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NOTICE

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OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
CODE OOCC3
ARLINGTON VA 22217-5660

Navy Case No. 76760

EXHAUST EMISSION CONTROL THROUGH A HYDROGEN PEROXIDE FUEL AUGMENTATION SYSTEM

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

CROSS-REFERENCE TO RELATED PATENT APPLICATION

This patent application is co-pending with related patent application entitled Fuel Oxidizer Emulsion System (Navy Case No. 77690) by the same inventor as this application.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates to internal combustion engine systems and more particularly to a system for reducing the exhaust emissions of an internal combustion engine. The system utilizes an oxidant and water mixture added to the air intake system of an internal combustion engine. The oxidant provides for near stoichiometric combustion to reduce combustion products and to reduce the engine's air requirements. The water serves to cool the stoichiometric combustion temperature to prevent excessive engine wear and to control the formation of oxides of nitrogen.

(2) Description of the Prior Art

It is known to utilize fossil fuel distillates, such as diesel fuel or gasoline, or organic fuels, such as alcohol, for combustion in internal combustion engines. Typically, a piston or rotary engine operates on a two or four cycle process to compress air and inject fuel or a fuel/air mixture to initiate combustion in a cylinder or chamber for the purpose of releasing the thermal potential energy of the mixture to form a high pressure, high temperature working fluid. In a piston engine, the thermal energy is transferred to axial motion of the piston which in turn rotates the main engine shaft to generate mechanical work. In a rotary engine, the thermal energy is transferred directly to the output shaft through rotation of the rotor. For clarity, the remainder of the description will focus on piston engines. However, it is to be understood that the discussion applies to any power system in which thermal energy is converted to mechanical energy.

The typical two or four cycle process uses available air as a means to deliver the oxygenated working fluid necessary to burn with the fossil or organic fuels. During the induction phase of a diesel cycle, the piston displacement in a cylinder causes air to be drawn into the cylinder. The air intake valve or port is then closed as the piston begins traveling to the minimum volume position of the cycle. As the air in the cylinder is compressed, temperature and pressure of the air increase. Just prior to reaching the minimum volume, maximum temperature and pressure position, fuel is injected into the cylinder or pre-combustion chamber. The fuel ignites in the presence of the high temperature, high pressure air in a fuel rich central zone and oxygen rich perimeter. In an internal spark ignition engine, fuel is mixed with the air prior to compression. When compressed, the fuel/air mixture is ignited with an electrical stimulus from a spark plug. The combustion process initiates from a point adjacent the spark and propagates outward to consume the majority of the fuel/air mixture. In both engine types, the combustion process is not steady and can be quenched by relatively cold engine components.

These prior art engines generate several combustion products, such as unburned hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx), which present environmental hazards. Numerous studies, e.g., Jiang, Q., Ottikkutti, P., VanGerpen, J., VanMeter, D.,: "The Effect of Alcohol Fumigation on Diesel Flame Temperature and Emissions," Society of Automotive Engineers Transactions Volume 99, Section 3, 1990 paper number 900386, have shown a direct correlation of NOx formation to combustion temperature. However, lowering the combustion temperature also results in incomplete combustion with a corresponding increase in HC and CO emissions. Also, these engines are dependent on receiving adequate oxygen for combustion from the ambient air, making them unsuitable for operation in oxygen poor environments such as in ultra high altitude environments. To provide the necessary oxygen to systems operating in oxygen poor environments, extraordinary measures must be taken, such as carrying liquid oxygen or providing multiple stages of turbo charging. The resulting systems are heavy, inefficient and quite large in size. Further, controllers within these engines attempt to improve efficiency and reduce emissions by controlling the flow of ambient air into the engine and thus the fuel/air mixture being combusted in the cylinder compartment. Such control systems do provide improved efficiency and reduced emissions, but may not result in the most efficient combustion or lowest emissions. The oxygen content of the ambient air may vary significantly such that it may be impossible for the controller to provide adequate oxygen, regardless of air flow.

SUMMARY OF THE INVENTION

Accordingly, it is a general purpose and object of the present invention to provide a system for an internal combustion engine to control and reduce environmentally hazardous exhaust emissions.

It is a further object that the system provide a means for operating internal combustion engines in both standard and low oxygen environments.

These objects are accomplished with the present invention by providing an injection system for an internal combustion engine which utilizes an oxidant added to the ambient air intake stream of the engine. The oxidant provides sufficient oxygen for near stoichiometric or complete combustion of the fuel which reduces environmentally harmful combustion products such as unburned hydrocarbons and carbon monoxide. However, the high temperatures associated with complete combustion may lead to excessive engine temperatures and wear. Water is added to the oxidant to quench the stoichiometric combustion temperature, preventing excessive engine wear and also contributing to the reduction of oxides of nitrogen. The oxidant further provides the necessary oxygen for combustion and reduces the need to obtain oxygen from the ambient air, thus allowing operation of the engine in oxygen poor environments.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention and many of the attendant advantages thereto will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawings and wherein:

FIG. 1 shows a schematic representation of the injection system of the present invention for a diesel internal combustion engine; and

FIG. 2 shows a schematic representation of the injection system of the present invention for an internal spark ignition engine.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a schematic representation of an oxidant fuel augmentation system 10 for use on a diesel internal combustion engine 12. The system has an oxidant storage reservoir 14. The oxidant may be hydrogen peroxide, hydroxyl ammonium nitrate, or any such liquid oxidant whose chemical decomposition readily liberates free oxygen upon heating or increased pressure. Water is mixed with the oxidant for reasons which will become obvious. The reservoir is connected to air inlet 16 of diesel engine 12 via three way valve 18. Sensor 20 in exhaust outlet 22 provides temperature and oxygen level readings to controller 24 which operates valve 18 to control the amount of oxidant entering the air stream. Fuel enters diesel engine 12 through fuel inlet 26. In operation, the air/oxidant mixture enters the piston compartment (not shown) of diesel engine 12 through air inlet 16 during diesel engine 12 induction stage. During the compression stage, fuel enters the piston compartment via fuel inlet 26 and the air fuel mixture ignites.

Referring now additionally to FIG. 2, oxidant fuel augmentation system 10 is shown in use on internal spark ignition engine 28. The components and operation of the system are the same as previously described for diesel engine 12 with the exception that air inlet 16 and fuel inlet 26 are combined at precombustion chamber 30 prior to being injected into spark ignition engine 28 by injector 32. The fuel/air/oxidant mixture from injector 32 is compressed in the piston compartment (not shown) of spark ignition engine 28 and ignites.

Combustion byproducts are removed from the piston compartment of engines 12 and 28 through exhaust outlet 22. Sensor 20 monitors the temperature and oxygen level of the combustion byproducts. Depending on the parameters set within controller 24, valve 18 is opened or closed to vary the amount of oxidant introduced into the air stream. Under typical oxygen level operating conditions, controller 24 operates valve 18 to provide a stoichiometric total oxidant-fuel mix. In oxygen poor environments, such as high altitude operation, controller 24 opens valve 18 to provide additional oxidant and thus maintain oxygen necessary for combustion.

The oxidant fuel augmentation system of the present invention has many advantages over the prior art. The introduction of an oxidant into the engine air stream allows more complete, or near stoichiometric, combustion. The oxidant further allows the combustion process to continue to completion by the liberation of free oxygen as heat is transferred to the oxidizer droplets. Both these processes reduce HC and CO emissions. The high temperatures of near stoichiometric combustion could lead to excessive engine wear. The water within the oxidant serves to lower the combustion temperature and prevent damage to engine components. The lower combustion temperature also serves to reduce the formation of NOx. Also, controller 24 acts in a manner similar to fuel/air mixture controllers in existing engine systems. However, more precise control of the oxygen level can be obtained by having the controller govern the amount of oxidant entering the air stream since, unlike ambient air, the oxidant is a determinable oxygen source. The greater control afforded by the use of the present system provides for more efficient combustion and reduced emissions. Further, depending on the oxidant used, the engine is provided with an essentially unlimited source of oxygen allowing operation in oxygen poor environments.

What has thus been described is a system for dispersing an oxidant into the induction air stream of an internal combustion engine to improve efficiency and reduce harmful emissions. The oxidant also provides the necessary oxygen to run the engine in oxygen poor environments, such as high altitude operation. The system has an oxidant reservoir in fluid communication with the air induction stream. The flow of oxidant into the airstream is governed by a valve actuated by a controller. The controller senses the temperature and level of oxygen in the engine exhaust and opens or closes the valve to maintain maximum efficiency and minimum emissions in accordance with predetermined parameter settings.

Obviously many modifications and variations of the present invention may become apparent in light of the above teachings. For example, the system can be used on any type of engine burning fossil or organic fuels in addition to the diesel and internal spark ignition engines described herein. Also, the oxidant can be any one of a number of substances which provide free oxygen for combustion, such as hydrogen peroxide or hydroxyl ammonium nitrate.

In light of the above, it is therefore understood that the invention may be practiced otherwise than as specifically described.

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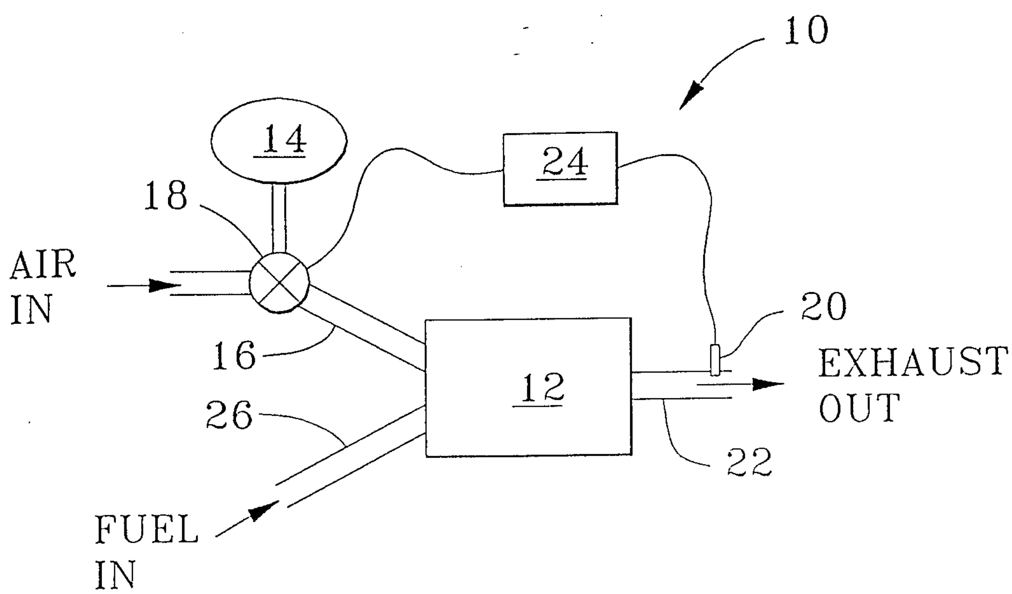
ABSTRACT OF THE DISCLOSURE

A system for improving efficiency and reducing harmful emissions in an internal combustion engine and for allowing the engine to run in oxygen poor environments. An oxidant, such as hydrogen peroxide, is introduced into the induction air stream of the engine. A controller senses the temperature and oxygen level in the exhaust stream of the engine and operates a valve to vary the amount of oxidant introduced to maintain maximum efficiency and minimum emissions. The oxidant provides for near stoichiometric combustion to reduce combustion products and reduce the engine's air requirements. The reduced air requirements allow for operation of the engine in oxygen poor environments, such as operation at high altitudes. Water is added to the oxidant to cool the stoichiometric combustion temperature to prevent excessive engine wear and to further block the formation of oxides of nitrogen.


10
14
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AIR
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FIG. 1

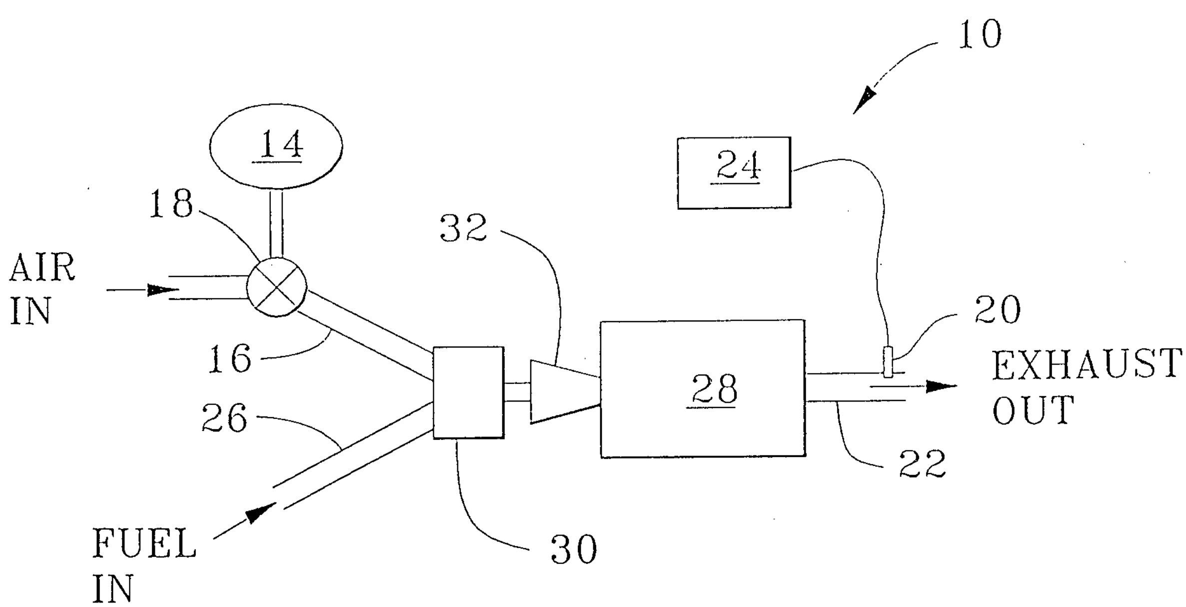
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FIG. 2