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Combined Effect Of Inlet Manifold Swirl And Piston Head Configuration In A Constant Speed Four Stoke Diesel Engine

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Abstract: The internal combustion engine manifold has a subsystem that supplies the fresh A/F mixture to the engine cylinders where the fuel is combusted. For efficient combustion of charge, the walls of the intake manifold must be smooth / polished to minimize any side resistance. To redesign the inlet port of a small internal combustion engine, to increase the production of turbulence by a swirl. A good swirl promotes more rapid combustion and improves efficiency. The CI engine has a piston shaped flat on the crown and a concave combustion chamber, with this geometry we are driving the engine. But here the A/F ratio mixture cannot mix properly. To avoid this we make piston geometry changes. The main objective of this project is that three new technologies have been adopted here. The first stage is varying the diameter of the convergence - the divergent nozzle. The second stage is the change on the piston head and the last stage is replacing the inlet and exhaust valve with pitch 0.5. Mm to 2 mm and the cut thread depth is 4 mm and three threads per inch. All of these techniques aim to investigate performance techniques to increase air flow to achieve improved engine performance and emissions in direct injection (DI) single cylinder diesel engines. Compared with traditional engine.

Keywords : Diesel Engine, Inlet Valve, Grooves on piston Top, swirl Motion, Exhaust valve

I. INTRODUCTION

Intake and exhaust valves are very important engine components used to control the flow and exchange of gases in IC engines. They are used to seal the working space inside the cylinder inside the manifold cylinder in a valve train mechanism. Such valves are encumbered by spring forces and are subject to thermal loading due to the high temperature and pressure inside the cylinder. The opening and closing of the inlet and outlet valves according to the firing sequence of the cylinder is conducted through a valve mechanism. In each cycle of operation, the intake and exhaust processes take place in a very short period of time. Valve mechanism components operate at high and changing speeds[6]. Some components have to withstand high temperatures; Therefore the components of the valve mechanism have very high inertia and thermal stresses. The modification in the exhaust valve by anecdotal its position size and shape along with particular thermal and structural considerations which helps in increasing the rate of heat transfer from the seat portion of the exhaust valve thereby reducing the possibility of knocking. In addition, the increased size of the exhaust valve pushes large amount of exhaust gas outside through the manifold which reduces the dilution inside the engine's combustion chamber

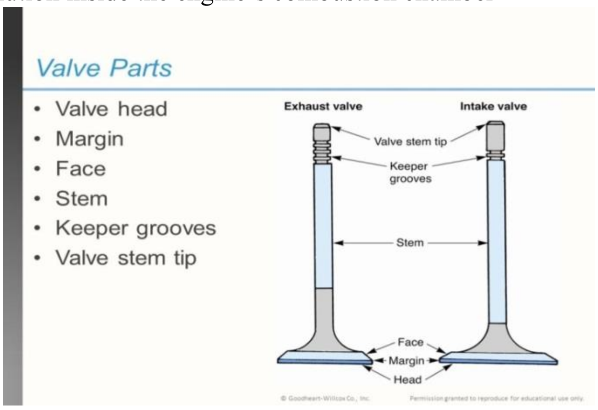

Figure 1: Valve Parts of the Inlet and Exhaust

The reduced dilution reduces the amount of un burnt mixture/charge inside the chamber which reduces the hydrocarbon emissions coming out of the engine. The reduced emissions help in development of the emission standards. Reduction in un burnt fuel inside the chamber results in increased power with less consumption of fuel thereby increasing its fuel efficiency. Large amount of gas escapes due to larger size of the exhaust valve and hence the heat energy coming out will be more which can be completely utilized for turbochargers thereby increasing its turbine efficiency. These advantages can be achieved by using large exhaust valve by doing few modifications discussed before for good and smooth running of the engine.

II. LITERATURE REVIEW

Many Experiments were conducted on the basis of Convergent –Divergent Nozzle changing the Throat diameter[3]. The nozzles were fabricated to be self-supportive, with the weight of the air box hose requiring support to hold rigid for consistency in testing. The outside diameter of the intake of the engine was 66 mm and the nozzle was made to suit that. The critical diameter (i.e throat diameter) of the nozzle was 25 mm. The material chosen for the nozzle was an epoxy resin and woven fibres of glass matting for strength and vibration. During experimenting, the nozzle showed no signs of fatigue or failure indicating that the fibre glass was a suitable material for nozzle construction. It is to be noted that the plastic material wasn't appropriate to face up to constant vibration and temperature variations.

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The engine was connected to the mechanical measuring system to record the brake power of the engines. From this experiment the overall performance of an IC engine shows increase in the brake power, air flow and mechanical efficiency which indicate that the induction system increases the overall performance of the engine. Rearranging of the intake manifold of the CI Engine was modified by using nozzle with different throat[1]. A Convergent Divergent Nozzle of throat 15mm, 17mm, 19mm and 21mm in the manifold were used to evaluate the performance characteristics and among them it is found that 19mm throat nozzle showed better performance by increasing the Brake Power, Indicated Power, Brake thermal efficiency, indicated thermal efficiency and decreased by Total fuel consumption, Specific Fuel consumption and Heat Input. In the past, most of the research Work has been focused on the

Experiments were then carried out to determine the performance characteristics of the standard and best cone-base angle piston crown equipped Yoshita 165 F using a TQ TD115 MKH absorption dynamometer. Data were statistically analyzed using ANOVA at α0.05[2]. The fringe cone-shaped piston crown with a cone-base angle of a 40 ° equipped engine gave an overall superior performance and was designed with the idea of a circular and square shaped piston head in use. This paper explains why square pistons cannot be used once compared to two[4]. The piston is designed using the Autodesk Inventor and neglects friction losses using the ANSYS Static Structural Analysis. From the analysis it can be seen that a square piston is preferable for some examples. This is seen in the case of total deformation, equivalent stress and maximum principle stress. However it may be better to use a square shaped piston head instead of a circular shape. Another paper on emission reduction by increasing the air swirl in a diesel engine with trapezoidal grooves on the piston crown. Turbulence in the engine cylinder is made by cutting the trapezoidal grooves[5] on the piston crown (TGP), the different configurations of the piston, that is, in the order of 2 grooves, used to sharpen the sliver for better mixing of air and fuel. is. From the investigation, it is clear that out of the normal piston configuration tested in a single cylinder direct injection (DI) four stroke diesel engine, the piston with the piston i.e. TGP2 gives better performance

III. EXPERIMENTAL SETUP

Technical Specifications of the Engine

Table1: Specifications of Engine

Name of engine type	Four Stroke Single cylinder Diesel engines
Engine capacity	5 kW (kilo Watt)
Fuel capacity	10 cc (Cubic Centimeters)
Speed	1500 rpm (revolutions per minute)
Current (volts)	230 V (Volts) single phase generator
Loading unit	Eddy Current Dynamometer
Diameter of the bore	0.095m
Length of the cylinder and bore	0.110m &0.080m

Procedure

The technique of this Investigational Work has three stages adopted. First stage is changing the diameter Convergent- Divergent Nozzle with 32mm.Second stage is knurling on the piston head with in the form of solid of cones with 3 slots with 2mm depth of cut.

Figure 2: Inlet valve With Pitch diameter 1.5mm

The final stage is changing the valve stem diameter 9.5mm,Inlet Valve diameter 36mm ,Exhaust Valve diameter 28mm,pitch is 0.5 to 2mm insteps of 0.5mm Helical grooves on the surface of the inlet valve rod. Thread per inch is 3 ,Thread depth of cut is 4mm.Increase the size of an inlet valve than Exhaust Valve, Because the inlet air (or) F/A mixture has a lower pressure than the exhaust gas. The exhaust gas in the engine cylinder after the power stroke has more pressure and the temperature and gases are ready to release into the combustion chamber. Engine power is measured using an eddy current dynamometer coupled with engine and engine exhaust emissions, measured at different loads by the gas analyzer[7]. This research work presents a way to increase the speed and turbulence in the inlet valves and the internal combustion engine performance and their emission characteristics.

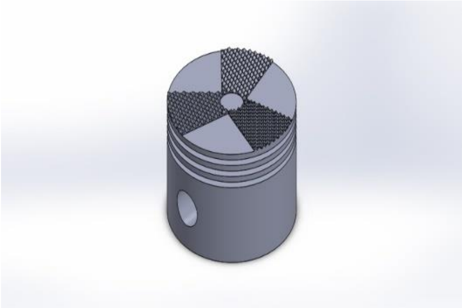

Figure 3: Three frustum of cones with 2mm depth of cut

IV. RESULTS

The variations of Brake Thermal Efficiency with Brake Power as shown in fig 4. The brake thermal efficiency for Convergent-Divergent Nozzle for 32mm diameter is 30.5%,Three Frustum of cones with 2mm depth of cut is 32.65% and Three thread per inch with 1.5mm depth of cut is 33.12% these three techniques adopted at ¾ the load, whereas for normal piston bake thermal efficiency is 28.94%.Using above techniques the overall performance is increased by 14.4% when compare with conventional engine with diesel as fuel.

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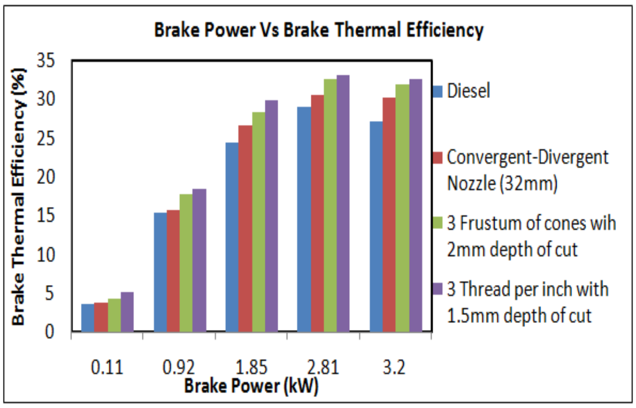

Figure 4: variation of Brake Power Vs Brake Thermal Efficiency

By using all these techniques inside the cylinder there is a proper air-fuel mixture occurs and increases the turbulence to enhance the air swirl motion.

Brake Specific Fuel Consumption:

The variations of brake specific consumption with Brake power as shown in fig 5. The brake specific consumption for Convergent-Divergent Nozzle for 32mm diameter is 0.269 kg/kW-hr, Three Frustum of cones with 2mm depth of cut is 0.25 kg/kW-hr and Three thread per inch with 1.5mm depth of cut is 0.23 kg/kW-hr these three techniques adopted at ¾ the load, whereas for normal piston bake specific fuel consumption is 0.31 kg/kW-hr.

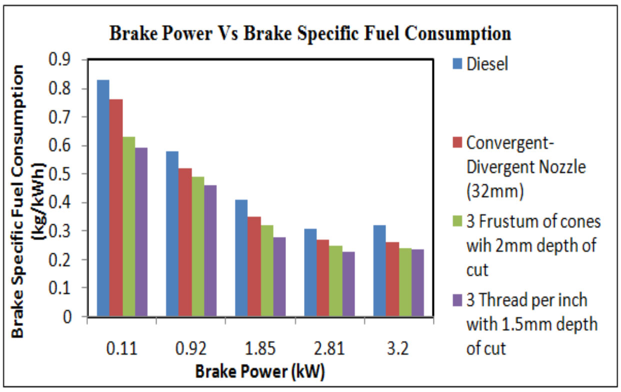

Figure 5: Variation of Brake Power Vs BSFC

Using above techniques the brake specific fuel consumption is decreased by 25.8% when compare with conventional engine with diesel as fuel. The air fuel mixture enters into the cylinder through the inlet port where the swirl motion occurs with increasing the turbulence here brake specific fuel consumption decreases when the swirl motion occurs freely then the complete combustion done in the combustion chamber. When the complete combustion occurs the fuel consumption is less.

Exhaust Gas Temperature:

The variations of Exhaust Gas Temperature with Brake power as shown in fig 6.The Exhaust Gas Temperature for Convergent-Divergent Nozzle for 32mm diameter is 265.30C, Three Frustum of cones with 2mm depth of cut is 358.90C and the depth of cut of 1.5 mm for a Three thread per inch is 247.90Cthese three techniques adopted at ¾ the load, whereas for normal piston the Exhaust Gas Temperature is 273.30C.

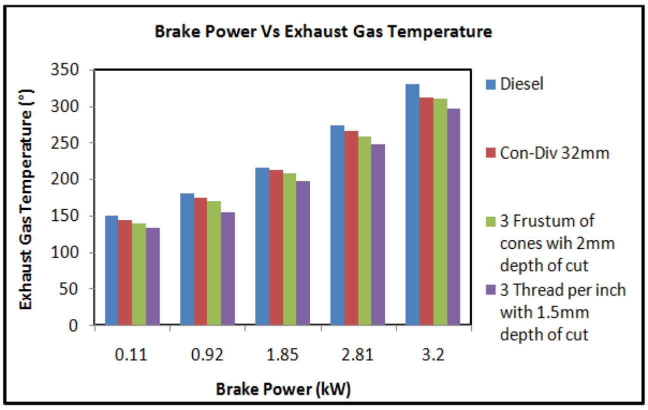

Figure 6: Variation of Brake Power Vs Exhaust Gas Temperature

Using above techniques the exhaust gas temperatures decreased by 9.29% when compare with normal diesel engine with diesel as fuel.

Hydro Carbon Emissions:

The comparisons of hydro carbon emissions with load are shown in fig 7. The HC emissions for Convergent-Divergent Nozzle for 32mm diameter is 39ppm, Three Frustum of cones with 2mm depth of cut is 34ppm and Three thread per inch with 1.5mm depth of cut is 31ppm these three techniques adopted at ¾ the load, whereas for normal piston the Exhaust Gas Temperature is 41ppm. Using above techniques HC emissions decreased by 24% when compare with conventional engine with diesel as fuel

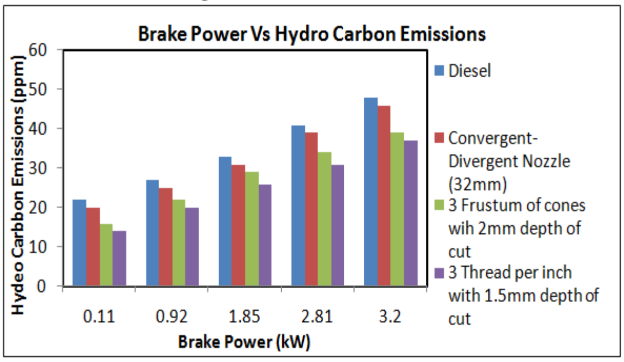

Figure 7: Variation of Brake Power Vs Hydro Carbon Emissions

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 and the late combustion phase where heat release continues at a low rate controlled by the mixing of residual combustible gases with excess oxygen and the kinetics of the oxidation process.

Carbon Monoxide Emissions:

The Variations of Carbon Monoxide Emissions with Brake Power is shown in fig 8. The Carbon Monoxide Emissions for 32mm diameter is 0.052%, Three Frustum of cones with 2mm depth of cut is 0.049% and Three thread per inch with 1.5mm depth of cut is 0.042% these three techniques adopted at ¾ the load, whereas for normal piston the Carbon Monoxide Emissions are 0.062%. Using above

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techniques Co emissions decreased by 32.2% when compare with conventional engine with diesel as fuel.

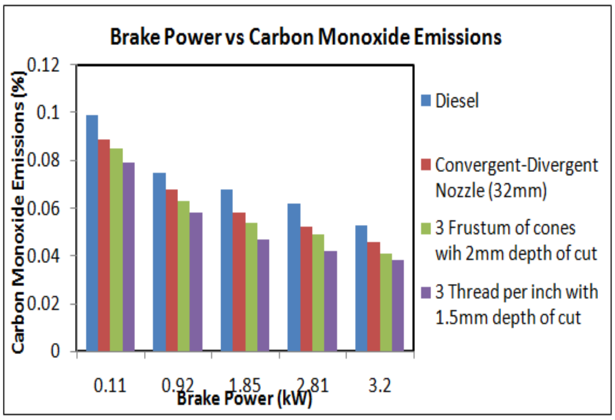

Figure 8: Variation of Brake Power Vs Carbon Monoxide Emissions

Nitrogen Oxide Emissions:

The variation of the brake power with Nitrogen oxide emissions are shown in the fig 9.The Nitrogen Oxide Emissions for 32mm diameter is 956ppm, Three Frustum of cones with 2mm depth of cut is 996.54ppm and Three thread per inch with 1.5mm depth of cut is 1000ppm these three techniques adopted at ¾ the load, whereas for normal piston the Carbon Monoxide Emissions are 792ppm. Using above techniques NOx emissions are increased by 26.2% when compare with conventional engine with diesel as fuel.

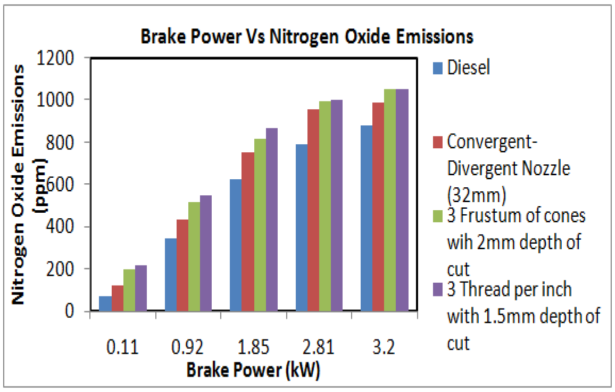

Figure 9: Variation of Brake Power Vs Nitrogen Oxide emissions

V. CONCLUSION

1) Brake Thermal Efficiency increased by 14.4%
2) Brake Specific Fuel Consumption decreased by 25.8%.
3) Exhaust Gas Temperature reduced by 9.29%
4) Hydro Carbon Emissions decreased by 24%
5) Carbon Monoxide Emissions decreased by 32.2%
6) Nitrogen oxide Emissions Increased by 26.2%

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