

# DEVELOPMENT OF SWIRL GENERATION IN INTAKE MANIFOLD TO ENHANCE PERFORMANCE OF THE ENGINE.

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## ABSTRACT

Nowadays Diesel engine plays a dominant role in the field of power, propulsion and energy with increase of its performance in the field of internal combustion engines. Internal combustion engines are the weightier misogynist and reliable source of power for all domestic, large scale industrial and transportation applications. The fluid spritz dynamics plays an important role for air-fuel mixture in Uncontrived Injection Diesel engines, Turbulence is the way air fuel mixture moves inside a combustion chamber. If the turbulence of charge is more, then the air and fuel moves randomly inside the chamber. Swirl plays an important role in the pattern of air motion as it affects both the fuel air mixing and combustion process in the diesel engines; moreover older studies indicate that it has a significant impact on the heat transfer, combustion efficiency and engine emissions. This paper presents performance characteristics on convergent divergent nozzle and piston of a four stroke Diesel engine moreover this paper presents the effects of an air swirl in the cylinder on its performance. Here a Four stroke pinch ignition engine with power 5 H. P and rated speed 1500 revolutions per minute is chosen for performance characteristics. For obtaining variegated swirl intensities the pursuit diamond parameters have been preferred and major pollutants emitted from the exhaust due to incomplete combustion are also discussed in this paper. The intake manifold is modified with throat of size of 32 mm diameter to uncontrived the air spritz and three frustum of cones with 2mm depth of cut on the piston to enhance the turbulence. The results obtained are compared with normal piston values. The Frustum of cones develops in the increase of swirl intensity for largest mixing of fuel and air.

**KEYWORDS:** Engine, Convergent-Divergent Nozzle, Piston, Exhaust Emissions

## 1. LITERATURE REVIEW

In the past, most of the research Work has been focused on the Performance Characteristics of a Four Stroke Compression Ignition engine by arranging Convergent Divergent Nozzle by varying the pitch of the helical threads from 10 mm to 25 mm in steps of 5 mm inside the intake manifold. The measurements were done at a constant speed of 1500 rpm. Among them it is found that 19 mm throat nozzle showed better performance. So there is a lot of scope for research by varying the diameter inside the intake manifold. A convergent-divergent induction nozzle is tested in order to increase the air flow into the engine which in turn may increase the overall performance with and without the nozzle to increase the brake power as well as mechanical efficiency. Through this research work by inserting the nozzle, gives the better performance as compared to without nozzle in the inlet manifold. Through this concept research

work can be carried out by changing nozzle throat diameter. In the present work the intake manifold is modified with a throat of size from 28 mm to 32 mm diameter to uncontrived the air spritz. The other technic adopted in this research work is Knurling on the piston head in the shape of frustum of cones with 2,3,4 slots with 1 mm and 2 mm depth of cut in order to enhance the swirl motion and turbulence. Exploratory research analysis is carried out on emissions also. In this paper, the emissions from Diesel engines and their control systems are reviewed. The four main pollutant emissions from Diesel engines (carbon monoxide-CO, hydrocarbons-HC, Exhaust gas Temperature and nitrogen oxides-NOx) are also discussed and analyzed. This work presents how to improve the Diesel engine performance and their emission characteristics.

## 2. INTRODUCTION

Internal combustion engines are devices that generate work using the products of combustion as the working fluid rather than as a heat transfer medium. To produce work, the combustion is carried out in a manner that produces high-pressure combustion products that can be expanded through a turbine or piston. The engineering of these high pressure systems introduces a number of features that profoundly influence the formation of pollutants. The diesel engine, which is used in large vehicles and industrial systems where the improvements in cycle efficiency make it advantageous over the more compact and lighter-weight spark ignition engine. Diesel engines are a commonly used in heavy machinery, locomotives, ships, and some automobiles.. Most important function of CI engine combustion chamber is to provide proper mixing of fuel and air in short possible time. For this purpose an organized air movement called air swirl is to be produced to produce high relative velocity between the fuel droplets and air.

A piston is a cylindrical engine component that slides back and forth in the cylinder bore by forces produced during the combustion process. The piston acts as a movable end of the combustion chamber. The stationary end of the combustion chamber is the cylinder head. Pistons are commonly made of a cast aluminum alloy for excellent and lightweight thermal conductivity. Most important function of CI engine combustion chamber is to provide proper mixing of fuel and air in short possible time. Air motions are required in both S.I. and C.I. engines. In S.I. engine, we call it turbulence and in C.I. engine, we call it swirl. Turbulence which is required in S.I. engines implies disordered air motion with no general direction of flow, to break up the surface of flame front and to distribute flame throughout an externally prepared combustible mixture. Air swirl which is required in C.I. engines is an orderly movement of whole body of air with a particular direction of flow to bring a continuous supply of fresh air to each burning droplet and sweep away the products of combustion which otherwise would suffocate it.



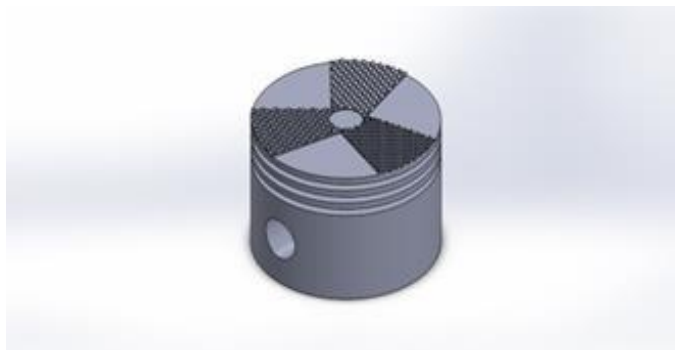
### 3. TECHNICAL SPECIFICATIONS OF THE ENGINE

Table1: Specifications of Engine

1. Name of engine type	Four Stroke Single cylinder Diesel engines
2. Engine capacity	5 kW (kilo Watt)
3. Fuel capacity	10 cc (Cubic Centimeters)
4. Speed	1500 rpm (revolutions per minute)
5. Current (volts)	230 V (Volts) single phase generator
6. Loading unit	Eddy Current Dynamometer
7. Diameter of the bore	0.095m
8: Length of the cylinder	0.110m

### 4. PROCEDURE

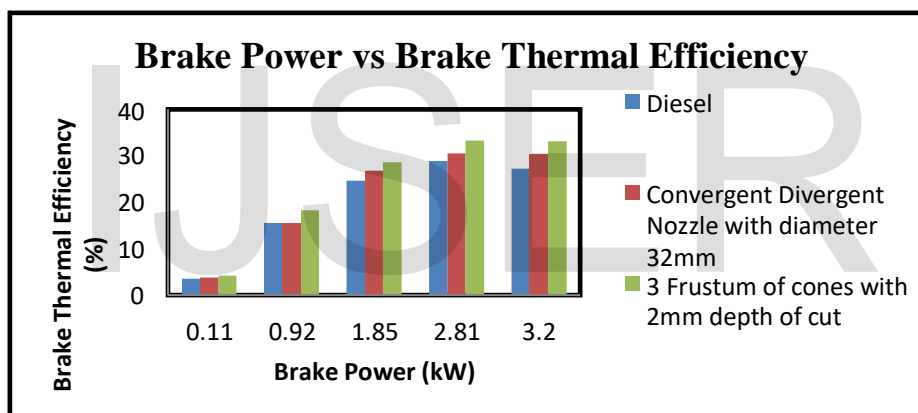
Coming to Experimental Work Procedure the manifold and piston head of the CI Engine was changed by employing a convergent divergent nozzle and knurling on the piston head and there performance characteristics square measure verified by scrutiny with the quality diesel engines performance. The length of the manifold is regarding ninety millimeter, the convergent section is thirty millimeter and also the length of the divergent section is 45mm, core diameter of the manifold is regarding thirty six millimeters. The inner diameter of the nozzle is varied from twenty eight millimeter to thirty four millimeter therein thirty two millimeter offers the higher engine performance characteristics compared to different diameters. The performance of the engine is evaluated with thirty two millimeter throat diameter and new methodology is adopted during this analysis work is Knurling on the piston head within the form of solid of cones with 2,3,4 slots with two millimeter depth of cut so as to boost the swirl motion and turbulence. Exploratory analysis is administered on emissions conjointly during this paper, the emissions from Diesel engines and their management systems square measure reviewed also are mentioned and analyzed. This work presents a way to improve the internal-combustion engine performance and their emission characteristics.



**Fig1: Three Frustum of Cones with Two mm depth of cut**

## 5. RESULTS AND DISCUSSIONS

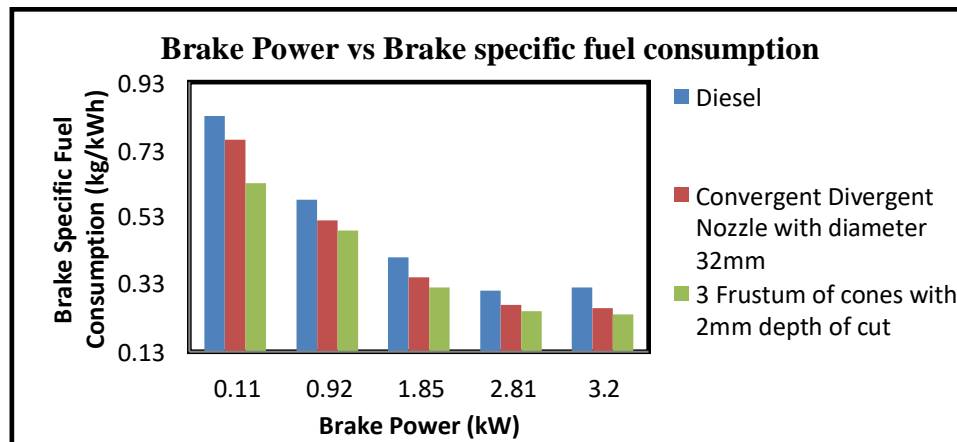
### 5.1 Brake Thermal Efficiency:



**Fig1: Variation of Brake Thermal Efficiency with Brake Power**

From the figure1, Engine brake thermal efficiency increases with Engine load because the ratio of friction to brake power goes down with different configurations are shown in Figure 1. The brake thermal efficiency for the normal engine at 3/4 of rated load is 28.94%. It can be observed that the engine with convergent divergent nozzle increases the quantity of air and intensity of air swirl due to convergent divergent type inlet manifold with diameter 32 mm and 3 Frustum of cones with 2 mm depth of cut on the piston head gives the thermal efficiencies of 4.22%, 18.32%, 28.54%, 33.29%, 33.12% respectively, at 3/4 of rated load. From the Figure, higher compression ratio is 1 needed for increase of theoretical thermal efficiency, shorter combustion period and control of ignition timing for improvement of degree of constant volume, higher excess air ratio and higher fuel-air mixture formation energy for increase of combustion efficiency, lowering of heat transfer coefficient in gas by controlling swirl velocity for reduction of heat loss, and lower friction loss for increasing of mechanical efficiency.

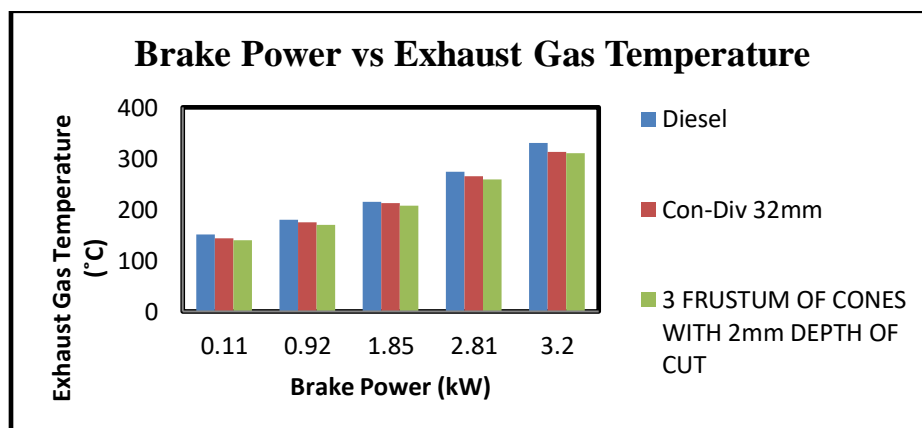
## 5.2 Brake Specific Fuel Consumption



*Fig2 : Variation of Brake Specific Fuel Consumption with Brake power*

From the fig 2 the variations of brake specific fuel consumption with brake power for different configurations are observed. Brake specific fuel consumption decreases with engine load and speed. Part load potency of any engine is less than full load. Fuel consumption to supply unit power decreases due reduction of energy losses. The brake specific fuel consumption for traditional engine at 3/4 of rated load is zero.031kg/kW-hr. It can be observed that diesel engine with convergent divergent nozzle diameter 32 mm and 3 Frustum of cones with 2mm depth of cut gives brake specific fuel consumption of 0.63% , 0.49% ,0.32% , 0.25% ,0.24% respectively, at 3/4 of rated load. As the convergent divergent nozzle type inlet manifold assembled to the engine makes the air to move with high velocity causes to increase the intensity of swirl which leads to better mixing of air and fuel causes, effective combustion in the combustion chamber this leads the consumption decreases with engine load and speed. Fuel consumption to produce unit power decreases due reduction of energy losses As the Brake power increases the Brake specific fuel consumption decreases by decreasing the nozzle diameter 32 mm and 3 Frustum of cones with 2mm depth of cut has the lowest rate of fuel consumption of 0.22 kg/kWh, when compared with normal engine.

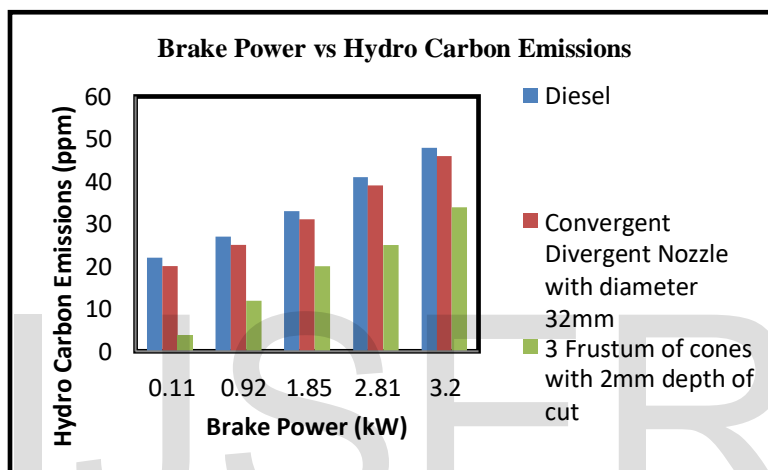
## 5.3 Exhaust Gas Temperature



*Fig 3: Variation of Exhaust gas temperature with Brake power*

Fig 3.shows the variation of the Exhaust gas temperature at totally different engine load conditions for the fuel. The Diesel exhaust gas temperature is already quite low attributable to being a product of combustion ignition, however it still it must be controlled inside an inexpensive varies to avoid thermal stressing of other components. Exhaust gas temperature was found to decrease in both concentration of Diesel and engine load. It can be observed that Diesel engine with convergent divergent nozzle diameter 32 mm and 3 Frustum of cones with 2mm depth of cut gives Exhaust gas temperature of 143.4<sup>0</sup>C, 174.5<sup>0</sup>C, 211.7<sup>0</sup>C , 265.3<sup>0</sup>C, 312.5<sup>0</sup>C respectively, at 3/4 of rated load .The decrease in exhaust gas temperature with engine load is due to the fact that a higher amount of fuel is needed within the engine to get further power required to require up conditional loading. Exhaust gas temperature three frustum of cones with 2mm depth of cut is lowest as compared to the normal Diesel engines.

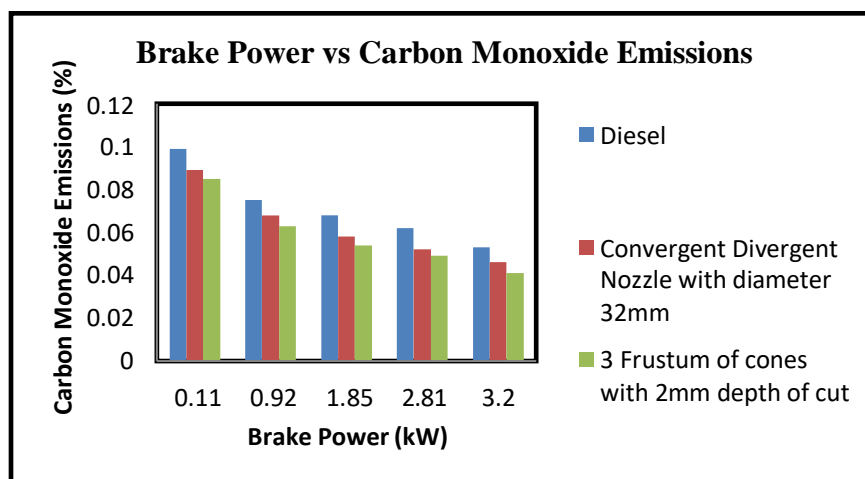
#### 5.4 Hydro Carbon Emissions



*Fig 4: Variation of Hydro Carbon Emissions with Brake Power*

Fig 4.shows the variation of Hydro Carbon at different load conditions for various methods. The Combustion in Diesel engine is very complex due to its heterogeneous nature where fuel evaporation, fuel-air and burned and unburned gas mixing and combustion occur. Hydro carbon emissions are composed of unburned fuels as a result of insufficient temperature which occurs near the cylinder wall. At this point the rate of the burning depends on the rate of fuel-air mixing to within the combustible limits and is referred to as mixing-controlled combustion phase. It can be observed that the engine with convergent divergent nozzle with 32mm diameter and 3 frustum of cones with Two mm depth of cut decreases with 25ppm compared with normal diesel engine it is 41 ppm at ¾ load. Diesel engines normally emit low levels of hydrocarbons. Diesel hydrocarbon emissions occur principally at light loads. The major source of hydrocarbon which appears as un burnt fuel. This can be due to lesser amount of O<sub>2</sub>, incomplete mixing of fuel or lesser lapse time for the fuel to burn

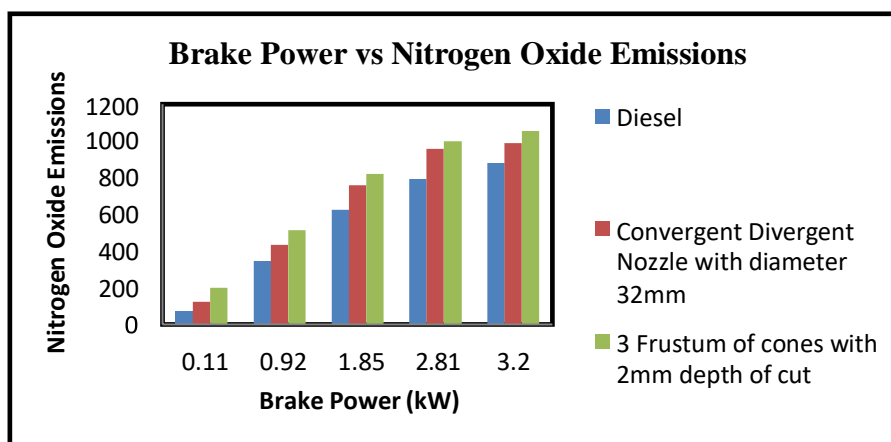
## 5.5 Carbon Monoxide Emissions



**Fig5: Variation of Carbon Monoxide Emissions with Brake power**

Fig 5. Shows the Comparison of CO emissions with Brake power. From the above graph CO emissions decrease from Diesel to 3 Frustum of cones. Carbon monoxide results from the incomplete combustion where the oxidation process does not occur completely. This concentration is largely dependent on air/fuel mixture and it is highest where the excess-air factor is less than 1.0 that is classified as rich mixture. It can be caused especially at the time of starting and instantaneous acceleration of engine where the rich mixtures are required. From the fig 5 the engine rated at  $\frac{3}{4}$  load as the brake power increases, bit by bit decreasing the CO emissions with convergent divergent nozzle to 3 Frustum of cones with 2mm depth of cut. CO emissions decrease from 0.062% to 0.049%. The formation of CO is minimal in diesel engines to enhance the swirl or turbulence in the combustion chamber.

## 5.6 Nitrogen Oxide Emissions



**Fig 6: Variation of Nitrogen Oxide emissions with Brake power**

From the fig6. The comparison of NOx emission with brake power for various configurations are shown. The Nitrogen emissions increase from Diesel to Frustum of cones. Nitrogen emissions are relatively high.

from Diesel engines due to high local combustion temperatures time. The amount of produce NO<sub>x</sub> is a function of the maximum temperature in the cylinder, Oxygen concentrations and residence time. Most of the emitted NO<sub>x</sub> is formed early in the combustion process. When the piston is near the top of its stroke. This is when the flame temperature is the highest. Increasing the temperature of combustion increases the amount of NO<sub>x</sub> increases. From the above graph Nitrogen emissions increases from 792ppm to 996.54ppm at  $\frac{3}{4}$  rated load. From this we say that increasing the temperature in the combustions chamber gives to enhance the swirl motion in the engine.

## 6. Conclusions

The performance and emission characteristics of a single cylinder four stroke diesel engine with, the intake manifold is modified with throat of size of 32 mm diameter to direct the air flow and frustum of cones with 1 mm depth of cut on the piston to enhance the turbulence. The results obtained are compared with normal piston values.

- 1) Brake Thermal Efficiency increased by 15.03%.
- 2) Brake Specific Fuel Consumption decreased by 19.35%.
- 3) Exhaust Gas Temperature Increased by 12.1%.
- 4) Hydro Carbon Emissions decreased by 39%.
- 5) Carbon Monoxide Emissions decreased by 20.1%.
- 6) Nitrogen oxide Emissions Increased by 25.8%.

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