EXPERIMENTAL INVESTIGATION ON THE EFFECT OF BEAK GROOVES ON PISTON CROWN OF D.I. DIESEL ENGINE WITH BLENDS OF APRICOT BIO-DIESEL

G. Pavan Sai[1], Dr. D. Maneiah[2]

[1] Department of Mechanical Engineering, CMR Technical Campus (UGC Autonomous), -Kandlakoya

[2]Department of Mechanical Engineering, CMR Technical Campus (UGC Autonomous), -Kandlakoya.

ABSTRACT

Petroleum fuel prices are often rising due to the rapid depletion of natural resources, which are exorbitantly expensive for the average consumer, especially in the situation in India. Therefore, C.I. The importance of alternative fuel engines for use in is increasing. Much research has been done on alternative fuels. Intensive research is being conducted in the area of improving the thermal efficiency of engines. This shows that in a naturally aspirated diesel engine, only one-third of the heat supplied is converted to work. Many methods are recommended by some experts and researchers to improve engine performance characteristics. The purpose of this study is to increase the swirl effect in the cylinder, improve performance and reduce emissions. In DI diesel engines, swirls can increase the mixing speed of fuel and air. The vortex interaction with the squish flow caused by compression increases the level of turbulence in the combustion bowl and promotes mixing. It is clear that the effect of the shape has very little effect on the airflow during the inspiratory stroke and in the early part of the compression stroke. However, as the piston moves towards top dead center (TDC), the shape of the bowl has a significant effect on airflow, improving atomization, mixing and combustion. In CI, the engine piston shape of the head is a flat and concave combustion chamber, and the engine was driven in this shape. However, it is not possible to mix the air-fuel ratio mixture properly here. To avoid this, shape of the piston was changed.

***Keywords**: D.I. Diesel Engine, Bio- Diesel, Apricot oil, Beak Grooved Piston, B10, B20 and B30.*

1. INTRODUCTION

Energy is the most important aspect of economic and social development to improve quality of life. Most of the world's current energy sources are based on fossil fuels and will eventually run out unless we develop technologies that can use alternative fuels to supply energy [1]. Global energy consumption is increasing faster than population growth. Crude oil and petroleum products of this century are considered to be extremely rare and expensive. The daily fuel consumption of the engine has improved and this will continue for years [2]. However, fuel demand is increasing rapidly due to the significant increase in the number of vehicles. Due to high energy consumption in developing countries, especially in Asia, this growth forecast is expected to increase by up to 1.5% by 2030.

Increasing energy demand has forced major fuel energy exporters around the world to find alternative fuels that are independent of fossil fuel-based products. Sustainability is a major issue leading to the fact that the energy sector is not fully developed, so various authorities are being called upon to use new renewable energy sources [3]. Biodiesel is one of the future success alternative fuels to solve this problem. Biodiesel is renewable, biodegradable, non-toxic and has properties very similar to diesel fuel. It can be made from both vegetable oils and animal fats. However, these oils can’t be used directly as fuel due to high viscosity. In order to reduce viscosity, it is necessary to produce biodiesel to the transesterification process to remove glycerin from the product and ester [9]. Biodiesel can work with compressed ignition machinery, with or without modification as well as petroleum diesel. In addition, biodiesel is more effective in engine deductions, costs, and availability. If burned, biodiesel produces harmful contaminants for human health. In addition, it provides superior lubricants compared to diesel fuel. However, it is important to consider the performance and emission characteristics of the biodiesel fuel engine. In general, combustion of biodiesel fuel in a compression ignition (CI) engine produces less smoke, particulate matter, carbon monoxide, and hydrocarbons [8].

Objective of The Study:

The main purpose of this project is to study performance technologies to improve eddy in order to improve engine performance and reduce emissions in single-cylinder direct injection (DI) diesel engines. Changes have been made to the piston crown to achieve swirl strength in the cylinder. To increase the twist, a series of tests such as beak grooves were performed on the piston crown and the results were compared to normal piston values and apricots as a biodiesel blend. The blend was obtained by blending diesel and esterified apricot kernel oil in the following ratios: B10 and D90 indicate that apricot biodiesel is 10% and diesel is 90%. Similarly, B20 & D80, B30 & D70 were made. Performance parameters such as braking efficiency, fuel consumption rate, and braking power have been determined.

Need of Alternative Fuels

Alternative fuels come from sources other than petroleum. Many of them are domestic and some come from renewable resources. The number of vehicles is increasing day by day, which means that fossil fuel consumption is also increasing exponentially. So far, we have relied on fossil fuels made from hydrocarbons that produce large amounts of non-renewable and harmful emissions. Alternative renewable fuels are urgently needed as hydrocarbon fuel reserves are rapidly depleted due to population explosions and technological improvements using higher fuel energy consumption. Organizations such as governments and environmental controls impose additional taxes and fines not only on automakers, but also on customers who violate car emission standards. To avoid all these problems, such alternatives to harmful emissions are needed and the fuel is essentially renewable.

Engine Specifications

ENGINE	FOUR STROKE SINGLE CYLINDER
BHP	5 HP
SPEED	1500 RPM
FUEL	DIESEL
BORE DIA	80 MM
STROKE LENGTH	110 MM
METHOD OF COOLING	WATER COOLED
METHOD OF IGNITION	COMPRESSION IGNITION

2. EXPERIMENTAL SETUP

Figure 2.1 Image of Normal and Beak Grooved Pistons Before Placing in to Cylinder

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 04 | April - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Figure 2.2 Experimental Setup

Figure 2.3 Modified Beak Grooved Pistons After Combustion

The piston crown of 80 mm diameter of base line engine is modified by producing four grooves. In the present experiment, Beak Grooves of inner diameter 29.35 mm and outer 39.44 mm is produced on piston of 80 mm diameter and maintaining a depth of 1.5 mm at outer and 2 mm at inner in each groove for Beak Groove Piston.

3. RESULTS AND DISCUSSIONS

The tests were carried by the modified beak grooved piston with a blend of B-10, B-20 & B-30 with a load such as 2,4,6,8 and 10 kgs. Compared to Normal & Beak groove piston at full load of Bio-Diesel (B-20) reduction of brake specific fuel consumption in Beak groove piston is observed and at full load of Bio-Diesel (B-30) increase of brake thermal efficiency in Beak groove piston is observed.

3.1 NORMAL PISTON WITH BLENDS OF B-10, B-20 AND B-30.

3.1.1 Brake thermal efficiency:

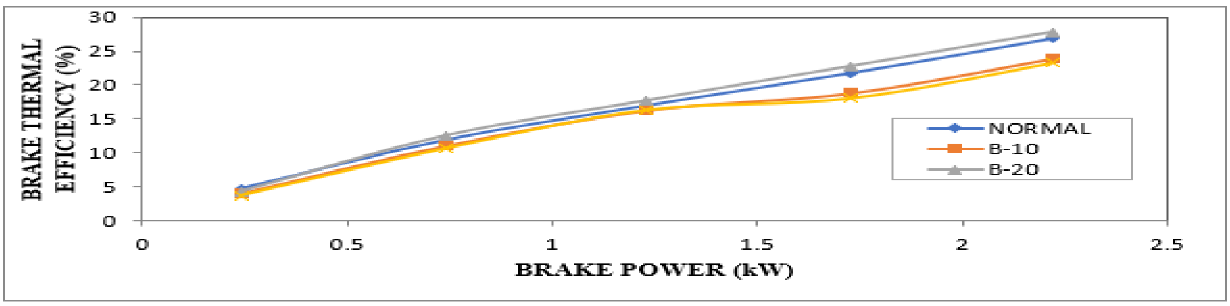

Fig- 3.1 Variation of Brake thermal efficiency with respect to Brake power at various blends

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 04 | April - 2022 Impact Factor: 7.185 ISSN: 2582-3930

The brake thermal efficiency with brake power will conduct a performance test on normal piston with Diesel and Bio-Diesel blends. The brake thermal efficiency for the normal piston with full load is 26.59%. The brake thermal efficiency for the normal piston with B-10, B-20 and B-30 full load is 21.35%.27.88% and 21.35%. Comparison of normal piston and B-20 the brake thermal efficiency will increases up to 1.29%.

3.1.2 Brake specific fuel consumption:

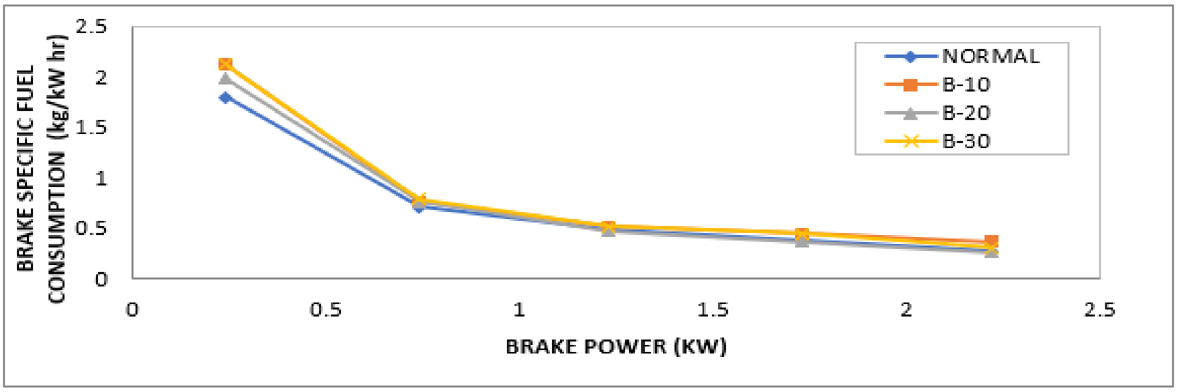

Fig- 3.2 Variation of Brake specific fuel consumption with respect to Brake power at various blends

The brake specific fuel consumption with brake power is conducted with a performance test on normal piston and Diesel and Bio-Diesel blends. The brake specific fuel consumption for the normal piston with full load is 0.2785 kg/kW hr. The brake specific fuel consumption for the normal piston withB-10, B-20 and B-30 with full load is 0.3797 kg/kW hr, 0.2647 kg/kW hr and 0.3197 kg/ kW hr. Comparison of normal piston and B-20 the brake specific fuel consumption is decreases up to 0.0138 kg/ kW hr.

3.1.3 Indicated thermal efficiency:

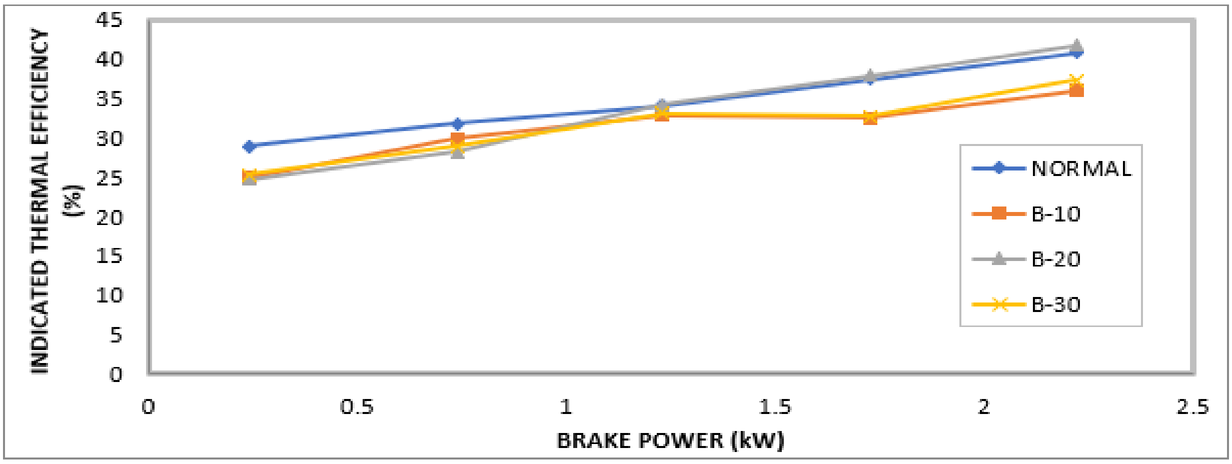

Fig-3.4 Variation of Indicated thermal efficiency with respect to Brake power at various blends

Indicated thermal efficiency with brake power is conducted with a performance test on normal piston and Diesel and Bio-Diesel blends. The indicated thermal efficiency for normal piston with full load is 40.83%. Compared with normal piston with B-10, B-20 AND B-30 with full load 35.96%, 41.74% and 37.35%. Indicated thermal efficiency has increased with increasing brake power. Comparison of normal piston and grooved piston the indicated thermal efficiency will increase up to 0.91%.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 04 | April - 2022 Impact Factor: 7.185 ISSN: 2582-3930

3.1.4 Mechanical efficiency:

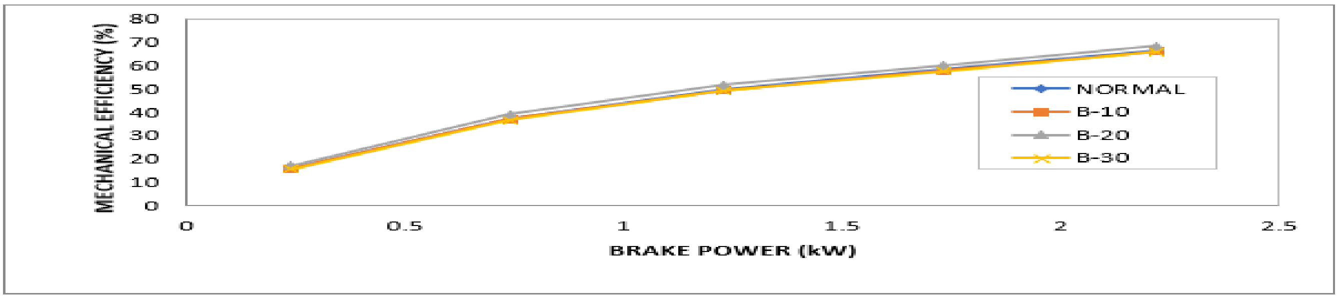

Fig- 3.5 Variation of Mechanical efficiency with respect to Brake power at various blends

Mechanical efficiency with brake power is conducted with a performance test on normal piston and Diesel and Bio-Diesel blends. The indicated thermal efficiency for normal piston with full load is 60.52%. Compared with normal piston with B-10, B-20 AND B-30 with full load 66.15%, 68.29% and 65.77%. Mechanical efficiency has increased with increasing brake power. Comparison of normal piston and grooved piston the indicated thermal efficiency will increase up to 7.77%.

3.2 BEAK GROOVED PISTON WITH BLENDS B-10, B-20 AND B-30.

3.2.1 Brake thermal efficiency

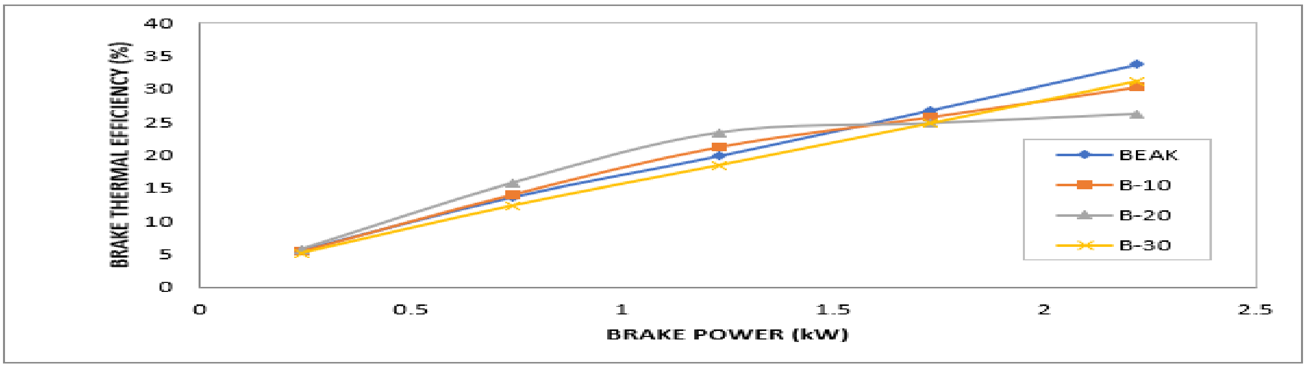

Fig- 3.6 Variation of Brake thermal efficiency with respect to Brake power at various blends

The brake thermal efficiency with brake power will conduct a performance test on beak piston and Diesel and Bio-Diesel blends. The brake thermal efficiency for the normal piston with full load is 33.67%. The brake thermal efficiency for the beak piston withB-10, B-20 and B-30 with full load is 30.27%, 26.18% and 31.13%. Comparison of beak piston and B-30 the brake thermal efficiency will decrease up to 2.54%.

3.2.2 Brake specific fuel consumption:

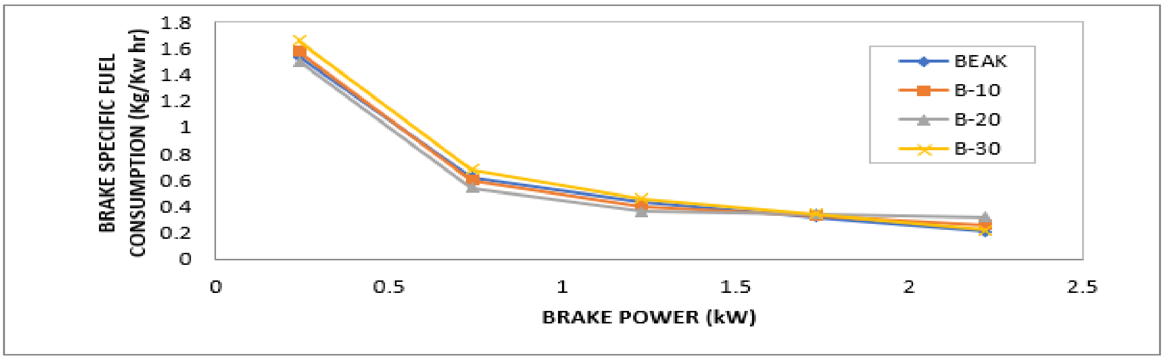

Fig- 3.7 Variation of Brake specific fuel consumption with respect to Brake power at various blends

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 04 | April - 2022 Impact Factor: 7.185 ISSN: 2582-3930

The brake specific fuel consumption with brake power is conducted with a performance test on beak piston and Diesel and Bio-Diesel blends. The brake specific fuel consumption for the beak piston with full load is 0.206kg/ kW hr. The brake specific fuel consumption for the beak piston withB-10, B-20 and B-30 with full load is 0.2587 kg/kWhr,0.3214 kg/kW hr and 0.2237 kg/ kW hr. Comparison of beak piston and B-20 the brake specific fuel consumption is increased up to 0.1154 kg/ kW hr.

3.2.3 Indicated thermal efficiency:

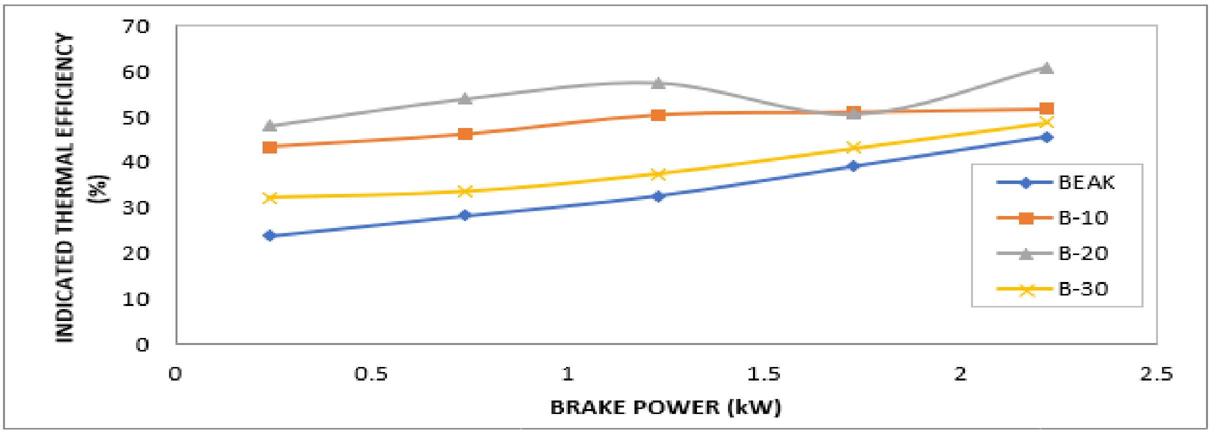

Fig- 3.8 Variation of Indicated thermal efficiency with respect to Brake power at various blends

Indicated thermal efficiency with brake power is conducted with a performance test on beak piston and Diesel and Bio-Diesel blends. The indicated thermal efficiency for beak piston with full load is 45.61%. Compared with normal piston with B-10 , B-20 and B-30 with full load 51.07%, 60.94% and 48.75%. Indicated thermal efficiency has increased with increasing brake power. Comparison of beak piston and beak piston with blends the indicated thermal efficiency will increase up to 15.33%.

3.2.4 Mechanical efficiency:

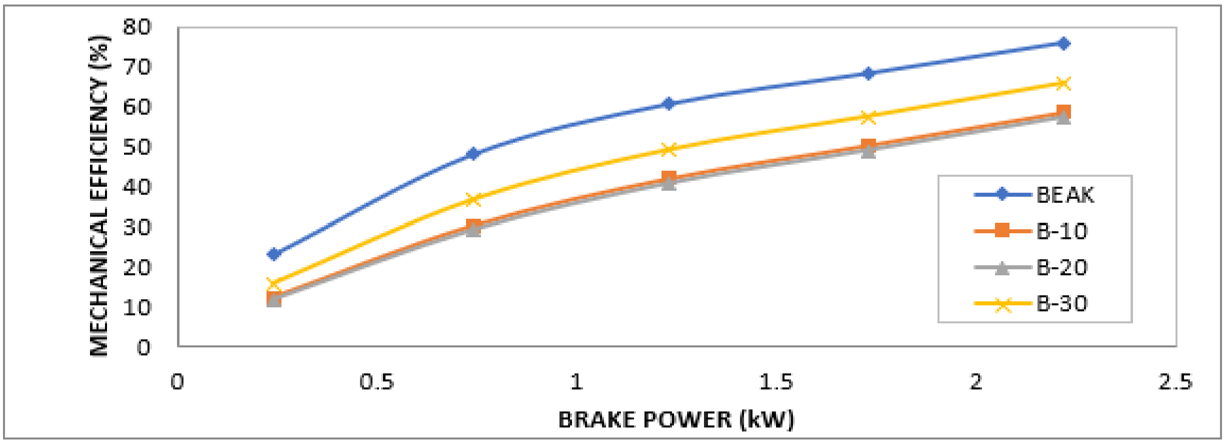

Fig- 3.9 Variation of Mechanical efficiency with respect to Brake power at various blends

Mechanical efficiency with brake power is conducted with a performance test on beak piston and Diesel and Bio-Diesel blends. The indicated thermal efficiency for beak piston with full load is 76.01%. Compared with beak piston with B-10, B-20 and B-30 with full load 58.72%, 57.25% and 65.77%. Mechanical efficiency has increased with increasing brake power. Comparison of beak piston and beak piston with blends the indicated thermal efficiency will decrease up to 10.24%.

4. CONCLUSION

Based on the experimental results for the normal piston engine with beak grooved piston configuration, the following conclusions are drawn:

- Compared to Normal & Beak groove piston at full load of Bio-Diesel (B-20) the brake specific fuel consumption in Beak groove piston is decreased up to 0.0567 kg/kW hr.
- Compared to Normal & Beak groove piston at full load of Bio-Diesel (B-30) the brake thermal efficiency in Beak groove piston increased up to 1.29%.

5. REFERENCES

[1]. S Karthikeyan and A Prathima "were conducted an experimental investigation to establish the performance and emission characteristics of a Compression Ignition engine while using aluminium oxide nanoparticles as additive with pure diesel., SAE 660130, Vol 75"

[2]. Harish Sivasubramanyam., "were carried out the research work on alternate fuels to reduce the demand of fossil fuels and to reduce harmful emissions. The Papaya seed oil was used as an alternative fuel with diesel in two proportions of 15 and 20%." SAE paper 2000-01-1823,2000.

[3]. Timoney, David J et.al., "Influence of fuel injection and air motion energy sources on fuel air mixing rates in a DI diesel engine combustion" SAE paper 960035.1996.

[4]. Yub-Yih,et.al.,"Investigation of realizing SDI with high swirl charge in motor cycle e.ngine" International Journal of Energy, issue2, Volume.3, 2009.

[5]. Yan-Liang, et.al., "Studies of Tumbling Motion generated during intake In a Bowl – in –Piston Engine" Journal of Science and Technology, Vol.7, No.1, pp.52-64,1999.

[6]. Sait,T., Knoff,F.,Jasomek,A. and Schindler, A. Effects of chambers geometry on diesel combustion, S A E paper,861186, 1986.

[7]. Stone, C.R. and Ladommatos, N. The measurements and analysis of swirl in steady flow, S A E paper,921642, 1992

[8]. M.A.Kalam, M.Husnawan,H.H.Masjuki,"Exhaust emission and combustion evaluation of coconut oil-powered indirect injection diesel engine", Renewable Energy, Vol.28, pp.2405–2415, 2003.

[9]. Draft Technical Report, "A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions", United States Environmental Protection Agency Air and Radiation, EPA420-P-02-001, October 2002.

[10]. Fuchs T R and Rutland C J 1998 Intake flow effects on combustion and emissions in a diesel engine (No. 980508). In: SAE Technical Paper.

[11]. Prasad B V V S U, Sharma C S, Anand T N C and Ravi krishna R V High swirl-inducing piston bowls in small diesel engines for emission reduction. Appl. Energy 88(7): 2355–2367, 2011.

[12]. Akkaraju H. Kiran Theja, Subbarao Rayapati "Experimental Studies on Diesel Engine with Piston Crown Modification Using an Optimum Alternative Fuel", November 2015, Applied Mechanics and Materials 830-835.

[13]. K.R.Lavaa[a] JagadeeshSannagoudraa[a] D.B.Ganesh[b], Experimental exploration on the influence of different piston geometry and injection timing by using bio-diesel, Materials today proceedings, Volume 4, Issue 10, 2017, Pages 10879-10885.

[14]. GANJI, P.R., SINGH, R.N., RAJU, V.R.K. et al. Design of piston bowl geometry for better combustion in direct-injection compression ignition engine. Sādhanā 43, 92 (2018).

[15]. S. K. Gugulothu, "Effect of piston bowl geometry modification and compression ratio on the performance and emission characteristics of DI diesel engine" Australian Journal of Mechanical Engineering, Volume 19, 2021 - Issue 3.