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A Study on the Effect of Compression Ratio on the Performance & Emissions of Stratified Charge Engine

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Abstract— In this review paper, work has been carries on the effect of the compression ratio on the performance of stratified charge engine. In the direct injection Gasoline engine, atomized spray is desired to achieve efficient mixture formation needed to good engine performance. The performance of gasoline fuelled stratified charge compression ignition engine according to compression ratio was examined.

Key words: Stratified Charge, Compression Ratio, Engine Performance

I. INTRODUCTION

The stratified charge engine is a type of internal-combustion engine which runs on gasoline. It is very much similar to the Diesel cycle. The name refers to the layering of the charge inside the cylinder. The stratified charge engine is designed to reduce the emissions from the engine cylinder without the use of exhaust gas recirculation systems, which is also known as the EGR or catalytic converters.

Stratified charge combustion engines utilize a method of distributing fuel that successively builds layers of fuel in the combustion chamber. The initial charge of fuel is directly injected into a small concentrated area of the combustion chamber where it ignites quickly. This arrangement works well in slow constant speed applications, but has proven difficult to manage across the wide range of speed and load incurred in automotive uses.

In IC engine the fuel ratio not equal throughout the cylinder. It is the process for the petrol engine. It is similar in some ways to the diesel cycle, but running on normal gasoline. In stratified charge engine, fuel is injected into cylinder just before ignition. This allows high compression ratio without knock and lean Air-fuel mixture than in conventional internal combustion engine. Stratified charge compression ignition also relies on temperature and density increases resulting from the compression.

A compression ratio is desirable because it allows an engine to extract more mechanical energy from a given mass of air-fuel mixture due to higher thermal efficiency. This occurs because internal combustion engine is heat engine and higher efficiency created because higher compression ratio permits same combustion temperature to be reached with less fuel, while giving longer combustion cycle creating more mechanical power output and lowering the exhaust temperature. It may be more helpful to think of it is an expansion ratio. Since more expansion reduce temperature of exhaust gas and energy wasted to atmosphere.

II. WORKING

A stratified charge engine only pulls air through the transfer system. The fuel required for combustion is forced into the cylinder through an injector placed in the top of the cylinder (head). The injector sprays a fuel/air mixture in the form of a fuel cloud into the cylinder. Surrounding this cloud is air supplied by the transfer system. As the cloud is ignited and burns, the surrounding air provides almost complete combustion before the exhaust port opens. For stratified charge engine, it is well know that lean, stratified combustion can reduce fuel consumption and gain some merits in gasoline spark-ignited, direct injection engines for several reasons. Fuel spreads in a thin film over the wall and is evaporated by the air swirling in the chamber to form the stratified charge.

In order to realize the stratified combustion, the cylinder mixture formation in-time, spatial control is essential. Stratified charge engine could operate unthrottled as does the diesel engine. First, unthrottled operation allows for a significant reduction in pumping loss, especially at low loads. Second, the lean mixture being compressed has a higher ratio of specific heats. This allows for a more efficient compression and expansion process. Third, there are lower wall heat losses in the cylinder because of the centralization of the mixture away from the walls.

A stratified charge engine concentrates a rich m39ixture near the spark plug (air-fuel ratio is less than 14.7:1) and lean mixture (at air-fuel ratios of 50:1 or greater) throughout into the cylinder.

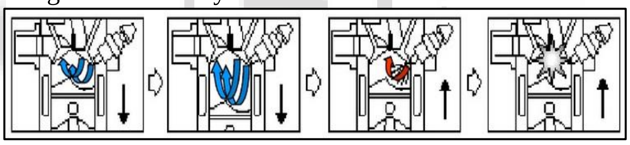

Fig. 1: Stratified Charger Engine

To do stratification, the fuel injectors are aimed in order to inject the fuel into only one area of the cylinder, often a small "subcylinder" at the top of the main cylinder. This leads to a very rich charge in that area that ignites easily and burns smoothly. As the combustion proceeds, it meets a very lean area (often only air) where it cools rapidly and the harmful NOx never has a chance to form. The additional oxygen in the lean charge also combines with any CO to form CO2, which is less harmful. The much cleaner combustion allows for the elimination of the catalytic converter, as well as allowing the engine to be run at leaner mixtures, using less fuel.

In a stratified charge engine, the fuel is injected into the cylinder just before ignition. This allows for higher compression ratios without "knock," and leaner air/fuel mixtures than in conventional internal combustion engines.

All the subtlety of engine operation in stratified mode occurs at level of injection. In this air-fuel ratio is free to range from rich limit of homogeneous to lean limit of stratified combustion and the combustion mode is varies between homogeneous and stratified as per need. This comprises two principal modes:

A. Lean Mode

It corresponds to operation at very low engine load.

B. Normal Mode

When it runs at full charge and delivers maximum power.

III. EFFECT OF COMPRESSION RATIO

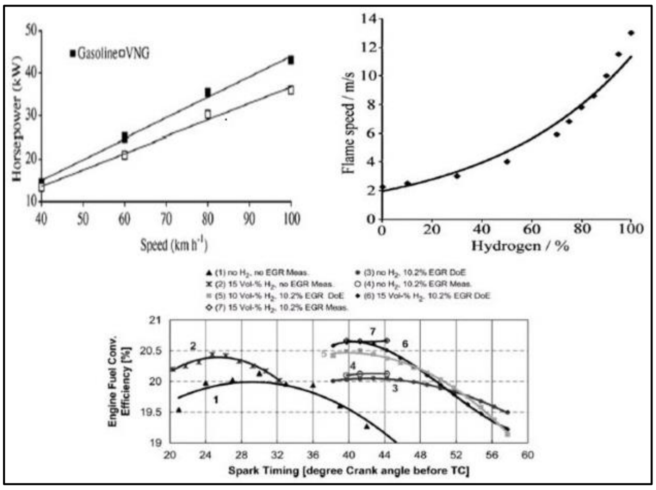

Fig. 2:

To investigate the performance, emission and combustion characteristics of the engine using petro-diesel. The simulation has been carried out for three compression ratios of 16, 17 and 18 at constant speed of 1500 rpm. The analysis of simulation results show that brake thermal efficiency decreases and brake specific fuel consumption increases with the use of petrol. The thermal efficiency increases and the brake specific fuel consumption decreases with the increase of compression ratio. The higher compression ratio results in higher in-cylinder pressure and higher heat release rate as well as lower ignition delay. The NO_x and CO_2 emissions increase at higher compression ratio due to the higher pressure and temperature. On the other hand, the specific PM emission and smoke opacity are less at higher compression ratio.

Compressing the fuel and air will make them burn faster, which makes the engine run better. Due to the high compression ratio (12.51) of the 11,000 RPM Hayabusa engine and the low compression ratio (9.8:1) of the 6500rpm Mustang V8.

There are secondary benefits to high compression ratios, too. High compression ratio engines burn both much more cleanly and much more efficiently than lower-compression engines. For example, a diesel engine, which burns fuel very differently to a gasolene engine, will often give fuel economy 60% greater than its gas equivalent, even though diesel only has about 10% more energy per gallon

IV. CONCLUSION

1) The combustion characteristics according to variation in injection timing revealed that as injection timing is advanced, ignition timing is delayed and combustion pressure is decreased. With a decreasing compression ratio, injection timing is delayed, and ignition timing is also delayed as the intake temperature increases.
2) Combustion and emission characteristics according to variation in the compression ratio revealed that as the compression ratio increased, injection timing is delayed and the IMEP value increased. A dense air-fuel ratio also increased the IMEP value and decreased the HC level while increasing the NOx level.

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