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Review on Efficiency Increasing HHO Kit for IC Engine

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***Abstract*: Today the world is facing three critical problems: (1) high fuel prices, (2) climatic changes, and (3) air pollution. Experts suggest that current oil and gas reserves would suffice to last only a few more decades. Bio renewable liquids are the main substitutes to petroleum-based gasoline and diesel fuel. These fuels are important because they replace petroleum fuels; however, some still include a small amount of petroleum in the mixture. There are four alternate fuels that can be relatively easily used in conventional diesel engines: vegetable oil, biodiesel, Fischer-Tropsch liquids, and dimethyl ether. The main alternate fuels include methanol, liquefied petroleum gas, compressed natural gas, hydrogen, and electricity for operating gasoline-type vehicles. Bioethanol is an alternate fuel that is produced almost entirely from food crops. The primary feedstock of this fuel is corn. Biohydrogen is an environmentally friendly alternative automotive fuel that can be used in an internal combustion engine.**

***Keywords*: IC engine, HHO kit**

1. Introduction

There is a lot of concern nowadays about the efficiency of the internal combustion engine (ICE), and a lot of research is being done to improve it. But what exactly is the efficiency of the internal combustion engine and how do we measure it? The efficiency of any engine is simply calculated from the energy of the fuel supplied per unit time to do work and the output at the shaft of the engine after subtracting all losses. The input power of the fuel can be obtained from the mass of the fuel and its calorific value. The shaft output can be measured from a brake dynamometer. Simply put efficiency is Output/Input. The average ICE has an efficiency between 20 to 30%, which is very low. If we see a heat balance sheet of the internal combustion engines for a spark ignition or gasoline engine we find that the brake load efficiency is between 21 to 28%, whereas loss to cooling water is between 12 to 27%, loss to exhaust is between 30 to 55 %, and loss due to incomplete combustion is between 0 to 45%.What is required is a simple and inexpensive system which overcomes the problems associated with the prior art devices. Most particularly, this system should include a sealed chamber, to prevent the electrolytic solution from being lost to effects other than electrolysis. In addition, the device should include electrodes which are located well beneath the surface of the electrolytic solution, to allow the electrolytic solution to be used up without exposing the electrodes. Further the system should include an automatic shut off switch to cause the unit to stop in the event the liquid level gets low enough to expose the electrodes. In addition, most preferably the device will conduct electrolysis in a low resistance electrolysis fluid, permitting it to operate at relatively low temperatures to prevent damaging heating and cooling cycles which can impair seal integrity. As well the device should have any joints or openings in the sealed chamber formed above the highest liquid level in the chamber. In this manner, even if a leak develops, the leak will simply allow additional air into the electrolysis chamber rather than leaking out electrolytic solution. Lastly, the system should preferably compensate for loss of liquid water to decomposition to prevent over concentration of the solution, which can lead to a higher resistance cell and excessive heat generation. Around the world, this gas powers more than 5 million vehicles, and just over 150,000 of these are in the American usage is growing at a dramatic rate. On top of these benefits, this kit has also greatly improved on the original design, managing to achieve consistently higher mileage. The basic impact that the HHO gas (brown gas as it is also called) has on the gasoline is that it reduces drastically the size of the fuel droplets.

2. Literature survey

Dezhi Zhou, Wenming Yang et. al (2016) [1] is research on Low temperature combustion (LTC) has been considered as a promising combustion technology in internal combustion engine due to its higher thermal efficiency and lower emission than the conventional combustion engines. Among LTC engines, reactivity-controlled compression ignition (RCCI) engine draws tremendous attention of engines researchers because of its super high efficiency and near-zero emissions. Featuring by high fuel variety and high combustion phase controllability, RCCI engine needs to be designed and tested by computational fluid dynamics (CFD) models to rapidly and inexpensively achieve combustion control. Hence, computational time is one of major concerns. Instead of the most commonly used CHEMKIN solver, this study proposed a faster hybrid model for the combustion modelling in RCCI engine. In the light of the basic idea of characteristic time-scale (CTC) of achieving species equilibrium in high temperature, this model basically uses CTC in high temperature combustion and CHEMKIN in low-intermediate temperature combustion.

A CEQ solver for species equilibrium calculation at certain temperature, pressure was integrated with CTC for detailed chemistry calculation. Then this combustion model was coupled in KIVA4 and validated in a RCCI engine. The predicted in-cylinder pressure and heat release rate (HRR) show a good consistency with both the data from experiment and CHEMKIN. More importantly, it is observed that this model could save about 20% computational time compared with CHEMKIN due to less stiff ordinary differential.

Varun, Paramvir Singh entail (2016) [2] is studied the Biodiesel is one of the most rapidly emerging fuels that promise to replace diesel in the near future. However, there are a number of challenges that lay ahead, both in terms of technical aspects as well as economic and replacement policies. If it is used in a regular engine, biodiesel does not give the same performance as diesel. This follows the fact that some alterations are to be incorporated into the engine. Combustion chamber (CC) geometry is one of the most important factors that affect the performance of the engine. Variations in these geometries, even by a slight amount have shown an enormous change in the performance and emission parameters. In this article, different combustion chamber geometries have been considered and results obtained from experimental and numerical analysis was discussed. The results include performance parameters (brake thermal efficiency, brake specific fuel consumption), combustion parameters (heat release rate, cylinder pressure, ignition delay, peak pressure) and emission parameters (Carbon Monoxide, Nitrogen Oxides, smoke, unburnt hydrocarbons and sulphur dioxide). The result shows that slight modification in combustion chamber.

Xudong Zhen, Yang Wang (2015) [3] is work on the Methanol is an alternative, renewable, environmentally and economically attractive fuel; it is cons dared to be one of the most favorable fuels for conventional fossil-basedfuels. Methanol has been recently used as an alternative to conventional fuels for internal combustion (IC) engines in order to satisfy some environmental and economical concerns. Because of a number of relatively large research projects that have been ongoing recently, much progress has been made that is worth reporting.

Peter Van Blarigan Britannica et.,al (2012) [4] is studied the In this manuscript, research on hydrogen internal combustion engines is discussed. The objective of this project is to provide a means of renewable hydrogen-based fuel utilization. The development of a high efficiency, low emissions electrical generator will lead to establishing a path for renewable hydrogen-based fuel utilization. A full-scale prototype will be produced in collaboration with commercial manufacturers. The electrical generator is based on developed internal combustion engine technology. It is able to operate on many hydrogen-containing fuels.

Rituparn Singh, Naresh Kumar et.,al (2015) [5] is study about the The rapid growth of society in all sectors of life is responsible for ever increasing the requirement for energy needs. The biggest consumer of energy is the transport sector and it is primarily based on diesel. But, the fossil fuel reserves are limited, even to the extent that they are being projected to last only for a few decades [1–4]. Diesel engines are growing in application because of their higher efficiency as compared to gasoline engines. So, the critical situations have stimulated scientists to look out for the alternative fuel options that would be suitable for diesel engines. However, while considering new fuels, it is not advisable to compromise with performance and also with their associated emissions. Hence, the search for new fuels is now being concentrated upon the biodegradable realm. Vegetable oil is one of the possible alternatives [5–9]. In general, any vegetable seed oil which comprises of triglycerides of long chain saturated and unsaturated fatty acid can be used in diesel engines [10]. But this vegetable seed oil cannot be directly used in CI engines due to its higher viscosity and poor non-volatility [11]. Some methods like preheating, transistor if action and thermal cracking help in reducing the viscosity of vegetable seed oil [12]-[14]. Above methods are used to convert the vegetable oil into biodiesel that can be directly used in CI engine. In general, biodiesel are mono-alkyl esters derived from long chain fatty acids of edible/non-edible oil, animal fats, micro-algae, etc. [15, 16]. Biodiesel production has increased and its consumption will be continuously increased around the world.

3. Problem Definition

Internal combustion engines such as reciprocating internal combustion engines produce air pollution emissions, due to incomplete combustion of carbonaceous fuel. The main derivatives of the process are carbon dioxide CO2, water and some soot — also called particulate matter (PM). The effects of inhaling particulate matter have been studied in humans and animals and include asthma, lung cancer, cardiovascular issues, and premature death. There are, however, some additional products of the combustion process that include nitrogen oxides and Sulphur and some uncombusted hydrocarbons, depending on the operating conditions and the fuel-air ratio. Not all of the fuel is completely consumed by the combustion process; a small amount of fuel is present after combustion, and some of it reacts to form oxygenates, such as formaldehyde or acetaldehyde, or hydrocarbons not originally present in the input fuel mixture. Incomplete combustion usually results from insufficient oxygen to achieve the perfect stoichiometric ratio. Significant contributions to noise pollution are made by internal combustion engines. Automobile and truck traffic operating on highways and street systems produce noise, as do aircraft flights due to jet noise, particularly supersonic-capable aircraft. Rocket engines create the most intense noise.

4. Project basics

The magnetic fuel saver basically consists of neodymium iron boron magnets strategically placed over the copper fuel line. The copper fuel line replaces the convention rubber or plastic tube. By applying a magnetic field, to ionizing fuel to be feed to the combustion device we can ensure more complete combustion obtaining a maximization of the fuel economy, improving the fuel efficiency and reducing polluting emissions. A fuel magnet is a device that is strapped to the fuel line in your vehicle (or each injector line on a diesel engine) and makes the fuel more receptive to oxygen, thus producing a linear combustion with less exhaust waste. The magnetic field strength must be a higher gauss level i.e. 500 gausses since it may be demagnetized to some extent before reaching the combustion chamber.

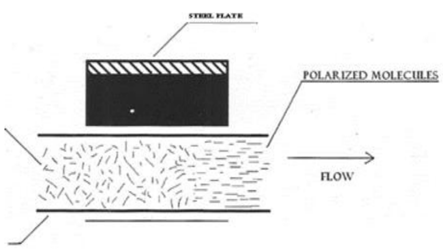

Fig. 1. Polarized molecule in magnetic fuel saver

5. Overview

Modern gasoline and diesel engines are much more efficient and less polluting than similar engines of even a few years ago. However, due to the increased number of vehicles in use, levels of air pollution continue to rise even in light of more efficient and clean running vehicles. Therefore, there has been increasing pressure to develop vehicles which have lower emissions, and thus are less polluting than conventional automotive technology permits. For example, under certain government "Clean Air" legislation, a certain number of vehicles are required to be emission free. This legislation has put pressure to develop alternate fuel technologies including electric cars and vans, natural gas and propane fuelled vehicles, hydrogen cell vehicles and the like. While a number of these technologies are promising, some are still a long way from commercial implementation, and others appear to have reached the limit of present design capabilities without yielding a consumer acceptable product. Therefore, attention has refocused on conventional gas and diesel burning engines, to try to develop a more pollution free and efficient combustion system. In the past, it has been discovered that the use of hydrogen and oxygen as a fuel additive increases the efficiency of an internal combustion engine and reduces pollution considerably. Both advantages appear to be the byproduct of faster flame speed that is as much as 9 times that of gasoline, resulting in more complete combustion of the fuel in the combustion chamber, with the resultant reduction in soot (semi-bituminous hydrocarbons) and other pollutants such as nitrous oxide, carbon monoxide, and an increase in output energy for a greater fuel efficiency and horsepower. The motor is comprised of two pistons, on either side of a single combustion chamber. Instead of using a crankcase to convert linear piston movement into rotational energy to turn a driveshaft or conventional electric motor, the pistons are mounted on air springs that generate electricity directly as they move back and forth.

6. Principle

An electrical power source is connected to two electrodes, or two plates (typically made from some inert metal such as platinum, stainless steel or iridium) which are placed in the water. Hydrogen will appear at the cathode (the negatively charged electrode, where electrons enter the water), and oxygen will appear at the anode (the positively charged electrode). Hydrogen kit works on the principle of electrolysis of water. Where hydrogen gas produced is used to combust the petrol in the engine and hence increases the fuel efficiency of the vehicle. The electrolysis of water is considered a well-known principle to produce oxygen and hydrogen gas. In Fig.1 a schematic of an electrochemical cell is presented. The core of an electrolysis unit is an electrochemical cell, which is filled with pure water and has two electrodes connected with an external power supply. At a certain voltage, which is called critical voltage, between both electrodes, the electrodes start to produce hydrogen gas at the negatively biased electrode and oxygen gas at the positively biased electrode. The amount of gases produced per unit time is directly related to the current that passes through the electrochemical cell. In water, there is always a certain percentage found as ionic species; H+ and OH- represented by the equilibrium equation:

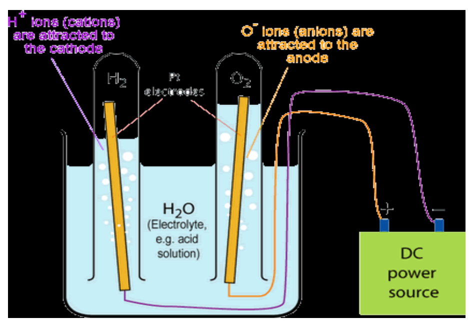

Fig. 2. Layout of an electrochemical cell

H_2O (l). H^+ (aq) + OH^- (aq) (1)

Oxygen and hydrogen gas can be generated at noble metal electrodes by the electrolysis of water:

\+ electrode (anode):

$4OH^-.2H_2O + O_2 + 4e^-$ (2a)

\- electrode (cathode):

$2H^+$ (aq) + $2e^-$. H_2 (g) (2b)

In case of acidic or basic water, the reactions which occur at the electrode interface are slightly different.

In water electrolysis there are no side reactions that could yield undesired byproducts, therefore the net balance is:

$2H_2O.(4e^-).O_2 + 2H_2$ (3)

The minimum necessary cell voltage for the start-up of electrolysis, Eo cell, is given under standard conditions (P, T constant) by the following equation:

Eo cell = $N_f G_o$.-

Where .Go is the change in the free energy under standard conditions and n is the number of electrons transferred. In the case of a closed electrochemical cell, the conditions slightly change from standard conditions, open cell (P, T) = constant to closed cell (V, T) = constant because the change in the cell volume is smaller compared to that of pressure. Therefore, instead of .Go, .Ao. free energy (Helmholtz) is used. The necessary voltage for an electron to overcome the Helmholtz energy barrier is given below:

Eo cell = nF Ao.

7. Construction

1. An internal combustion engine kit for producing a combustible gas to enhance combustion of an internal combustion engine, the internal combustion engine kit comprising: at least one electrolysis cell, to produce a combustible gas, said at least one electrolysis cell having a cathode and an anode, wherein said cathode and said anode are in the form of spaced apart rings within said body, each ring having a plurality of fingers extending therefrom. the fingers of the anode being adjacent to the fingers of the cathode to promote electrolysis; a power conditioning means, to provide appropriate electrical power to said at least one electrolysis cell; a water reservoir, to provide water to said at least one electrolysis and an electronic controller, for controlling the supply of electrical power to the electrolysis cells, so that the electrolysis cells can perform electrolysis, and for controlling the supply of water from the water reservoir to the electrolysis cells.

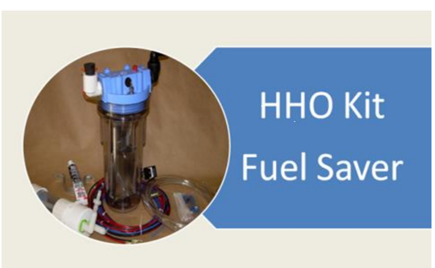

Fig. 3. Mini kit

2. An internal combustion engine kit according to statement 1, further including a high liquid level sensing means for sensing a high liquid level in said one or more electrolysis cells.
3. An internal combustion engine kit according to statement 1, wherein said combustible gas flowing from said electrolysis cells is connected to a moisture trap.
4. An internal combustion engine kit according to statement 1, further including a temperature sensor for sensing the ambient temperature adjacent to said power conditioning means.
5. An internal combustion engine kit according to statement 1, wherein said electrolysis cell is housed in an enclosure, the interior of said enclosure being accessible through a removable cover, further including a cover switch for detecting whether the cover is properly closed.
6. An internal combustion engine kit according to statement 1, further including an inertia switch for detecting whether said electrolysis cell is maintained in a proper spatial orientation.
7. An internal combustion engine kit according to statement 4, 5, 6, or 7, wherein upon the activation of any or all of said temperature sensor, pressure sensor, oil pressure sensor, or cover switch, a warning signal is generated for an operator.
8. An internal combustion engine kit according to statement 4, 5, 6, 7, or 8, wherein upon the activation of any or all of said temperature sensor, pressure sensor, oil pressure sensor, cover switch, or inertia switch, a power shut off of the cell power supply is directed by the electronic controller, to prevent the electrolysis cells from performing electrolysis.

8. System modification

A permanent magnet is a magnet that is permanent, in contrast to an electromagnet, which only behaves like a magnet when an electric current is flowing through it. Permanent magnets are made out of substances like magnetite (Fe_3O_4), the most magnetic naturally occurring mineral, or neodymium, a powerfully magnetic synthetic substance. The Earth itself is a huge permanent magnet, though its magnetic field is quite weak relative to its size. Humans have used the magnetic field of the Earth for navigation since the compass was invented in ancient China. Even the most powerful permanent magnet is not as strong as the stronger electromagnets, so their applications are limited, but they still have many uses. The most mundane would be used as refrigerator magnets, but magnets can be found everywhere, including your hard disk, ATM and credit cards, speakers and microphones, electric motors, and toys. Electric motors work through an interaction between an electromagnet and a permanent magnet. The tiny molecular charge makes the molecules rotate in the alignment with the applied field and they then hold that position for short time due to the matching alignment of their neighboring molecules. This alignment can be disrupted by turbulence in the liquid and the molecules will gradually return to a disorganized alignment state. The liquid flows through the pipe past the magnet and as it does so its randomly oriented molecules are aligned by the strong unipolar magnetic field and retain their polarized state as they leave the vicinity of the magnets. The tube should be non-ferrous to avoid reducing the level of magnetic field applied to the liquid. And a metal plate should be applied to the back of the magnet to increase the strength of the field on the pipe side. Polarity of the magnet is not really important.

Fig. 4. Ionized fuel

Fuel mainly consists of hydrocarbons. Groupings of hydrocarbons when flowing through NIBM field change their orientation of magnetization in a direction opposite to that of NIBM field. The molecules of hydrocarbons change their configuration at the same time intermolecular force is considerably reduced or depressed. In addition, hydrogen ions in fuel and oxygen ions in air or steam are magnetized to form magnetic domains, which are believed to assist in atomizing fuel into finer particles. Thus the resultant conditioned fuel/air mixture re-oriented in opposite polarities burns more completely, producing higher engine output, better fuel economy, more power and most importantly reduces the amount of hydro-carbons (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) in the exhaust. Another benefit is that re-oriented fuel and air molecules with opposite polarities dissolve carbon buildup in carburetor jets, fuel injectors, and combustion chambers help to clean up the engine and maintain the clean condition.

9. Working

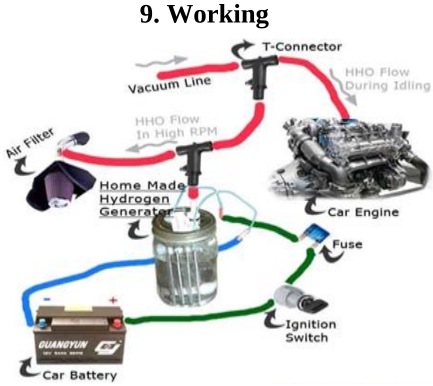

Fig. 5. General layout of system

Methods of hydrogen production through water electrolysis despite the fact that the discovery of electrolytical water decomposing was first observed in acidic water, in industrial plants the alkaline medium is preferred, because corrosion is more easily controlled and cheaper construction materials can be used compared to acidic electrolysis technology. Other methods of hydrogen production, such as proton exchange membrane electrolysis, steam electrolysis have been developed in recent years. Hydrogen could also be generated as a byproduct.

An electrolysis cell and internal combustion engine kit including an electrolysis cell is disclosed. The cell includes a sealed plastic body having an inlet and an outlet. The plastic body includes a first terminal located at the top of the body, a second terminal located adjacent to the first terminal and insulated conductors associated with each terminal extending through the body and towards the bottom end thereof. Each terminal ends in a respective anode and cathode which are operatively connected to the terminals. The anode and cathode are spaced apart from one another within the body. When an electrolysis solution is placed in the body, and a current provided across the electrodes, water is caused to decompose into hydrogen and oxygen. These combustible gases are then passed into the internal combustion engine to increase the efficiency and power thereof. In one embodiment a reservoir is provided to ensure that the level is maintained in the cell. This kit is a helpful agent in reducing the fuel consumption and increasing the efficiency of the engine without any adverse effect on the performance of the vehicle. The HHO kit separates Oxygen and Hydrogen from the water and hence hydrogen gas is used as the fuel to propel the vehicle causing less use of fuel. The Oxygen helps in burring the fuel and hydrogen burn itself thus having full control on the fuel consumption. The HHO kit automatically manages the injection of fuel into the engine. The oxygen is released into the environment and hence it is environment friendly.

10. Conclusion

- In this paper, research on hydrogen internal combustion engines is discussed. The objective of this project is to provide a means of renewable hydrogen-based fuel utilization. The development of a high efficiency, low emissions electrical generator will lead to establishing a path for renewable hydrogen-based fuel utilization. A full-scale prototype will be produced in collaboration with commercial manufacturers. The electrical generator is based on developed internal combustion engine technology. It is able to operate on many hydrogen-containing fuels. The efficiency and emissions are comparable to fuel cells (50% fuel to electricity, ~ 0 NOx). This electrical generator is applicable to both stationary power and hybrid vehicles. It also allows specific markets to utilize hydrogen economically and painlessly.
- Decarbonization of fossil fuels with subsequent CO_2 sequestration to reduce or eliminate our CO_2 atmospheric emissions provides a transition strategy to a renewable, sustainable, carbonless society. However, this requires hydrogen as an energy carrier. The objectives of this program for the year 2000 are to continue to design, build, and test the advanced

electrical generator components, research hydrogen based renewable fuels, and develop industrial partnerships. The rationale behind the continuation of designing, building, and testing generator components is to produce a research prototype for demonstration in two years. Similarly, researching hydrogen based renewable fuels will provide utilization components for the largest possible application. Finally, developing industrial partnerships can lead to the transfer of technology to the commercial sector as rapidly as possible. This year work is being done on the linear alternator, two-stroke cycle scavenging system, electromagnetic / combustion / dynamic modeling, and fuel research. The Sandia alternator design and prototype will be finished, and the Sandia and Magnequench designs will be tested. Woron the scavenging system consists of learning to use KIVA-3V, and designing the scavenging experiment.

- Thermodynamic properties, and chemical species concentration were included. He found that even as the compression ratio is increased to 300:1, the thermal efficiency still increases for all of the fuels investigated. At this extreme operating for instance, the cycle efficiency for isooctane fuel at stoichiometric ratio is over 80%. Indeed it appears that no fundamental limit exists to achieving high efficiency from an internal combustion engine cycle. However, many engineering challenges are involved in approaching ideal Otto cycle performance in real systems, especially where high compression ratios are utilized. Caris and Nelson (1959) investigated the use of high compression ratios for improving the thermal efficiency of a production V8 spark ignition engine. They found that operation at compression ratios above about 17:1 did not continue to improve the thermal efficiency in their configuration. They concluded that this was due to the problem of non-constant volume combustion, as time is required to propagate the spark-ignited flame. In addition to the problem of burn duration, other barriers exist. These include the transfer of heat energy from the combustion gases to the cylinder walls, as well as the operating difficulties associated with increased pressure levels for engines configured to compression ratios above 25:1.
- HCCI operation is unconventional, but is not new. As early as 1957 Alperstein et al. (1958) experimented with premixed charges of hexane and air, and n-heptane and air in a Diesel engine. They found that under certain operating conditions their single cylinder engine would run quite well in a premixed mode with no fuel injection whatsoever. In general, HCCI combustion has been shown to be faster than spark ignition or compression ignition combustion. And much leaner operation is possible than in SI engines, while lower NOx emissions result.
- Most of the HCCI studies to date however, have concentrated on achieving smooth releases of energy under conventional compression condition (CR ~ 9:1). Crankshaft driven pistons have been utilized in all of these previous investigations. Because of these operating parameters, successful HCCI operation has required extensive EGR and/or intake air preheating.
- An additional benefit is that the mechanical friction can be reduced relative to crankshaft driven geometries since there is only one moving engine part and no piston side loads. Also, combustion seems to be faster than in conventional slider-crank configurations. Further, the unique piston dynamics (characteristically non-sinusoidal) seem to improve the engine fuel economy and NOx emissions by limiting the time that the combustion gases spend at top dead center (TDC) (thereby reducing engine heat transfer and limiting the NOx kinetics). Finally, one researcher (Braun 1973) reports that the cylinder/piston/ring wear characteristics are superior to slider/crank configurations by a factor of 4. The combination of the HCCI combustion process and the free piston geometry is expected to result in significant improvements in the engine's thermal efficiency and its exhaust emission.

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