensuring that the injector may continuously operate at an optimal level. Furthermore, the disclosed injector cleaning system may inject a quantity of cleaning fluid based on the severity of a restriction, thereby ensuring efficient use of cleaning fluid. Additionally, the disclosed injector cleaning system may measure the effectiveness of each cleaning event and either initiate a second cleaning event or log a failure. In this manner, the disclosed injector cleaning system may ensure that either the injectors remain clean and unrestricted, or an operator is alerted to sub-optimal operations.

[0041] It will be apparent to those skilled in the art that various modifications and variations can be made to the injector cleaning system of the present disclosure without departing from the scope of the disclosure. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the injector cleaning system disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims and their equivalents.

What is claimed is:
1. An injector cleaning system, comprising:
   a supply of injection fluid;
   an injector configured to receive and inject the injection fluid;
   a pressure sensor associated with the injector to generate a signal indicative of the pressure of the injection fluid supplied to the injector; and
   a controller in communication with the injector and the pressure sensor, the controller being configured to:
determine a pressure decay rate of injection fluid supplied to the injector during a normal injection event based on the signal; compare the determined pressure decay rate to an expected pressure decay rate; and supply cleaning fluid to the injector based on the comparison.

2. The injector cleaning system of claim 1, wherein supplying cleaning fluid initiates a cleaning event and the controller is further configured to determine a second pressure decay rate following every cleaning event to determine an effectiveness of the cleaning event.

3. The injector cleaning system of claim 2, wherein a supplemental injection event is initiated for determination of the second pressure decay rate.

4. The injector cleaning system of claim 3, wherein injection fluid associated with the supplemental injection event passes from the injector through an associated combustion chamber without combustion.

5. The injector cleaning system of claim 2, wherein the controller is further configured to determine a secondary cleaning event when the second pressure decay rate exceeds the expected pressure decay rate by a predetermined amount.

6. The injector cleaning system of claim 5, wherein the controller is further configured to determine a third pressure decay rate following the secondary cleaning event and log a fault condition when the third pressure decay rate exceeds the expected decay rate by a predetermined amount.

7. The injector cleaning system of claim 1, wherein the controller is configured to determine the pressure decay rate during every normal injection event.

8. The injector cleaning system of claim 1, wherein the controller includes at least one map stored in memory thereof relating the comparison to an injector restriction amount, and the amount of cleaning fluid supplied to the injector is based on the injector restriction amount.

9. The injector cleaning system of claim 8, wherein the at least one map includes a plurality of maps, each of the plurality of maps being indexed accordingly to an engine operational parameter.

10. The injector cleaning system of claim 1, wherein supplying includes directing the cleaning fluid to mix with the injecting fluid upstream of the injector.

11. The injector control system of claim 1, wherein the injector is located to inject the injection fluid into an exhaust stream to raise a temperature of the exhaust stream.

12. A method of cleaning, comprising: pressurizing an injection fluid; injecting the pressurized injection fluid during a normal injection event; sensing a pressure decay rate associated with the normal injection event; comparing the sensed pressure decay rate to an expected pressure decay rate; and injecting a cleaning fluid based on the comparison.

13. The method of claim 12, wherein injecting the cleaning fluid initiates a cleaning event and the method further includes determining a second pressure decay rate following every cleaning event to determine an effectiveness of the cleaning event.

14. The method of claim 13, further including initiating a supplemental injection event is initiated for determination of the second pressure decay rate.

15. The method of claim 13, further including initiating a secondary cleaning event when the second pressure decay rate exceeds the expected pressure decay rate by a predetermined amount.

16. The method of claim 15, further including determining a third pressure decay rate following the secondary cleaning event and logging a fault condition when the third pressure decay rate exceeds the expected decay rate by a predetermined amount.

17. The method of claim 12, wherein sensing the pressure decay rate includes sensing the pressure decay rate during every normal injection event.

18. The method of claim 12, further including relating the comparison to a restriction amount, wherein an amount of cleaning fluid injected is based on the restriction amount.

19. The method of claim 12, wherein injecting the cleaning fluid includes directing the cleaning fluid to mix with the injecting fluid prior to injection.

20. An exhaust treatment system, comprising: a supply of injection fluid; a sensor associated with the supply of injection fluid to generate a signal indicative of an injection fluid pressure; a housing configured to receive a flow of exhaust; an injector disposed within the housing to receive the supply of injection fluid and inject the injection fluid into the flow of exhaust; a supply of cleaning fluid; and a controller in communication with the sensor and the injector, the controller being configured to: determine a pressure decay rate of injection fluid supplied to the injector during a normal injection event based on the signal; compare the determined pressure decay rate to an expected pressure decay rate; and supply cleaning fluid to the injector in an amount based on the comparison.

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