# "Studies Of Squish And Tumble Effect On Performance Of Multi Chambered Piston Ci Engine"

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## ABSTRACT

**The primary aim is to investigate the study of squish and tumble effect on performance of multi chambered piston biodiesel fueled CI engine. The engine is four stroke, single cylinder DI diesel engine. The engine was tested for performance by using diesel & different composition of biodiesel by varying torque with base line piston. The modification was that, three chambers have been made on the piston crown at $120^0$ angle to each other. Multi chamber is made to enhance the squish and tumble effect which in turn enhances the combustion. The multi chambered piston was tested as the same operating conditions of the standard piston. Engine tests were performed with different loads and constant engine speed. The performance of multi chamber is analyzed for different loads and for different blends. The experimental results showed that the emissions have been decreased at the cost of thermal efficiency for honge blends when compared to the engine run with diesel for same operating conditions as the standard piston.**

**Keywords: Multi chambered piston, Tumble, Squish, Bio-diesel, Performance characteristics, Emission**

## I. INTRODUCTION

Squish is radially inward or transverse gas motion that occurs toward the end of the compression stroke when a portion of the piston face and cylinder head approach each other closely. Squish is also known to lead to flame quenching in thin sections in the extremities of squish region. Tumble is a large scale vortex with a rotation axis perpendicular to both the axis of piston motion and the plane of intake manifold. Tumble is also known as barrel-swirl. Multi chamber on piston crown induces squish and tumble which enhances the combustion, due to better combustion emission characteristics has been decreased at the cost the cost of performance.

**B.Murali Krishna and J.M.Mallikarjuna [1]** to analyze the tumble flows, ensemble average velocity vectors are used and to characterize it, tumble ratio is estimated. From the results, generally, we have found that tumble ratio varies mainly with crank angle position. Also, at the end of compression Stroke, average turbulent kinetic energy is more at higher engine speeds. **Nagarahalli. M.V *et al* [2**], conducted experiments on Karanja biodiesel and its blends in a C.I. engine. Concluded that tests for emission and performance were conducted on 4 strokes, constant speed diesel engine said that the results are in line with that reported in literature by different literature and recommended 40% biodiesel 60% diesel (B40). **Deepak Agarwal *et al.*, [3]** conducted experiments with esters of linseed, mahua, rice bran and Lome. They observed that the performance and the emission parameters were very close to diesel. They even observed that a diesel engine can perform satisfactorily by esterified biodiesel blends without any hardware modifications. **Katsuhiko Miyamoto *et al* [4],** showed that for reduction of fuel consumption, it was confirmed that improved in thermal efficiency yielded by squish-enabled increase in combustion speed is beneficial with low engine loading and that squish-enabled suppression of knock is beneficial with high engine loading**. Muammer ¨O ZKAN et al [5]** Biodiesel, traditional Diesel and biodiesel with glycerine were used as the fuel of a direct injection compression ignition engine. The torque, brake power and fuel consumption values associated with these fuels were determined under certain operating conditions. Effective efficiency, Effective pressure and SFC values were calculated according to the formulae given in the Appendix. The obtained results were compared and it was noted that all fuels yielded similar results at some points. However, biodiesel and biodiesel with glycerine gave different values under the same conditions. According to these results, glycerine affects engine performance under certain engine speed conditions

**Thangavelu ELANGO et al [6]** In his work the combustion, performance and emission characteristics of a single cylinder Diesel engine when fuelled with blends of jatropha and diesel oil are evaluated. Experiments were conducted with different blends of jatropha oil and diesel at various loads. The peak pressures of all the blends at full load are slightly lower than the base diesel. There is an increase in the ignition delay with biodiesel because of its high viscosity and density. The results show that the brake thermal efficiency of diesel is higher at all loads followed by blends of jatropha oil and diesel. The maximum brake thermal efficiency and minimum specific fuel consumption were found for blends up to B20. The specific fuel consumption, exhaust gas temperature, smoke opacity and NOx were comparatively higher. However there is an appreciable decrease in HC and CO2 emissions while the decrease in CO emission is margin-al. It was observed that the combustion characteristics of the blends of esterified jatropha oil with diesel followed closely with that of the base line diesel. **TAMILVENDHAN.D et al (7**) In the present work the performance, emission and combustion characteristics of a single cylinder constant speed , direct injection diesel engine using methyl ester of sun flower oil – eucalyptus oil blend as an alternative fuel were studied and the results are compared with the standard diesel fuel operation. Result indicated that 50% reduction in smoke, 34% reduction in HC emission and a 37.5% reduction in CO emission for the MeS50Eu50 blend with 2.8 % increase in NOx emission at full load. Brake thermal efficiency was increased 2.7 % for MeS50Eu50 blend. **N.JANARDHANA RAO et al [8]** Biodiesel is an environmentally friend renewable diesel fuel alternative. A single cylinder direct injection diesel engine was first run with diesel fuel and then with blends of biodiesel based palm oil. The performance and emission characteristics of the engine run with both the fuel have been compared and the results obtained are shown in this paper. From the results obtained, it is understood that the thermal efficiency is slightly less and the specific fuel consumption is slightly higher with biodiesel when compared with Diesel. This is due to the lower calorific value of the biodiesel. It is concluded that the biodiesel can be used as alternative fuel in the Diesel engine without any engine modifications.

The aim of this study is to investigate the brake thermal efficiency and brake specific fuel consumption at different loads with standard piston and with multi chambered piston. The experiments were conducted with a single cylinder, four stroke and DI diesel engine. The results showed that emission has been decreased with little decrement in performance for multi chamber piston.

## II. EXPERIMENTAL WORK.

A 4S, DI single cylinder diesel engine was used (Table 1). The experimental set up is shown in Fig 1. Engine torque used to measure by eddy current dynamometer provided in the engine. The engine has a conventional fuel injection system. The injector is placed at $28^0$ to the combustion chamber. A piezoelectric pressure transducer was used to measure the in cylinder pressure. It was also provided with temperature sensors for the measurement of jacket water, calorimeter water, and calorimeter exhaust gas inlet and outlet temperatures. An encoder is fixed for crank angle record. Emissions were measured by using INDUS model **PEA205 *is*** a 5-gas analyzer meant for monitoring CO, $CO_2$, HC, $O_2$ and NO in automotive exhaust.

An engine VCR tool was correlated with engine used to measure the performance characteristics like break thermal efficiency and specific fuel consumption for different loads.

The standard piston was tested. The tests were performed for diesel and different composition of Honge bio-diesel (i.e. B10, B20 and B30) for a CR=17.5 and injection pressure of 200 bar.

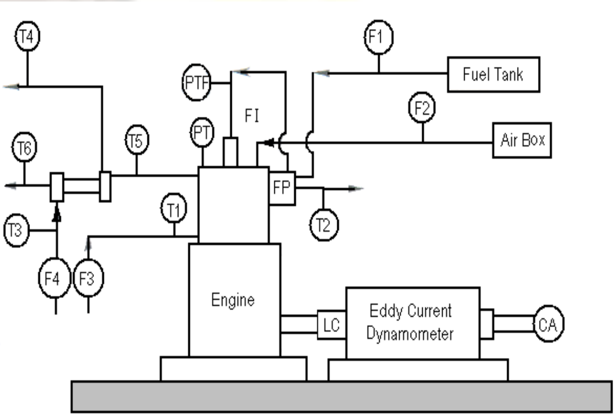


**Fig.1. Schematic diagram of experimental set up**

| SL NO | ENGINE PARAMETERS | SPECIFICTION |
|---|---|---|
| 01 | Engine Type | TV1(Kirloskar) |
| 02 | Number of cylinders | Single Cylinder |
| 03 | Number of strokes | Four-Stroke |
| 04 | Rated power | 5.2KW (7 HP) @1500RPM |
| 05 | Bore | 87.5mm |
| 06 | Stroke | 110mm |
| 07 | Cubic Capacity | 661cc |
| 08 | Compression ratio | 17.5:1 |
| 09 | Rated Speed | 1500 |

Table 1. Engine Specification

## III. RESULTS AND DISCUSSIONS.

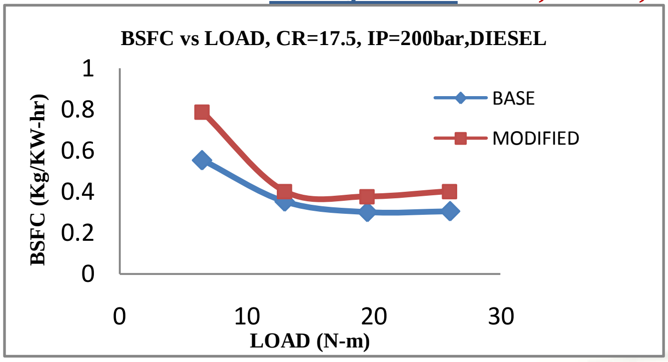


Fig.2: sfc vs. load for Diesel.

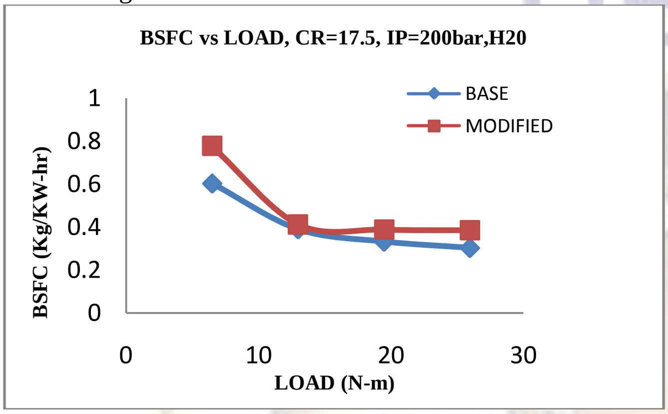


Fig.3: sfc vs. load for honge 20

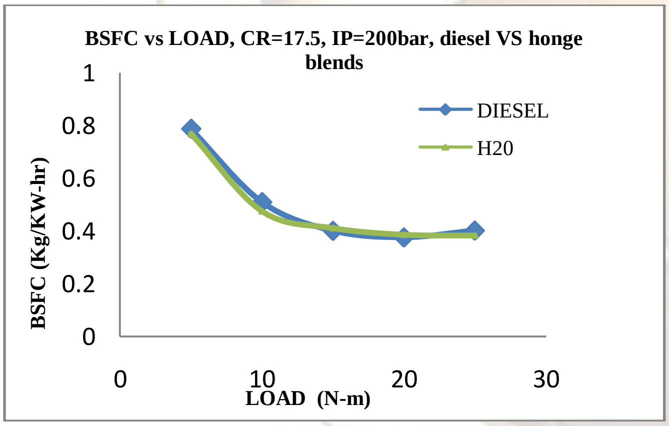


Fig.4: sfc vs. load for modified piston

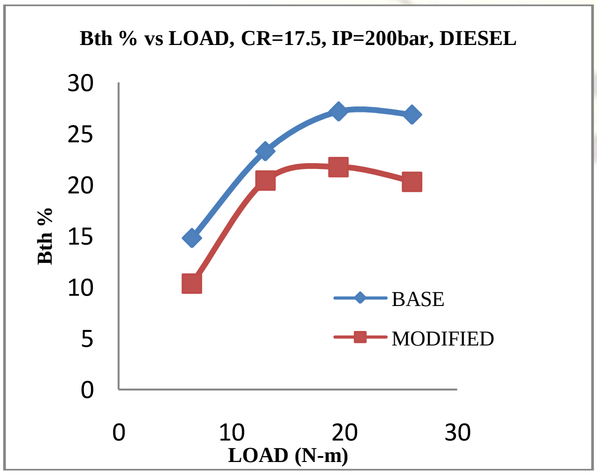


Fig 5: $B_{th}$ vs. load for diesel

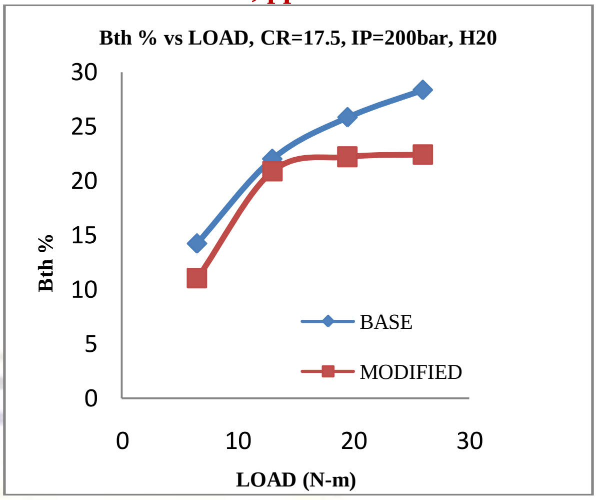


Fig.6: $B_{th}$ vs. load for honge 20

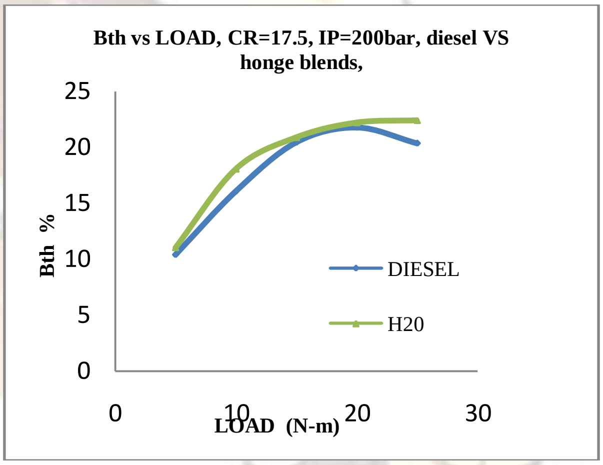


Fig.7: $B_{th}$ vs. load for modified piston

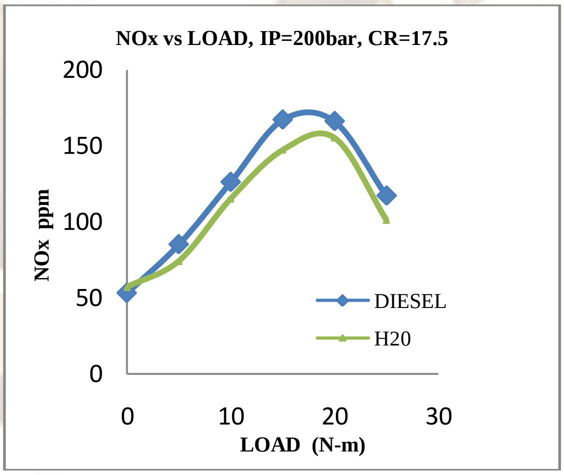


Fig 8: NOx vs load for modified piston

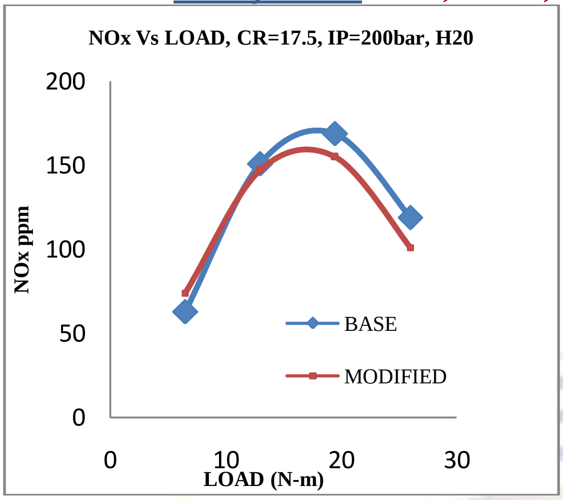


Fig.9: NOx vs. load for honge20

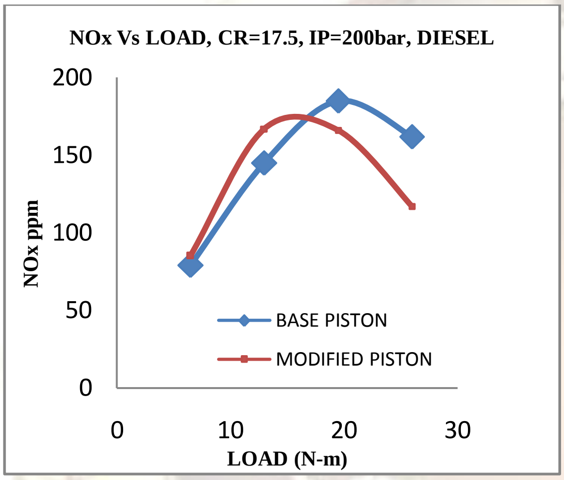


Fig.10: NOx vs. load for diesel

## SPECIFIC FUEL CONSUMPTION:

It is observed from fig.2 that at 80% load the consumption of diesel is 0.305Kg/KW-hr and honge is 0.402Kg/KW-hr. From f ig3it is observed that at 80% load the consumption of honge20 for base line piston is 0.303Kg/KW-hr and honge20 for modified piston is 0.384Kg/KW-hr. From fig4 it is observed that at 80% load the consumption of diesel for modified piston is 0.402Kg/KW-hr and honge20 for modified piston is 0.384Kg/KW-hr. so the consumption has increased. It is observed from the graph that as the load increases the energy requirement in terms of fuel decreases since the calorific value honge bio-diesel is less. To generate the energy at par with diesel the bio-diesel should be consumed more.

## BREAK THERMAL EFFICIENCY:

It is observed from fig.5 that at 80% load Brake thermal efficiency of diesel is 26.84% and honge20 is 20.34%. From fig6 it is observed that at 80% load the Brake thermal efficiency of honge20 for base line piston is 28.36% and honge20 for modified piston is 22.39%. From fig7 it is observed that at 80% load Brake thermal efficiency of diesel for modified piston is 20.34% and honge20 for modified piston is 22.39%. So the thermal efficiency has slightly been reduced for modified piston in comparison with base line piston. Owing to poor mixture formation as a result of low volatility and higher viscosity that causes longer ignition delay. The diesel has better atomization than bio-diesel.

## $NO_x$ EMISSION:

Formation of $NO_x$ is temperature dependent phenomenon. As the engine load increases the combustion gas temperature increases which in turn increases formation of $NO_x$. Honge20 has less emission of $NO_x$ due to lower peak combustion temperature because of its lower energy content.

## IV. CONCLUSIONS:

Experimental investigations on squish and tumble effect on performance of multi chambered piston CI engine was conducted on single cylinder, 4Stroke, DI, constant speed diesel engine. Tests were conducted for the base piston and multi chamber piston for different loads and compression ratio of 17.5 and injection pressure of 200 bar. The major conclusions drawn from these experiments are as follows:

1). Specific fuel consumption for diesel and Honge20 for base line piston is lower in comparison with multi chamber piston. But for multi chamber piston the consumption of H20 is slightly lower than that of diesel.

2). Brake thermal efficiency of diesel and honge20 for base line piston is more when compared with multi chamber piston. But for multi chamber piston the brake thermal efficiency of honge20 is slightly more than that of diesel.

3). Emission of NOx for both diesel and honge20 has decreased for multi chamber piston when compared with base line piston and also for multi chamber piston, emission of NOx for honge20 is lesser than diesel.

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