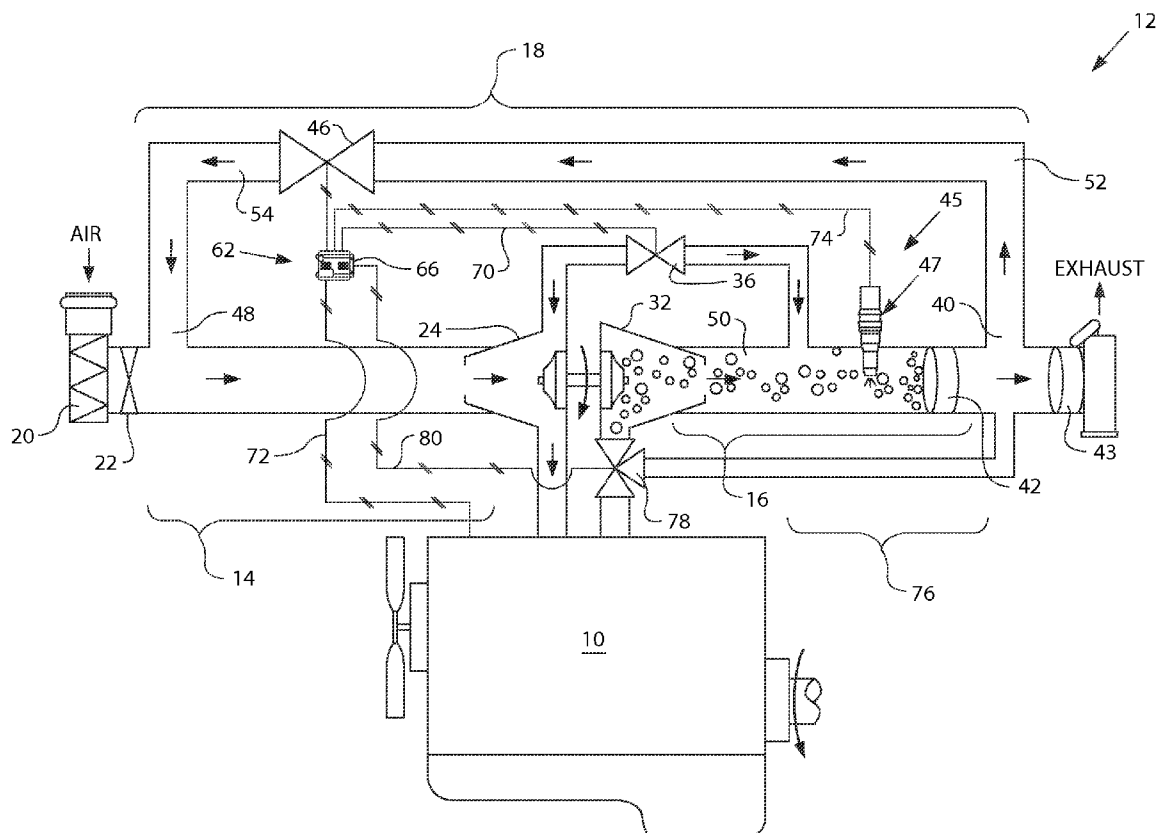


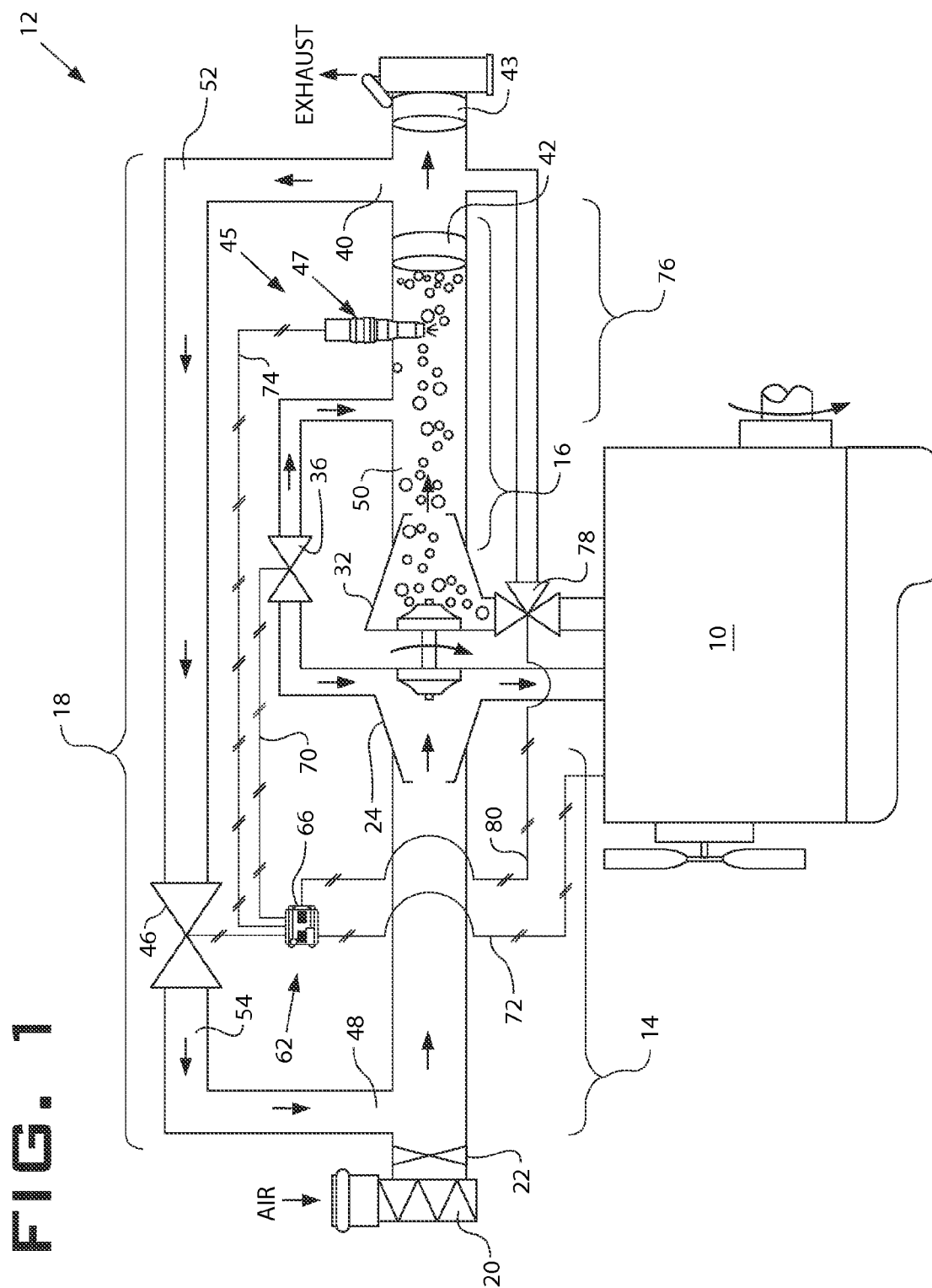


US 20110041483A1

(19) **United States**(12) **Patent Application Publication**
Kapparos(10) **Pub. No.: US 2011/0041483 A1**(43) **Pub. Date: Feb. 24, 2011**(54) **METHOD OF CONTROLLING FUEL IN AN
EXHAUST TREATMENT SYSTEM
IMPLEMENTING TEMPORARY ENGINE
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PEORIA, IL 61629-9510 (US)(73) Assignee: **Caterpillar Inc.**, Peoria, IL (US)(21) Appl. No.: **12/545,124**(22) Filed: **Aug. 21, 2009****Publication Classification**(51) **Int. Cl.**
F01N 9/00 (2006.01)
F01N 3/023 (2006.01)(52) **U.S. Cl.** **60/288; 60/295**(57) **ABSTRACT**

An exhaust treatment system associated with a power source is disclosed. The exhaust treatment system may have a filter located to remove particulate matter from a flow of exhaust, and a regeneration device located proximal the filter. The exhaust treatment system may also have a first fluid handling component located upstream of the power source to vary an amount of oxygen in the flow of exhaust, a second fluid handling component located downstream of the power source to vary the amount of exhaust air flow in the exhaust circuit, and a controller in communication with the regeneration device and the fluid handling component. The controller may determine a need for filter regeneration, and determine adjustments to the first and second fluid handling components required to provide sufficient oxygen and air mass flow in the exhaust for filter regeneration. The controller may further determine an effect the adjustments will have on operation of the power source, and determine corrections for the power source to account for the effects. The controller may substantially simultaneously implement the adjustments and the corrections.





METHOD OF CONTROLLING FUEL IN AN EXHAUST TREATMENT SYSTEM IMPLEMENTING TEMPORARY ENGINE CONTROL

TECHNICAL FIELD

[0001] The present disclosure relates generally to an exhaust treatment system and, more particularly, to a method of controlling fuel in an exhaust treatment system that implements temporary engine control.

BACKGROUND

[0002] Engines, including diesel engines, gasoline engines, natural gas engines, and other engines known in the art, exhaust a complex mixture of air pollutants. The air pollutants may be composed of gaseous and solid material, which include nitrous oxides (NOx) and particulate matter. Due to increased attention on the environment, exhaust emission standards have become more stringent and the amount of NOx and particulate matter emitted from an engine may be regulated depending on the type of engine, size of engine, and/or class of engine.

[0003] One method that has been implemented by engine manufacturers to comply with the regulation of NOx exhausted to the environment has been to recirculate exhaust gas from an engine back into the engine for subsequent combustion. The recirculated exhaust gas reduces the concentration of oxygen in the intake air supplied to the engine, which in turn lowers the maximum combustion temperature within cylinders of the engine. The reduced temperature slows the chemical process associated with combustion and, thereby, decreases the formation of NOx.

[0004] A method used by engine manufacturers to reduce the amount of particulate matter emitted to the environment includes removing the particulate matter from the exhaust flow of an engine with a device called a particulate filter. A particulate filter is designed to trap particulate matter and typically consists of a wire mesh or ceramic honeycomb filtration medium. Although efficient at removing particulate matter from an exhaust flow, the use of the particulate filter for extended periods of time may cause the particulate matter to build up in the filtration medium, thereby reducing the functionality of the filter and subsequent engine performance. The collected particulate matter may be removed from the filtration medium through a process called regeneration. To initiate regeneration of the filtration medium, the temperature of the particulate matter entrained within the filtration medium must be elevated to a combustion threshold, at which the particulate matter is burned away in the presence of oxygen.

[0005] Although the recirculation of exhaust gas and the use of a particulate filter may minimize the discharge of NOx and particulate matter to the atmosphere, both methods may affect or be affected by the amount of oxygen entering and leaving the engine. Specifically, exhaust gas recirculation (EGR) works by lowering the amount of oxygen entering the engine and available for combustion. Regeneration of the particulate filter requires oxygen to facilitate the burning away of trapped particulate matter. Thus, when EGR is operational, regeneration of the particulate filter may be only minimally effective, as the amount of oxygen available for regeneration is reduced by the use of EGR. For this reason, in some applications, the two exhaust treatment methods may be

mutually exclusive or require additional or dedicated sources of oxygen for regeneration purposes.

[0006] One attempt at using both EGR and particulate trapping/regeneration in the same engine system is described in U.S. Patent Publication No. 2002/50,150,218 (the '218 publication), by Crawley et al. published on Jul. 14, 2005. Specifically, the '218 publication describes an engine having an exhaust gas recirculation system and an emission abatement assembly. The emission abatement assembly includes a fuel-fired burner located upstream of a particulate filter to regenerate the particulate filter. During operation of the engine, exhaust gas flows through the particulate filter, thereby trapping soot (i.e., particulate matter) in the filter. The treated exhaust gas is then released into the atmosphere through an exhaust pipe. From time to time during operation of the engine, a control unit selectively operates the fuel-fired burner to regenerate the particulate filter. In one configuration, the emission abatement assembly does not utilize supplemental air. As such, the position of an EGR valve is coordinated with the regeneration of the particulate filter. That is, to increase both the temperature and the oxygen content in the exhaust gas, the engine's EGR valve is momentarily closed for a period of about ten minutes. During this period of time, the fuel-fired burner, being provided with a flow of fuel and sufficient oxygen in the exhaust, is actuated to heat and thereby regenerate the particulate filter.

[0007] Although the engine of the '218 publication may utilize and benefit from both an EGR system and a particulate filter, operation of the associated engine may be non-compliant and/or sub-optimal during regeneration. That is, because EGR is utilized to reduce NOx emissions, by turning EGR off (i.e., by closing the EGR valve) during particulate regeneration, the engine may discharge excessive amounts of NOx during that time period. In addition, because relative amounts of air and fuel entering and being combusted by the engine change when the EGR valve closes, regeneration of the particulate filter could negatively and/or unexpectedly affect other aspects of engine performance (i.e., power output, fuel consumption, etc.) during the regeneration period. Additionally, during regeneration, large quantities of fuel are consumed as the fuel-fired burner heats all of the exhaust gases coming from the power source.

[0008] The disclosed exhaust treatment system is directed to overcoming one or more of the problems set forth above.

SUMMARY OF THE INVENTION

[0009] In one aspect, the present disclosure is directed to an exhaust treatment system associated with a power source. The exhaust treatment system may include a filter located downstream of the power source to remove particulate matter from a flow of exhaust produced by the power source. The exhaust treatment system may also include a regeneration device located proximal the filter to raise a temperature of the removed particulate matter above an ignition threshold. The exhaust treatment system may also include a first fluid handling component located upstream of the power source to vary an amount of oxygen in the flow of exhaust, and a second fluid handling component located downstream of the power source and upstream of the regeneration device to vary the flow of exhaust bypassing the regeneration device. The exhaust treatment system may also include a controller in communication with the power source, filter, regeneration device, first fluid handling component, and second fluid handling component. The controller may be configured to deter-

mine a need for filter regeneration. The controller may also be configured to determine a first adjustment to the first fluid handling component to provide sufficient oxygen in the exhaust flow for filter regeneration. Further, the controller may also be configured to determine a second adjustment to the second fluid handling component to provide sufficient mass flow in the exhaust bypassing the regeneration device. The controller may also facilitate the regeneration of the filter.

[0010] In another aspect, the present disclosure is directed to a method for regenerating a filter that removes particulate matter from a flow of exhaust produced by a power source. The method may include the step of combusting a fuel and air mixture to generate power and a flow of exhaust. The method uses a filter to remove and collect particulate matter from the flow of exhaust. The need for regeneration of the filter may be determined. Additionally, adjustments in the amount of oxygen required for the regeneration device to regenerate the filter may be determined. Adjustments in the flow of exhaust bypassing the regeneration device may be determined. The filter may then be regenerated.

[0011] In yet another aspect, the present disclosure is directed to an engine system having an engine configured to combust a fuel and air mixture to generate power and a flow of exhaust. The engine system may also have a charged air induction circuit configured to introduce compressed air into the engine. The system may also have an exhaust circuit configured to direct the flow of exhaust from the engine to the atmosphere. Further, the system may have a filter located downstream of the engine to remove particulate matter from the flow of exhaust. The system may also include a regeneration device located proximal the filter to raise a temperature of the removed particulate matter above an ignition threshold. A first valve may be located upstream of the engine to vary an amount of oxygen in the flow of exhaust. A second valve may also be located downstream of the engine and upstream of the regeneration device to vary the flow of exhaust bypassing the regeneration device. The system may also include a controller in communication with the engine, filter, regeneration device, first valve and second valve. The controller may be configured to determine a need for particulate filter regeneration. The controller may also determine a first adjustment to the first valve regulating oxygen in the exhaust flow for filter regeneration. The controller may also determine a second adjustment to the second valve regulating exhaust flow bypassing the regeneration device. Further, the controller may also facilitate the regeneration of the filter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a diagrammatic illustration of a power source having an exemplary disclosed exhaust treatment system.

DETAILED DESCRIPTION

[0013] FIG. 1 illustrates a power source 10 having an exemplary exhaust treatment system 12. Power source 10 may embody an engine such as, for example, a diesel engine, a gasoline engine, a gaseous fuel-powered engine such as a natural gas engine, or any other engine apparent to one skilled in the art. Power source 10 may alternatively embody a non-engine source of power such as a furnace. Exhaust treatment system 12 may include an air induction circuit 14, an exhaust circuit 16, and a recirculation circuit 18 coupled to power source 10 to transfer fluids into and out of power source 10.

[0014] Air induction circuit 14 may include a means for introducing charged air into a combustion chamber (not shown) of power source 10. For example, air induction circuit 14 may include an air cleaner 20 and an induction valve 22 fluidly coupled upstream of one or more compressors 24. It is contemplated that additional and/or different components may be included within air induction circuit 14 such as, for example, one or more air coolers located upstream and/or downstream of compressors 24, a waste gate associated with pressure relief of compressors 24, and other means known in the art for introducing charged air into the combustion chambers of power source 10.

[0015] Induction valve 22 may regulate the flow of atmospheric air from cleaner 20 to compressors 24. Induction valve 22 may include, for example, a butterfly element, a shutter element, a gate element, a ball element, a globe element, or any other type of valve element known in the art. The element of induction valve 22 may be disposed within a passageway 28 and be movable from a flow passing position against a spring bias toward a flow restricting position. In one example, the element of induction valve 22 may be connected to a torsional spring (not shown) that may bias the element toward the flow restricting position. When in the flow passing position, atmospheric air may be directed from cleaner 20 through compressors 24 into power source 10 substantially unrestricted. The element of induction valve 22 may be moved to any position between the flow restricting and flow passing positions in response to one or more input.

[0016] Compressors 24 may be disposed in a series relationship and fluidly connected to power source 10 to compress the air flowing into power source 10 to a predetermined level. Each of compressors 24 may embody a fixed geometry compressor, a variable geometry compressor, or any other type of compressor known in the art. It is contemplated that compressors 24 may alternatively be disposed in a parallel relationship or that air induction circuit 14 may include only a single compressor 24. It is further contemplated that compressors 24 may be omitted, when a non-pressurized air induction circuit is desired.

[0017] Exhaust circuit 16 may include a means for treating and directing exhaust flow out of power source 10. For example, exhaust circuit 16 may include one or more turbines 32 connected to receive exhaust from power source 10 in a series relationship, a particulate filter 42 located downstream of turbines 32, and a NOx absorber 43 located downstream of particulate filter 42. It is contemplated that exhaust circuit 16 may include additional and/or different components such as, for example, catalyzed emission controlling devices, attenuation devices, and other means known in the art for treating and directing exhaust flow out of power source 10.

[0018] Each turbine 32 may be connected to one compressor 24 to drive the connected compressor 24. In particular, as the hot exhaust gases exiting power source 10 expand against blades (not shown) of turbine 32, turbine 32 may rotate and drive the connected compressor 24. It is contemplated that turbines 32 may alternatively be disposed in a parallel relationship or that only a single turbine 32 may be included within exhaust circuit 16. It is also contemplated that turbines 32 may be omitted and compressors 24 may be driven by power source 10 mechanically, hydraulically, electrically, or in any other manner known in the art, if desired.

[0019] Particulate filter 42 may be disposed downstream of turbines 32 to remove particulates from the exhaust flow of power source 10. It is contemplated that particulate filter 42

may include electrically conductive or non-conductive coarse mesh metallic or ceramic elements. It is also contemplated that particulate filter 42 may include a catalyst (not shown) for reducing an ignition temperature of the particulate matter trapped by particulate filter 42, a means 45 for regenerating the particulate matter trapped by particulate filter 42, or both a catalyst and a means for regenerating. The catalyst may support the reduction of HC, CO, and/or particulate matter, and may include, for example, a base metal oxide, a molten salt, and/or a precious metal. The means 45 for regenerating may include, among other things, a fuel-fired burner 47, an electrically-resistive heater, an engine control strategy, or any other suitable means for regenerating. It is further contemplated that particulate filter 42 may be relocated elsewhere within recirculation circuit 18, if desired.

[0020] NOx absorber 43 may include one or more substrates coated with or otherwise containing a liquid or gaseous catalyst such as, for example, a precious metal-containing washcoat. The catalyst may be utilized to reduce the byproducts of combustion in the exhaust flow by means of selective catalytic reduction (SCR) or NOx trapping. In one example, a reagent such as urea may be injected into the exhaust flow upstream of NOx absorber 43. The urea may decompose to ammonia, which reacts with NOx in the exhaust to form H₂O and N₂. In another example, NOx in the exhaust may be trapped by a barium salt-containing device and be periodically released and reduced across a catalyst to form CO₂ and N₂. NOx absorber 43 may also be utilized to oxidize particulate matter that remains in the exhaust flow after passing through particulate filter 42, if desired.

[0021] A first bypass circuit 34 may be associated with air induction circuit 14 and exhaust circuit 16 to selectively pass charged air from compressor 24 around power source 10 to the means 45 for regenerating particulate filter 42. A bypass valve 36 may be located within circuit 34 and include, for example, a butterfly element, a shutter element, a gate element, a ball element, a globe element, or any other type of valve element known in the art that is movable to regulate the flow of charge air through bypass circuit 34.

[0022] Recirculation circuit 18 may include a means for redirecting a portion of the exhaust flow of power source 10 from exhaust circuit 16 into air induction circuit 14. For example, recirculation circuit 18 may include an inlet port 40, a recirculation valve 46, and a discharge port 48. It is contemplated that recirculation circuit 18 may include additional and/or different components such as an exhaust cooler, a catalyst, an electrostatic precipitation device, a shield gas system, and other means known in the art for redirecting substantially particulate-free exhaust from exhaust circuit 16 into induction circuit 14. As a portion of the exhaust from exhaust circuit 16 enters recirculation circuit 18 via inlet port 40, the exhaust may be restricted to a desired flow rate by recirculation valve 46, and directed into induction circuit 14 via discharge port 48. Inlet port 40 may be connected to exhaust circuit 16 to receive at least a portion of the exhaust flow from power source 10. Specifically, inlet port 40 may be disposed downstream of turbines 32 to receive low-pressure exhaust gas from turbines 32.

[0023] A second bypass circuit 76 may be associated with recirculation circuit 18 to selectively pass at least a portion of exhaust gas from power source 10 around exhaust circuit 16; downstream of particulate filter 42; and into the inlet port 40 of recirculation circuit 18. A bypass valve 78 may be located within bypass circuit 76, and include, for example, a two-way

or three-way valve including a butterfly element, a shutter element, a gate element, a ball element, a globe element, or any other type of valve element known in the art. The bypass valve may be located adjacent and downstream of the power source 10. Further, bypass valve 76 may be located upstream of fuel fired burner 47.

[0024] Recirculation valve 46 may be fluidly connected to inlet port 40 via a fluid passageway 52, and to discharge port 48 via a fluid passageway 54. In this manner, recirculation valve 46 may be situated to selectively pass or restrict the flow of exhaust from exhaust circuit 16 into air induction circuit 14.

[0025] Discharge port 48 may be fluidly connected to recirculation valve 46 to direct the exhaust flow regulated by recirculation valve 46 into air induction circuit 14. Specifically, discharge port 48 may be connected to air induction circuit 14 upstream of compressors 24, such that compressors 24 may draw the exhaust flow from discharge port 48. In an alternative high pressure exhaust recirculation circuit, it is contemplated that discharge port 48 may be located downstream of compressors 24, if desired.

[0026] A control system 62 may include components that interact to determine and control operational characteristics of induction, exhaust, and recirculation circuits 14, 16, 18. In particular, control system 62 may include a controller 66 in communication with air induction valve 22, bypass valve 36, recirculation valve 46, the means 45 for regenerating particulate filter 42, power source 10, bypass valve 78, via communication lines 68, 70, 72, 74, and 80 respectively. It is contemplated that additional sensors such as, for example, an engine speed sensor, an exhaust temperature or oxygen sensor, an intake air pressure or temperature sensor, a fuel flow or pressure sensor, a NOx sensor, or any other type of sensor known in the art, may also be included within control system 62 and in communication with controller 66, if desired.

[0027] Controller 66 may embody a single microprocessor or multiple microprocessors that include a means for controlling an operation of induction, exhaust, and recirculation circuits 14, 16, 18, and power source 10. Numerous commercially available microprocessors can be configured to perform the functions of controller 66. It should be appreciated that controller 66 could readily embody a general power source microprocessor capable of controlling numerous engine functions. Controller 66 may include a memory, a secondary storage device, a processor, and other components for running an application. Various other circuits may be associated with controller 66 such as power supply circuitry, signal conditioning circuitry, solenoid driver circuitry, and other types of circuitry.

[0028] One or more maps relating an exhaust oxygen concentration, a boost pressure, an intake air temperature, an intake air flow rate, an engine fuel injection amount, an injection timing, an injection pressure, an engine power output, exhaust air flow rate, exhaust emission level, and/or a required setting or configuration of a first and second fluid handling component may be stored in the memory of controller 66. Each of these maps may be a collection of data in the form of tables, graphs, and/or equations.

[0029] Controller 66 may receive input indicative of a need for particulate filter regeneration, and reference the maps described above to determine an adjustment to a first fluid handling component (i.e., induction valve 22, compressor 24, bypass valve 36, recirculation valve 46, etc.) required to provide oxygen in the exhaust flow sufficient to facilitate the

regeneration event. That is, in order to achieve an appropriate temperature for regenerating particulate filter 42, a sufficient supply of oxygen must be present to properly combust the fuel injected by burner 47. Controller 66 may further reference the described maps to determine an adjustment to a second fluid handling component (i.e., bypass valve 78, recirculation valve 46, etc.) required to provide the minimum exhaust air flow rate to facilitate the regeneration event.

[0030] Thus, in response to the indicated need for regeneration, controller 66 may reference the maps to determine an increased opening amount of induction valve 22 (i.e., a decreased restriction of induction valve 22) that allows more oxygen to enter and pass through power source 10 to burner 47, a change in a compressor characteristic that increases a pressure and/or a flow rate of air entering and passing through power source 10, an increased opening of bypass valve 36 that amplifies an amount of air diverted directly to the exhaust downstream of power source 10, and/or a decreased opening of recirculation valve 46 (i.e., an increased restriction on the exhaust being recirculated to air induction circuit 14) such that the concentration of oxygen entering and leaving power source 10 increases. Further, in response to the indicated need for regeneration, controller 66 may reference maps to determine an increased restriction in bypass valve 78 that reduces the exhaust air flow rate in exhaust circuit 16 (i.e., increases the exhaust air flow rate in bypass circuit 76), and/or a increased opening of recirculation valve 46 (i.e., a decreased restriction on the exhaust being recirculated to air induction circuit 14) such that the mass flow rate of air being delivered to burner 47 is reduced. The need for regeneration may be based on an elapsed period of time, a pressure or temperature of the exhaust measured or predicted upstream of particulate filter 42, a differential pressure measured or predicted across particulate filter 42, a calculated amount of soot loading, or other similar parameter. It is contemplated that controller 66 may resolve conflicts between the aforementioned maps to optimize oxygen and exhaust air flow rates in order to achieve regeneration of particulate filter 42 in a manner that reduces energy and fuel costs.

[0031] Controller 66 may also be configured to determine a correction to the operation of power source 10 that is necessary to account for the adjustment(s) made to the fluid handling components. Specifically, when adjusting the opening amount of air induction valve 22, changing a characteristic of compressor 24 to increase a pressure and/or flow rate of air entering power source 10, increasing an opening of bypass valve 36, and/or decreasing an opening of recirculation valve 46, the air-to-fuel ratio of power source 10 may change significantly. For example, when air induction valve 22 is opened to a greater extent, the configuration or performance of compressor 24 is changed to increase boost pressure and/or intake air flow, or recirculation valve 46 is closed a greater amount, the air-to-fuel ratio of power source 10 may increase. In contrast, when bypass valve 36 is opened to a greater amount, the air-to-fuel ratio of power source 10 may decrease. As such, the power output, operating temperatures, exhaust emission levels, fuel consumption, and other performance factors of power source 10 may be affected. And, in order to continue providing a demanded power output, ensure operation of power source 10 remains within design guidelines, the emissions of power source 10 remain compliant with government regulations, and the general performance of power source 10 remains acceptable to an operator thereof, characteristics of power source 10 may require some correction

during the regeneration event. Some of these characteristics may include, among other things, a fueling characteristic (injection amount, pressure, number and/or distribution of injection shots, injection timing, etc) and an air induction characteristic (boost pressure, engine valve timing, etc.). Controller 66 may determine what correction may be required to maintain consistent or even improve power source operation during the regeneration event (i.e., during the time period when the operational characteristics of exhaust and recirculation circuits 16, 18 are being adjusted to accommodate a regeneration of particulate filter 42).

[0032] Controller 66 may implement both the adjustment(s) required for particulate filter regeneration and the power source operational correction(s) substantially simultaneously. That is, once controller 66 has determined the required adjustment(s) and the required correction(s), both the adjustment(s) and correction(s) may be implemented such that the performance of power source 10 remains substantially within or enters a desired performance range during the regeneration event. For the purposes of this disclosure, the term "substantially simultaneously" may refer to a predetermined time period during which multiple actions are performed by controller 66 such as, for example, when controller 66 implements the adjustment(s) and the correction(s) with a few seconds (or less) of each other.

INDUSTRIAL APPLICABILITY

[0033] The disclosed exhaust treatment system may be applicable to any combustion-type device such as, for example, an engine, a furnace, or any other combustion device known in the art where a particulate filter regeneration event may affect performance of the combustion-type device. The disclosed treatment system may maintain consistent or even improve performance of the combustion-type device during the regeneration event, by anticipating a change in air-to-fuel ratio of the device during the event, determining an affect the change will have on the device, and correcting operational characteristics of the device during the event to accommodate the affect. The operation of exhaust treatment system 12 will now be explained.

[0034] Atmospheric air may be drawn into air induction circuit 14 via induction valve 22 and directed through compressors 24 where it may be pressurized to a predetermined level before entering the combustion chamber of power source 10. Fuel may be mixed with the pressurized air before or after entering the combustion chamber of power source 10, and then be combusted by power source 10 to produce mechanical work and an exhaust flow containing gaseous compounds and solid particulate matter. The exhaust flow may be directed from power source 10 to turbines 32 where the expansion of hot exhaust gases may cause turbines 32 to rotate, thereby rotating connected compressors 24 to compress the inlet air. After exiting turbines 32 and flowing through particulate filter 42, the exhaust gas flow may be divided into two substantially particulate-free flows, including a first flow redirected to air induction circuit 14 and a second flow directed to the atmosphere.

[0035] The flow of the reduced-particulate exhaust directed through inlet port 40 may be drawn via recirculation valve 46 back into air induction circuit 14 by compressors 24. The controlled restriction of exhaust by recirculation valve 46 may affect the amount of exhaust drawn by compressors 24 through air induction circuit 14 to power source 10.

[0036] The recirculated exhaust flow may then be mixed with the air entering the combustion chambers. The exhaust gas, which is directed to the combustion chambers of power source 10, may reduce the concentration of oxygen therein, which in turn lowers the maximum combustion temperature within power source 10. The lowered maximum combustion temperature may slow the chemical reaction of the combustion process, thereby decreasing the formation of nitrous oxides. In this manner, the gaseous pollution produced by power source 10 may be reduced without experiencing the harmful effects and poor performance caused by excessive particulate matter being directed into power source 10. As the second flow of exhaust passes inlet port 40, it may be directed through a catalyst to remove NOx and other pollutants from the exhaust.

[0037] After a period of power source operation, the buildup of particulate matter in particulate filter 42 may be significant and require regeneration. To regenerate particulate filter 42, fuel-fired burner 47 may inject an amount of fuel into the exhaust stream of power source 10 upstream of particulate filter 42. To ensure efficient burning of the injected fuel and complete regeneration of particulate filter 42, a sufficient concentration of oxygen must be present in the exhaust flow. The oxygen may be supplied in at least two ways, including directly from compressor 24 via bypass circuit 34, or indirectly from compressor 24 via power source 10.

[0038] To directly increase the concentration of oxygen in the exhaust from power source 10, bypass valve 36 may be moved to reduce a restriction on the flow of charged air passing through bypass circuit 34. The amount of air passing through circuit 34 may be sufficient to regenerate particulate filter 42, and regulated by controller 66, as described above. However, by allowing a greater amount of air to pass through circuit 34, less air may be available for combustion within power source 10 (i.e., the air-to-fuel ratio may decrease), if the adjustment of bypass valve 36 is unaccounted for. A lower air-to-fuel ratio may increase exhaust temperatures and emissions of power source 10, while simultaneously reducing a power output and fuel efficiency thereof.

[0039] To minimize the affect that the adjustment of bypass valve 36 may have on the performance of power source 10, various operational characteristics of power source 10 may be corrected. For example, the boost pressure and/or flow rate of air at an inlet of power source 10 may be increased. This increase may be accomplished by correcting an operation of compressor 24, correcting a wastegate setting, and/or correcting an engine valve setting (i.e. an engine opening, closing, lift height, and/or lift duration) during the regeneration event. To minimize performance interruption of power source 10, the adjustment to bypass valve 36 and the correction of power source 10 may be implemented substantially simultaneously.

[0040] To indirectly increase the concentration of oxygen in the exhaust from power source 10, recirculation valve 46 may be moved to increase a restriction on the flow of exhaust passing into power source 10. By increasing the exhaust restriction, a greater amount of fresh air may be forced/drawn into power source 10 such that the concentration of oxygen in the exhaust exiting power source 10 may be sufficient to regenerate particulate filter 42. As above, the movement of exhaust recirculation valve 46 may be regulated by controller 66. However, by reducing the amount of exhaust recirculated through power source 10, the production of NOx may increase, if the adjustment of recirculation valve 46 is un-

counted for. An increased production of NOx may cause power source 10 to be noncompliant with government regulations.

[0041] To minimize the affect that the adjustment of recirculation valve 46 may have on the performance of power source 10 (i.e., on the production of NOx), various operational characteristics of power source 10 may be corrected. For example, an amount of fuel injected into power source 10, a timing of the injections, and/or a distribution of the injections may be adjusted to minimize the production of NOx during the regeneration event. These changes in the fuel injection profile may be implemented via controller regulation of a power source fuel system. To minimize performance interruption of power source 10, the adjustment to recirculation valve 46 and the correction of power source 10 may be implemented substantially simultaneously. Similar adjustments and corrections can be made in association with other fluid handling components.

[0042] In addition to regulating the requisite amount of oxygen necessary to perform a regeneration. During a regeneration event, the controller 66 also may optimize the amount of exhaust air mass flow that is delivered from power source 10 to regeneration means 45, which is shown as burner 47. During a regeneration event controller 66 may directly reduce the amount of exhaust air mass flow that is directed to the burner 47. Bypass valve 78 may be moved to increase a restriction on the flow of exhaust air that is provided to the burner 47. In so doing, at least a portion of exhaust air is diverted around the burner and particulate filter. The portion of exhaust air that is diverted around the exhaust circuit 16 passes through bypass circuit 76 and into regeneration circuit 18. By reducing the amount of exhaust air flow that is provided to the exhaust circuit 16, regeneration means 45 has less exhaust air to heat, thus lowering the amount of energy or fuel required to regenerate particulate filter 42.

[0043] Because the disclosed exhaust treatment system may correct power source operation in connection with control of associated fluid handling components, a particulate filter regeneration event may be accomplished without substantially affecting power source performance. In particular, the disclosed exhaust treatment system may ensure exhaust emission compliance and/or optimal engine performance, even when a regeneration-required adjustment to a fluid-handling component is made. In fact, because the power source correction may be made substantially simultaneously with the regeneration-required adjustment, little, if any, interruption in the output of power source 10 may be observed.

[0044] It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed exhaust treatment system. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the disclosed particulate regeneration system. It is intended that the specification and examples be considered as exemplary only, with a true scope being indicated by the following claims and their equivalents.

What is claimed is:

1. An exhaust treatment system associated with a power source, comprising:

- a filter located downstream of the power source to remove particulate matter from a flow of exhaust produced by the power source;
- a regeneration device located proximal the filter to raise a temperature of the removed particulate matter above an ignition threshold;

a first fluid handling component located upstream of the power source to vary an amount of oxygen in the flow of exhaust;

a second fluid handling component located downstream of the power source and upstream of the regeneration device to vary the flow of exhaust bypassing the regeneration device; and

a controller in communication with the power source, filter, regeneration device, first fluid handling component, and second fluid handling component, the controller being configured to:

- determine a need for filter regeneration;
- determine a first adjustment to the first fluid handling component to provide sufficient oxygen in the exhaust flow for filter regeneration;
- determine a second adjustment to the second fluid handling component to provide sufficient mass flow in the exhaust bypassing the regeneration device; and
- facilitate the regeneration of the filter.

2. The exhaust treatment system of claim 1, wherein the regeneration device is a fuel-fired burner.

3. The exhaust treatment system of claim 1, wherein the first fluid handling component is an induction valve configured to regulate the flow of atmospheric air to the power source.

4. The exhaust treatment system of claim 3, wherein the first adjustment is an increase in the amount of atmospheric air directed to the power source.

5. The exhaust treatment system of claim 1, wherein the first fluid handling component is a bypass valve configured to divert charged air around the power source to the exhaust flow.

6. The exhaust treatment system of claim 5, wherein the first adjustment is an increase in an amount of the charged air directed around the power source to the exhaust flow.

7. The exhaust treatment system of claim 1, wherein the second fluid handling component is a valve configured to divert exhaust flow around the regeneration device to an intake of the power source.

8. The exhaust treatment system of claim 7, wherein the second adjustment is an increase in the amount of exhaust flow diverted around the regeneration device to the intake of the power source.

9. A method regenerating a filter that removes particulate matter from a flow of exhaust produced by a power source, comprising:

- combusting a fuel and air mixture to generate power and a flow of exhaust;
- using a filter to remove and collect particulate matter from the flow of exhaust;
- determining a need for a regeneration device to regenerate the filter;
- determining a first adjustment in the amount of oxygen to required for the regeneration device to regenerate the filter;
- determining a second adjustment in the flow of exhaust bypassing the regeneration device; and
- regenerating the filter.

10. The method of claim 9, wherein the first adjustment is an increase in the amount of atmospheric air directed to the power source.

11. The method of claim 9, wherein the first adjustment is an increase in an amount of charged air directed around the power source to the exhaust flow.

12. The method of claim 9, wherein the second adjustment is an increase in the amount of exhaust flow diverted around the regeneration device to the intake of the power source.

13. An engine system, comprising:

- an engine configured to combust a fuel and air mixture to generate power and a flow of exhaust;
- a charged air induction circuit configured to introduce compressed air into the engine;
- an exhaust circuit configured to direct the flow of exhaust from the engine to the atmosphere;
- a filter located downstream of the engine to remove particulate matter from the flow of exhaust;
- a regeneration device located proximal the filter to raise a temperature of the removed particulate matter above an ignition threshold;
- a first valve located upstream of the engine to vary an amount of oxygen in the flow of exhaust;
- a second valve located downstream of the engine and upstream of the regeneration device to vary the flow of exhaust bypassing the regeneration device; and
- a controller in communication with the engine, filter, regeneration device, first valve and second valve, the controller being configured to:

- determine a need for particulate filter regeneration;
- determine a first adjustment to the first valve regulating oxygen in the exhaust flow for filter regeneration;
- determine a second adjustment to the second valve regulating exhaust flow bypassing the regeneration device; and
- facilitate the regeneration of the filter.

14. The engine system of claim 13, wherein the regeneration device is a fuel-fired burner.

15. The engine system of claim 13, wherein the first valve is an induction valve configured to regulate the flow of atmospheric air to the engine.

16. The engine system of claim 15, wherein the first adjustment is an increase in the amount of atmospheric air directed to the power source.

17. The engine system of claim 13, wherein the first valve is a bypass valve configured to divert charged air around the power source to the exhaust flow.

18. The engine system of claim 17, wherein the first adjustment is an increase in an amount of charged air directed around the power source to the exhaust flow.

19. The engine system of claim 13, wherein the second valve is a valve configured to divert exhaust flow around the regeneration device to an intake of the engine.

20. The engine system of claim 19, wherein the second adjustment is an increase in the amount of exhaust flow diverted around the regeneration device to the intake of the power source.

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