

# Green Engine

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**Abstract:** *The paper describes about green engine, which is the internal combustion engine with some major modifications in its parts and design. Green engine is well suited for atmosphere and it is pollution free. It has high efficiency compared to other type of engines. It is a 6 phase internal combustion engine and it also has important characteristics such as zero emission, reduced noise and lower cost when compared to other engines. It has some features like high expansion ratio, strong swirling, sequential variable compression ratio, direct intake and more. The significance of the engine lies in the efficiency when the present world conditions of limited resources of energy are considered. Generators have been produced by using green engines.*

**Keywords:** Green engine, efficiency, generator

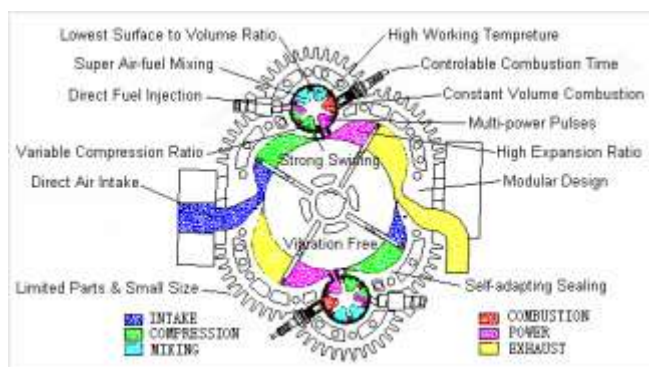
## 1. Introduction

The air that we breathe today is full of toxic and hazardous pollutants. Pollution of the environment could leave the Earth sapped of its beauty and bio-diversity. Each year millions of people die all around the world due to different pollution related problems. The key to live a healthy life is to identify the sources of air pollution and implement practical ways so that we can stop air pollution.

A new study by researchers at the University of Toronto found that 25% of cars and trucks are causing about 90% of pollution. The study shows that the daily consumption of petroleum of automobiles is over 2 million tones. When the petroleum is burned it emits gases like CO<sub>2</sub>, CO and other hydrocarbons. Emissions of CO<sub>2</sub> gases are responsible for greenhouse effect.

So in order to solve these problems the concept of green engine is introduced. This is a 6 phase IC engine in which charge (air-fuel mixture) is completely burnt. Therefore, it eliminates the emission of hazardous gases. Its significance lies in adaptability towards multiple fuels and its efficiency when the present world is facing some serious problems regarding fuel and energy crisis.

## 2. Technical Features



**Figure:** Technical Features of Green Engine

Conventional IC engine is operated on 4 phases whereas green engine is operated on 6 phases. The 6 phases are intake, compression, mixing, combustion, power and exhaust. The most important characteristic of green engine is the expansion ratio which is much higher than compression ratio. Therefore, its thermal efficiency is very high. Nearly zero emissions, quietness, light and small are some other characteristic of green engine.

### 1) Direct air intake

Direct air intake implies that there are no inlet pipe, throttle and inlet valves in green engine as in case of IC engine. Air filter is directly connected to the intake port of the engine. Therefore, a very high volumetric efficiency is achieved and pump which consumes the engine power is eliminated.

### 2) Strong swirling

Combustion chamber and compression chamber includes a tangential air duct between them. Hence, a very strong swirling of air is achieved. Consequently, combustion process and the air-fuel mixture can have satisfying working conditions.

### 3) Sequential variable compression ratio

The green engine provides the most suitable compression ratio irrespective of the mode of operation and the fuel. This leads to excellent combustion performance.

### 4) Direct fuel injection

In order to obtain higher output and torque, direct fuel injection feature is used. It also enhances the response for acceleration.

### 5) Super air fuel mixing

Since the independent air fuel mixing phase has enough time for mixing air and fuel under strong swirling and hot situation, the engine is capable to burn any liquid or gas fuels without any changes. An ideal air fuel mixture

can eliminate CO emission to a very high extent. Strong swirling and rotation of the burner produces the centrifugal effect which makes the air fuel mixture denser near the spark plug.

6) Lowest surface to volume ratio

As the shape of the combustion chamber is slightly paraboloidal, a very low surface to volume ratio is obtained. Thereby, the heat losses of engine are reduced and high combustion efficiency is achieved.

7) Constant volume combustion

More energy can be generated by burning the fuels when combustion of constant volume of fuel. Also, the constant volume combustion technology can allow the engine to have a stable combustion when the lean burning is managed so that the heat losses and NO<sub>2</sub> emission are decreased.

8) Multi power pulses

The conventional IC engine operates on single power pulse with large working chamber. On the other hand, the green engine operates on multi power pulses with a small volume of working chamber.

9) High expansion ratio

The gases that are burnt release much more power when the expansion ratio is considerably high. In other words, the waste gases carry much less energy with them. Hence the engine has higher efficiency.

10) Vibration free

As major moving parts, vanes, which are of very low mass and operated symmetrically, therefore the performance of the engine is very smooth. Hence vibrations are eliminated.

### 3. Construction and Working

#### Construction of Green Engine

The major parts of a green engine are:

- 1) Rotor
- 2) Vane Pump
- 3) Spark Plug
- 4) Fuel Injector

A set of vanes are present in the engine and these vanes consist of a small number of containers. Connections are made for the spark plug so that it can be deactivated when spark is not needed for ignition. A compressive spring is mounted on the bottom of the vane and the other part of the vane is mounted at the top of the spring. The rotor is made of ceramic which has low expansion rate and high heat resistance.

#### Working:

When differentiated with the normal engine, the green engine is a six phase internal combustion engine which has a very high expansion ratio. The key feature of this engine is that piston is not present and hence the usage of the word stroke is eliminated. Instead the word phase is used. There are six phases present, they are: intake, compression, mixing, combustion, power and exhaust.

1) Intake:

The air arrives to the engine through the direct air intake port in the absence of an air inlet pipe, throttle and inlet valves on the air intake system. On the sides of vane and rotor, there exists a duct. When air flows inside the duct, miniscule swirls are generated. Force is exerted by the air on the vane blades and rotational motion is imparted on the small rotor.

2) Compression:

The volume of the compression chamber is small when compared to the other chambers. The air from intake is pushed into these small chambers with the help of blades. Fuel is injected by the fuel injector and it mixes well with the compressed air. The elimination of CO gas takes place here. A small diameter duct connects the compression chamber with the combustion chamber. The pressurized air is forced to flow through this duct. Thus this marks the entry of air into the combustion chamber.

3) Mixing:

This step deals with the mixing of air and fuel before it enters the combustion chamber. As mentioned above, the fuel injector injects fuel and it is mixed with the compressed air. A centrifugal effect forms within the air and fuel mixture and CO gas is eliminated. Complete burning of fuel is assured with the mixing process.

4) Combustion:

Now the chamber is rotated and is positioned in front of the spark plug. One small spark from the spark plug is enough to ignite the air fuel mixture. In addition due to the proper mixing in the previous step, the mixture is more dense. This enables a lean burning of the charge and the flame is also uniform.

5) Power:

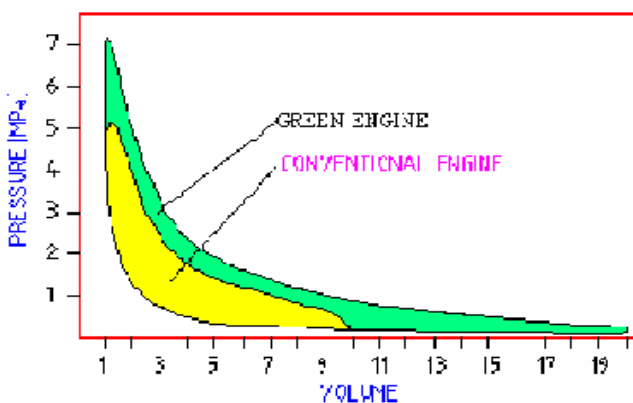
The products from the combustion chamber are expelled out. This causes an increase in pressure and hence the high pressure gases generate power and cause a work output. There is also a sudden increase in volume. The power generated helps to drive the engine and thus energy is utilized.

6) Exhaust:

The thermal energy is completely utilized in the previous step. Hence, the exhaust gases will be carrying less heat and the thermal efficiency of the engine will increase. The gases are released into the atmosphere with the help of exhaust pipes. As the charge is completely burnt, the CO emissions are very less.

ITEM	GREEN ENGINE	STANDARD PISTON ENGINE	DIESEL ENGINE
	THT-C1B	Volvo Penta 230 S	Hercules 3400 DT
POWER	120 hp	120 hp	120 hp
WEIGHT	60 lbs	400 lbs	935 lbs
VOLUME	1 Cubic ft	11.2 Cubic ft	20 Cubic ft
SIZE	15" Diameter x 8"L	25"W x 24"H x 32"L	-----

**Figure 3:** Comparison of Green Engine with conventional I. C. engines



**Figure 4:** Graph of work and power output

#### 4. Green Engines Development Using Compressed Natural Gas as an Alternative Fuel

Production of Natural Gas is either from Gas wells or tied in with Crude oil production. The composition of Natural gas would be Methane (CH<sub>4</sub>) but frequently contains trace amounts of ethane, propane, nitrogen, carbon dioxide, hydrogen sulphide and water vapor. Though the main constituent being Methane. Natural gas which is produced can be compressed, so hence it can be stored and used as CNG, natural Gas can also be liquefied (LNG) and stored cryogenically. Although these both are stored form of natural gas, the key difference is that CNG is in compressed form, while LNG is in liquefied form.

Natural Gas is safer than Gasoline in many respects. The ignition temperature of natural gas is higher than gasoline and diesel fuel. Also, natural gas is found to be lighter than air and tends to dissipate upwards rapidly if a rupture occurs. Diesel and gasoline increases the danger of fire when pooled on ground. On the contrary Compressed Natural Gas is nontoxic and will not contaminate groundwater if spilled. CNG has various advantages compared to gasoline and diesel. It is a cleaner fuel as far as emissions are concerned. CNG is environmentally clean alternative to those fuels.

Some advantages of compressed natural gas as a fuel is that it has very good octane number, octane number determines

the flame speed, which in turn allows engines to operate with high compression ratio, less engine emissions. The disadvantage of CNG as a fuel would be low energy density resulting in low performance, low engine volumetric efficiency. Also, there is need for large pressurized fuel storage, so there is some safety concern with a pressurized fuel tank, inconsistent fuel properties and refueling of the compressed natural gas is a slow process.

CNG as a green alternative fuel: CNG has been long used in stationary engines, but the application of CNG as a transport engines fuel has been considerably advanced with the development of lightweight high pressure storage cylinders. There are several other fuels which are recognized of producing lower overall pollutant emissions compared to gasoline and diesel fuel. Natural Gas being Identified as a leading candidate for transportations applications. The reason behind this being is first availability, the second attraction would be natural gas in its environmental availability and third the most important one is that it can be used in place conventional diesel and gasoline engines.

Large increase in number of CNG would require new gas pipelines and other infrastructure. Though natural gas reserves are large, its not clear whether extraction could be doubled in coming years without an increase in extraction cost. The CNG vehicles exhibit significant potential for reduction of gas emissions and particulars

#### 5. Green CNG Engines Research and Development

The technology of engine conversion is well established and suitable conversion is readily available. There are two options for petrol engines or spark engines, a bi-fuel conversion and use a dedicated to CNG engine. The bi-fuel conversion of vehicles fitted with fuel-injected engines may utilize the original engine management system. The fuel injectors must be disabled when the engine is running on gas, although fuel should flow to the injectors and then pass directly to the return fuel line to provide cooling.

A bi-fuel arrangement exists when the petrol system is retained. Thus it provides a backup fuel where CNG refueling facilities are not developed. The dedicated natural gas engines is the engine dedicated to mono fuel of natural gas engines. Either they can be designed or can be derived from petrol engines.

With the advancement in diesel engines to run on natural gas, there are two options discussed. The first being is dual-fuel engines. These engines operate on the mixture of natural gas and diesel fuel. Since natural gas has a low cetane rating it's not suited for compression ignition. But if injection of diesel occurs within the gas/ air mixture, ignition can be initiated. The engine can also revert back to 100% diesel operation. The second one being dedicated natural gas engines. They are optimized for the natural gas fuel. And can be derived from petrol engines. Until original equipment engines are more readily available, the practice of converting of diesel engines to spark engines will continue, which involves the replacement of diesel fueling equipment by a

gas carburetor and the addition of an ignition system and spark plugs.

An approximate measure of the equivalent petrol and diesel fuel capacity of a cylinder filled with gas at 20 Map have been obtained by dividing the cylinder by 3.5 thus a 60 liter cylinder will provide the energy equivalent to 17 lts of conventional fuel. Design and installation of high on board storage cylinders plays an important part on safe operation of gas fueled vehicle. Cost constitutes significant proportion of total vehicle cost. Molybdenum steel gas cylinders are the cheapest but one of the heaviest forms of storage cylinder. Also it is even possible to increase the stored fuels energy density by, increasing the storage pressure of gas. Hence the Future dedicated gas fueled vehicles will benefit by the fuel storage systems being put into the vehicle structure. One such proposals being the so called "fortress frame."

Although the design is likely to be as safe as conventional CNG vehicles, product liability issues, make the future development of this concept uncertain. Research is going on to use adsorbent materials in tank to store natural gas which in turn reduces the required pressure and consequently avoids the need for high pressure compressors and provides more design flexibility for the tank. Adsorbent materials include activated carbon, zeolites, clays, and phosphates. However, it has not yet been possible to find an adsorbent material which provides the same storage capacity of usable gas at the same cost, weight, and volume as with high pressure cylinders.

## 6. Advantage

As obvious from the technical features which include effective innovations, the advantages of the Green engine over the contemporary piston engines are many.

### 6.1 Low Cost

Limited parts, small in size, light in weight and depending upon current mature materials and manufacturing technologies, mean that it would be done at much lower cost on manufacture, transportation, installing to other devices, and maintenance.

### 6.2 Multi-fuels

Due to six phases of working principle, super air fuel mixing process and constant volume combustion with controllable time, the Green engine becomes the only real multi-fuel engine on our planet; any liquid or gas fuels can be burnt well. Also it would be ideal to coal powder if special antiwearing material is employed.

### 6.3 Smooth Operation

Due to inherence of good dynamic and static balance the performance of the Green engine is as smooth as an electric motor.

### 6.4 Quietness and Low Exhaust Temperature

Burst out under small amount of mixtures, free of vibrations, and high expansion ratio make the Green engine much quieter. It is really environment-friendly. Green engine vehicles could transport troops on the battlefield of the future, and could serve as a vital source of auxiliary power in combat. This is because these engines are quiet, flexible and operate at low temperature, making them ideal for use in "stealth" vehicle.

### 6.5 Small Size and Light Weight

As Green engine is very compact with multi-power pulses, the size and weight could be 1/5 to 1/10 of the conventional piston engines on same output. Its power to weight ratio could be more than 2 hp per pound without supercharge or turbo charge.

### 6.6 High Efficiency

Because many great innovations are being employed in the engine design such as: direct air intake, sequential variable compression ratio, super mixing process, constant volume combustion, controllable combustion time, high working temperature of the burner, high expansion ratio and self adapting sealing system etc., the thermal efficiency of the engine could be potentially as high as 65 %, even more if water add-in technology is to be considered..

### 6.7 Disadvantage

- 1) Variation of HC emission.
- 2) Variation in smoke opacity.

## 7. Applications

The Green Engines could be used as the ideal power plants on a very wide range of applications in transportation, communication, farm, mine, engineering, military uses, such as automobiles, aircrafts, boats, ships, hovers, tractors, locomotives, generators, snowmobiles, chainsaws, helicopters, tanks, torpedoes, submarines etc.

## 8. Conclusion

Green engine is the future of the current engines. As the name itself indicates, it is the new economical engine with zero pollution and well suited for atmosphere. This paper is the introduction to the next generation of engines. It is a six phase internal combustion engine with its unique features like high efficiency, Light weight, zero emission, Noise free etc make it a better engine than other conventional engines. Green engine comes with the major modifications in parts and design to meet the requirements of current technology. The limitations of the engine have not been determined till date, and looking forward to replace the current internal combustion engines very soon.

## 9. Acknowledgement

We would like to thank all the teachers who helped us in the paper. Also would like to thank Mr. Chandru Appaji for giving us an opportunity to participate. The librarian for their inputs on the paper.

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