RESEARCH ARTICLE OPEN ACCESS

REDUCTION OF EMISSIONS BY ENHANCING AIR SWIRL IN A DIESEL ENGINE BY ARRANGING A WHIRL AIR FAN BEFORE THE INTAKE MANIFOLD

G.S.Gurudattatreya[*], G.Naresh Babu[**], B.Srinivasa Reddy[***]
[*]Asst.prof, Mechanical Engineering Department, Siddhartha institute of technology & sciences Ghatkesar, Hyderabad, India, Mail Id: sankarguru123@gmail.com.
[**]Asst.prof, Mechanical Engineering Department, Siddhartha institute of technology & sciences Ghatkesar, Hyderabad, India, Mail Id: gongatin@gmail.com.
[***]Asst.prof, Mechanical Engineering Department, Siddhartha institute of technology & sciences Ghatkesar, Hyderabad, India, Mail Id:311srinivasreddy@gmail.com.

ABSTRACT
In the present context, the world is confronted with the twin crisis of fossil fuel and environmental degradation. The fuel economy is achieved by efficient combustion inside the cylinder which is possible by uniform mixing of air and fuel in the cylinder. The swirl can be generated in the diesel engine by modifying three parameters in the engine; they are the cylinder head, the piston crown, and the inlet manifold. The objective of the present study is to enhance the swirl effect in the cylinder which causes better performance and reduces the emissions. In this work an attempt is made using whirl air fan with different inclinations placed before the intake manifold for effective air swirl motion. For this, the experiment is done on Kirloskar AV1 water cooled, natural aspirated direct injection diesel engine with pure diesel.

Keywords: D.I.Diesel Engine, Whirl air fan, Swirl, Emissions

I. INTRODUCTION

In present days developed and developing countries are using diesel engines in power plant for different purpose like generating electricity and transportation. These engines consume heavy quantity fuel per hour, where these engines produce the power as well as they also produce the different types of toxic gases that are harmful for our human beings and environment. Environmental pollution at this time is very serious problem for our human beings and flora-fauna. Our environment is polluted day by day from industrial emissions and road vehicles emissions[1,2].

Petrol engine and diesel engine produced different types of harmful gases during combustion like NO_x, CO, CO_2, HC and some quantity of SO_x due to poor fuel quality. These gases are produced by different engine factor such as homogeneous mixture, injection timing, compression ratio etc. These factors also affect the combustion efficiency, fuel consumption and engine brake power[3,4].

Due to heterogeneous combustion the thermal "η" of C.I. Engine is less in spite of using a large excess air. Therefore thought of conducting the experiment to overcome the above problem of low thermal efficiency & also to reduce levels of pollution. The thermal efficiency of the conventional C.I. Engine is low around 20%to28% due to low rate of air swirl and improves the improper mixing of air and fuel. If the swirl is weak the products of combustion are not swept away fast from the surface of the burning drop plate. This will further suffocate burning of droplet[5,6].

Due to heterogeneous mixing of air and fuel the thermal efficiency of diesel engine is less[7,8]. In order to increase the efficiency and also to reduce the pollutants an attempt is done for better mixing of air and fuel by using fixed curved blade before the intake manifold. Different Inclinations are also used to find the better blade angle for better swirl motion. Swirl flow has been used in many different kinds of internal combustion engine because of their effects in increasing efficiency, reducing the noise and other emission pollutants also to improve combustion instability.

II. Specifications of Diesel Engine and Dynamometer

Fig 1

Table 1

Item	**Specification**
Kirloskar Diese lEngine	AV1
Model	
Engine power	3.7 kW
Cylinder Bore	80 mm
Stroke Length	110 mm
Engine Speed	1500 rpm
Compression Ratio	16.5 : 1
Swept volume	553 cc
Stroke	Four
Injection Pressure	180 bar
Injection Timing	27^0 b TDC
Number of hole of injector	Three x 0.25 mm
and size	
Dynamometer	Eddy current Dynamometer

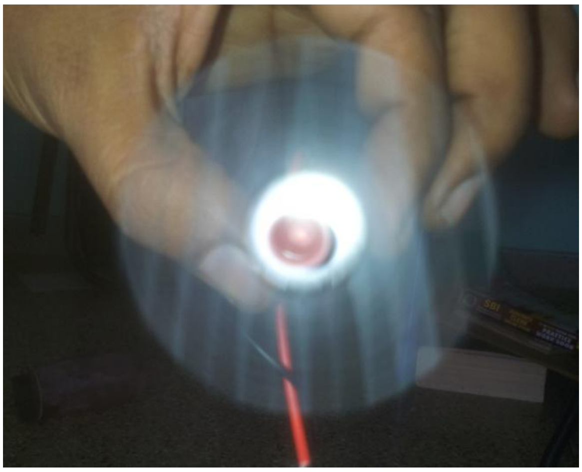


Fig 2

II. a. Experimental Procedure

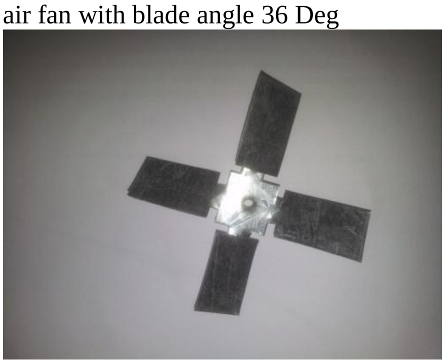
The experiments are conducted on single cylinder four stroke water cooled direct injection diesel engine Kirloskar AV1 engine. The engine was coupled to an eddy current dynamometer to measure the output. Fuel flow rates were timed with calibrated burette. Exhaust gas analysis was performed using exhaust gas analyzer. In the present work the effects of air swirl in combustion chamber are experimentally studied by arranging whirl air fan before the intake manifold. The experiment are performed on D.I .Diesel Engine at constant speed 1500 rpm with injection pressure 180 bar by using pure diesel. In first phase the data recorded with standard engine and in second phase the data recorded with whirl air fan blade angles 24Deg, 28Deg, 32Deg and 36Deg respectively. The power of engine is measured by the Eddy current dynamometer that is coupled to the engine and engine exhaust emission are measured by ARO five gas analyzer at different loads. The performance and emission characteristic are compared with standard engine results.

III. RESULTS AND DISCUSSION

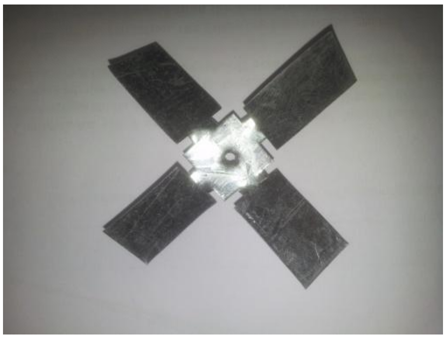
Based on the experimental data the graphs are drawn. These graphs show the variation in brake thermal efficiency, Brake specific fuel consumption (BSFC), Hydrocarbon (HC), Carbon monoxide (CO), Nitrogen oxides (NO_x) emissions at various rotate blade angles.

The various configurations used in the present work are

1. Whirl air fan with blade angle 24 Deg
2. Whirl air fan with blade angle 28 Deg
3. Whirl air fan with blade angle 32 Deg
4. Whirl air fan with blade angle 36 Deg

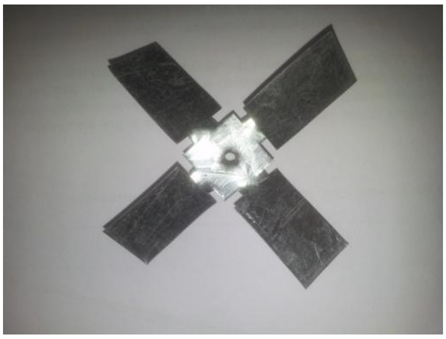


BLADE ANGLE = 24 Deg



BLADE ANGLE = 28 Deg

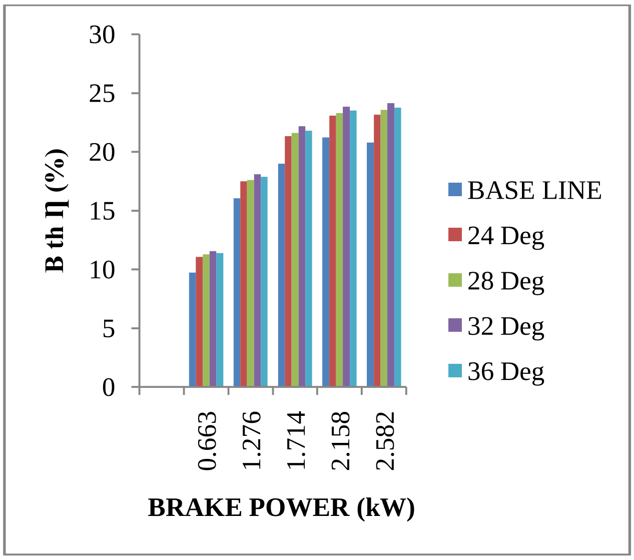
BLADE ANGLE = 32 Deg



BLADE ANGLE = 36 Deg

III. a. Brake Thermal Efficiency

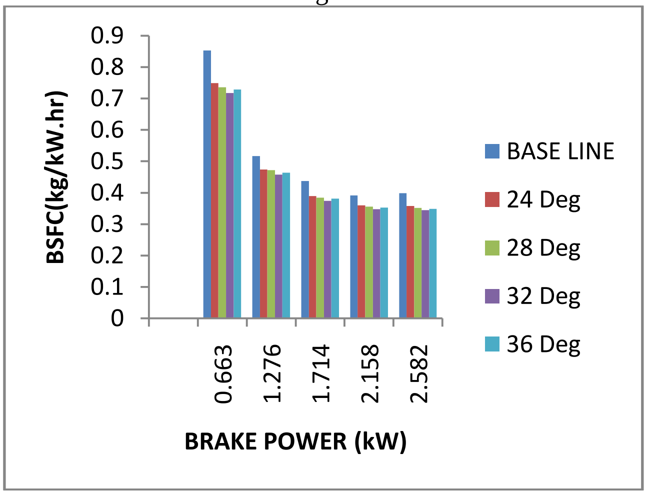
The brake thermal efficiency with brake power for different blade configurations is compared with the normal engine and is shown in graph 1. The brake thermal efficiency for base line at 3/4th rated load is 20.799%. It can be observed that the engine with blade angle of 32 give thermal efficiency of 24144% at 3/4th rated load. It is observed that there is a gain of 3345 % with 32 Deg blade angle compared to normal engine. It was inferred that the brake thermal efficiencies were increasing with an increase in brake power for various configurations which increases the performance of the engine. These configurations were found to offer better thermal efficiencies than the normal engine.



Graph 1

III. b. Brake Specific Fuel Consumption

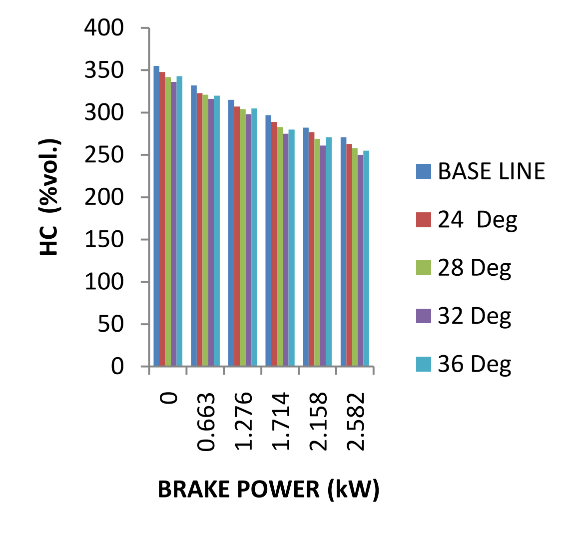
It is an important parameter that reflects how good the engine performance is. It is inversely proportional to the thermal efficiency of the engine. In graph2. The comparison of BSFC for whirl air fan with respect to engine brake power is presented. For 32 Deg blade whirl air fan the BSFC reduced by 0.055 kg/kW.hr at 3/4th rated load than Standard engine. From the graph it can be concluded that for 32 Deg blade whirl air fan the fuel consumption is less than the normal diesel engine.



Graph 2

III. c. Hydrocarbon Emission

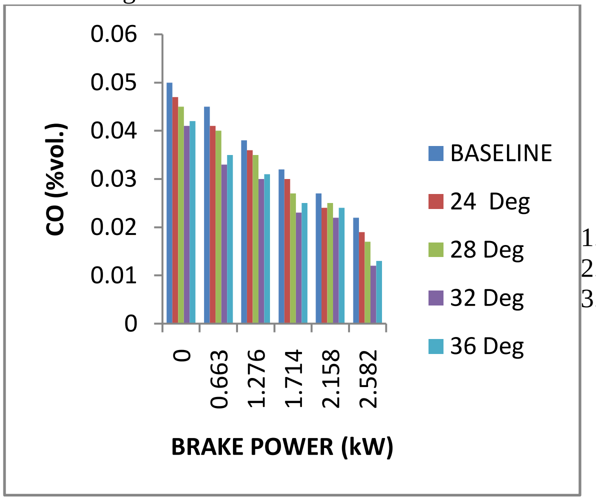
When hydrocarbon emissions get in to the atmosphere, they act as irritants and odorants; some are carcinogenic. All components except CH_4 react with atmospheric gases to form photochemical smog. In graph 3 the comparison of HC with respect to engine brake power at various rotate blade configurations. HC emission reductions at 3/4th rated load significantly lower than standard engine. However it is reduced by 21% vol. for 32 Deg fixed curved blade.



Graph 3

III. d. Carbon Monoxide

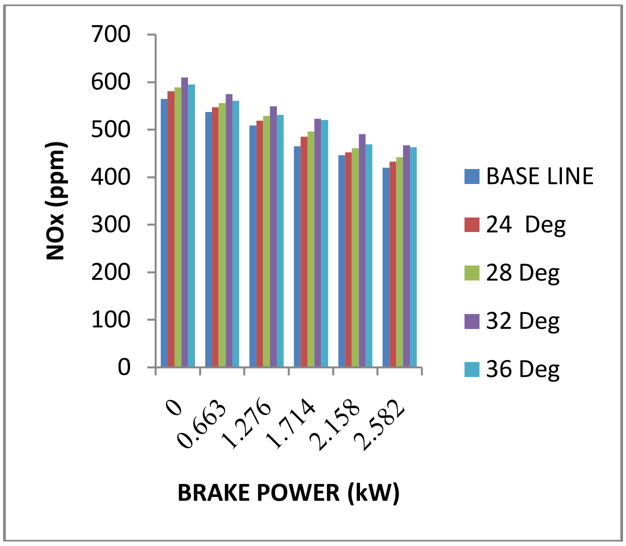
When there is not enough oxygen to convert all carbon to CO_2, some fuel does not get burned and some carbon ends up as CO. Brake power Vs CO are presented in the graph4 for various rotate blade configurations. It can be concluded that CO emissions reduces at 3/4 rated load by 0.02 %vol. For 32 Deg rotate blade angle compared with the standard engine.



Graph 4

III. e. Nitrogen Oxides

NOx emission from engine depends on various factors like compression ratio, temperature, piston bowl shape, and injection pressure etc. Here a NOx emission increases at 3/4 rated load more than standard baseline. However it is increased by 47 ppm for 32 Deg rotate blade angle.



Graph 5

IV. Conclusions

The following conclusions are drawn from the experimental work.

Rotate blade angle 32 Deg is the best for enhancing the performance of the engine when compared to other rotate blade angles.

Brake thermal efficiency increased by 3.345% compared to standard engine.

BSFC is reduced by 0.055 kg/kW.hr

1. CO emissions are less by 0.02 %vol.
2. HC emissions are reduced by 21 %vol.
3. Nitrogen oxide emissions are increased by 47 ppm.

V. Future scope

Fixed curved blade before the intake manifold enhances the air swirl within combustion chamber as well as increasing the air capacity. However, further investigations are required for the following configurations.

1. By varying injection pressure.
2. By varying no. of holes in the nozzle.
3. By varying the injection timing.

REFERENCES

[1] Xueliang H; ShuSong L ,(1990) ; “Combustion in an internal combustion engine”.Mechanical Industry Press, Peking

[2] Shaoxi S; Wanhua S (1990) “Some new advances in engine combustion research”. Trans CSICE 8: 95-104

[3] Wu Zhijun, Huang Zhen In-cylinder swirl formation process in a four-valve diesel engine Experiments in Fluids 31 (2001) 467 – 473 Springer-Verlag 2001

[4] Arturo de Risi, Teresa Donateo, Domenico Laforgia," Optimization of the Combustion

Chamber of Direct Injection Diesel Engines" SAE2003-01-1064.

[5] Herbert Schapertons, Fred Thiele,"Three Dimensional Computations for Flow Fields in D I Piston Bowls". SAE60463.

[6] Corcione. F. E, Annunziata Fusca, and Gerardo Valentino, "Numerical and Experimental Analysis of Diesel Air Fuel Mixing" SAE 931948.

[7] Ogawa. H, Matsui. Y, Kimura. S, Kawashima. J, "Three Dimensional Computations of the Effects of the Swirl Ratio in Direct- Injection Diesel Engines on [NO.sub.X] and Soot emissions" SAE: 961125.

[8] Gunabalan, A.; Ramaprabhu, Nov 2009; "Effect of piston bowl geometry on flow, combustion and emission in DI diesel engine-a CFD approach". , International Journal of Applied Engineering Research.