Performance Test On Single Cylinder Four Stroke Diesel Engine By Using Convergent-Divergent Nozzle At The Inlet Manifold

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Abstract: The reduction of IC Engine fuel consumption by improved combustion using the modified new designs to increase its performance and optimize the existing designs is implemented. Air flow in CI Engine has effects in the atomization and dispersion of fuel flown into the manifold. The improved atomization of fuel injected allows for progressive and complete burning which helps in reducing the Knock. A four stroke CI Engine with 8 Horse Power is chosen for the current work to explore the performance characteristics. The swirl flow movement of the air is a major parameter in the optimization of the engine performance. In order to improve the air flow in the inlet manifold use of Convergent- Divergent Nozzle to Increase the velocity and turbulence at the end of the manifold. Finally nozzle provides better combustion of the injected fuel. The performance parameters were observed and compared with normal nozzle. It is noticed that at all loads mechanical efficiency gradually increases BSFC reduces. At higher load break power and indicated power also improves. Hence it is concluded that by using Convergent Divergent nozzle gives better results compared with normal manifold

IndexTerms—FOUR STROKE DIESEL ENGINE,NOZZLE

I. Introduction

An important task in the development of internal combustion engines is the reduction of emissions. As the individual mobility in the world is increasing and the transportation sector is growing, it is important to limit the impact of traffic on both the environment and the health of the population. The main combustion products nitrogen oxides (NOx), particulate matter (PM), hydrocarbons (HC), carbon monoxide (CO) and water vapourare contained in engine exhaust gases. All of theseare considered environmentally harmful except the water vapour. This is also reflected in the fact that governments all over the world enact limits for the emission of these gases. Therefore, engine developers work on diminishing these emissions.

Thermal or Heat energy is the oldest energy forms familiar to the world. This type of energy is generally exhausted from energies like Chemical and Electrical energy. Engine is the device used for conversion of one form of energy to the other form. In this process of conversion, efficiencyhas a dominant place and also decides the effective use of energy supplied. Heat engine, a deviceused to transform Chemical energy of a fuel to thermal or heat energy. The energy so converted
is utilized for useful work.

LITERATURE REVIEW

In any injector, the geometry of the nozzle has an impact role in regulating atomization of diesel spray as well as combustion. Nozzle properties like diameter of hole, Dia-to-length ratio, nozzle inlet roundness have their effects on atomization of fuel as well as on combustion. These effects were put forward by Bergwerk. Aspects regarding internal flow like distribution of velocity inside the nozzle, cavity effect, turbulent factor determines the variation level in the jet near nozzle exit. Primary variations will affect the penetration, liquid divergence factor, and ignitions well as combustion. Large diametric nozzles are less efficient in fuel spray atomization when compared to small diametric nozzles. Moreover small diametric nozzles need to decrease combustion efficiency and duration of injection of small diametric nozzles by enhancing injection velocity. Size of the nozzle also has effect on performance and emissions of fuel. So nozzles of various diameters were checked in a process in which volume reduces with reduction in nozzle diameter. Pickett and Siebers observed and finalized the effect formation in diesel engine environments. Numerical modeling also used to derive the variation level in the jet near the nozzle exit relating to lift-off length. Large diametric nozzles are less efficient when compared to higher injection time in atomizing the fuel.
To acquire low temperature combustion, use of high exhaust gas recirculation is recommended. Deviation in the cross-sectional area of nozzle is also the vital aspect. This aspect is understood by Conicity of nozzle also known as K-factor. Different investigations helped those deviations in geometry of nozzle produces various characteristics of fuel spray. Nurick experimented that effect on nozzle flow because of nozzle geometry at the inlet and derived that
cavitation can be minimized if inlet nozzle is made round-edged with radius to nozzle diameter more than 0.15. Benjes analyzed the effect of various geometries of orifices on the rate of injection and derived that coefficient of discharge was larger in conical shaped nozzle than in cylindrical shaped nozzle. Flow in the cylindrical shaped nozzle broke down at large injection pressures because of cavitation which was absent in the conical shaped nozzle. Literature on the study of conicity in aspects regarding cavitation, injection speed is less. Descants et al.measured different nozzles with various Conicity for caviatation with various injection and ambient
pressures and calculated the rate of fuel flow and momentum flux at the exit nozzle. Injection pressure ranged between 3-170 MPa and if K-factor increases, cavitation adoption reduces. At large injection pressures

mass flow rate gets decreased. Momentum flux was not altered as cavitation didn't affect it. So to compensate mass flow rate velocity at the exit is decreased.

Fig. 1 fuel injector and display spray in a diesel engine.

Table 1. Engine specifications	
Make	Kirloskar
Bhp	14 hp
Speed	1500 rpm
Compression ratio	17.5:1
Bore	87.5 mm
Stroke	110 mm
Orifice diameter	20 mm
Type of ignition	Compression ignition
Method of starting	Crank shaft
Method of cooling	Water cooled
Method of Loading	Hydraulic Dynamometer

A CI engine also called as Diesel engine is a typical heat engine in the class of IC engines. In this of engine, to initiate the process of ignition, heat released during compression is used. This engine has the maximum thermal efficiency because of very large compression ratio. Direct type CI engines are the engines in which injection of fuel is done in direct manner and the mixing depends on the air movement in the Combustion chamber. Air enters the cylinder via inlet manifold with large velocity, this kinetic energy of fluid is responsible for turbulence thereby causing quick mixing air and fuel. Increase in turbulence causes high cooling of the surfaces of cylinder to decrease the loss of heat to surroundings. Heat from the walls of cylinder gets absorbed by the supplied air at the time of suction and utilized for decreasing the delay period in order to enhance the engine thermal efficiency. Diesel or CI engines of low speed type have thermal efficiencies exceeding 50%. These engines are made in 2-stroke as well as 4-stroke types.

Low-speed diesel engines (as used in ships and other applications where overall engine weight is relatively unimportant) can have a thermal efficiency that exceeds 50%. Diesel engines are manufactured in two-stroke and four-stroke versions. They were originally used as a more efficient replacement for stationary steam engines. Since the 1910s they have been used in submarines and ships. Use in locomotives, trucks, heavy equipment and electric generating plants followed later. In the 1930s, they slowly began to be used in a few automobiles. Since the 1970s, the use of diesel engines in larger on road and off-road vehicles in the USA increased. Asof 2007, about 50% of all new car sales in Europe are diesel.

MATERIALS AND METHODS

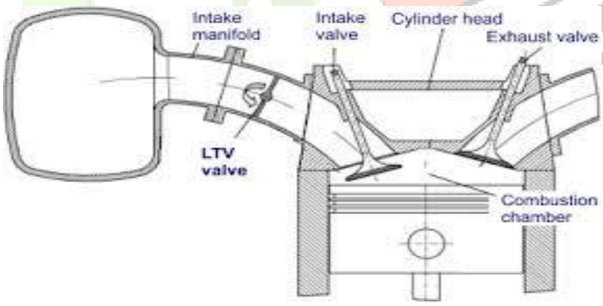
The experimental set up containing an engine, an alternator, top load system, fuel tank with immersion heater, exhaust gas, and manometer

ENGINE SPECIFICATION:

specifications of the engine

Introduction

The details of the experimental set up are provided in this lesson. The alternations made to the instrumentation are also explained. The experimental setup is fabricated to fulfill the objective of the current work. Different components of the experimental set up including modification are presented in this chapter



Diesel engine with manifold

EXPERIMENTAL SETUP AND PROCEDURE

A.Experimental Setup

The experimental set up containing an engine, an alternator, top load system, fuel tank with immersion heater, exhaust gas, and manometer

B.**Testing Procedure**

Before starting the CI engine separate the fuel injector from the fuel system which is attached on the fuel injector Fuel injection pressure tested and operates the tester pump Notice the pressure reading from the dial at which the injector starts spraying In order to accomplish the required pressure by balancing the screw, at the top of the injector As first said, diesel alone is allowed to run the engine for about 30 min, so that it gets The various steps involved in the setting of the experiments are explained below

1. The Experiments were carried out after installation of the engine 2. The injection pressure is set at 200 bar for the entire test. 3. Precautions were taken, before starting the experiment.

4. Always the engine was started with no load condition 5. The engine was started at no load condition and allowed to work for at least 10 minutes to stabilize. 6. The readings such as fuel consumption, spring balance reading, cooling water flow rate, manometer reading etc., were

taken as per the observation table. 7. The load on the engine was increased by 20% of FULL Load using the engine controls and the readings were taken as shown in the tables. 8. Step 3 was repeated for different loads from no load to full load. 9. After completion of test, the load on the engine was completely relieved and then the engine was stopped. 10. The results were calculated as follows.

The above experiment is repeated for various loads on the engine. The experimental procedure is similar as foresaid. While starting the engine, the fuel tank is filled in required fuel proportions up to its capacity. The engine is allowed to run for 20 min, for steady state conditions, before load is performed. Finally, the engine is run by blend (200atm) at various injection pressures the corresponding observations are noted

Photography view of experimental setup

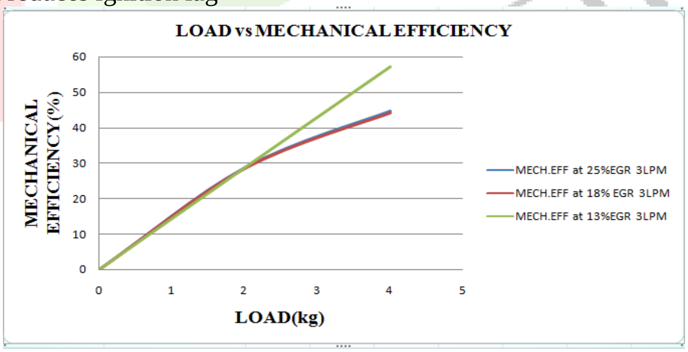
RESULTS AND DISCUSSIONS

Brake specific fuel consumption:

The result for the variations in the brake specific fuel consumption (BSFC) is presented in the below fig. 1.3 The results of the changes in the brake specific fuel consumption (BSFC) is shown in the below fig. BSFC decreases with the increasing load for all the fuels. The differences of BSFC are very small when using different speeds. The maximum BSFC values are 0.91 kg/kW hr for diesel, 0.48kg/kW hr for N1500, 0.67 kg/kW hr for N1400, 0.72 kg/kW hr for N1600, 0.9 kg/kWhr and for CD1500, 0.8 kg/kW hr. for CD1400, and 0.92kg/kW hr for CD 1600. Compare with normal nozzle, convergent divergent nozzle performance is good.

Mechanical Efficiency:

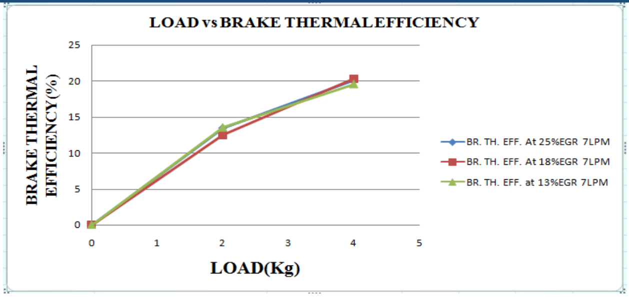
Mechanical efficiency indicates how good an engine is inverting the indicated power to useful power Fig1.4 shows the mechanical efficiency of normal manifold is less than CD manifold for the pure diesel at full load. Because higher fuel injection pressures increases the decrease of atomization. The fitness of atomization reduces ignition lag



Brake Thermal Efficiency:

The above figure shows the differentiation of brake thermal efficiency when various loads applied. Brake thermal efficiency gives an idea about the output generated by the engine with respect to heat supplied in the form of fuel. For all the fuels the brake thermal efficiency increases with load. The brake thermal efficiency values at full load are 11.2% for N1400, 12.54% for N1500 and 11.2% for N1600,12.1% for CD1400 ,12.9% for 1500 and 12.6% for CD1600. Comparison to normal manifold values slightly increases in convergent divergent manifold.

The above figure shows the varation of brake thermal thermal efficiency when different loads applied.



CONCLUSION

The performance characteristics of an IC engine without convergent divergent nozzle and with convergent divergent nozzle in the intake manifold were compared. A convergent divergent nozzle of various speeds N1400, N1500, N1500, CD1400, and CD1500 CD1600rpm

1. The result for the variations in the brake specific fuel consumption (BSFC) is dispensed. For all the fuels the BSFC decreases with increasing load. The variations of BSFC are very small when using various speeds. The highest BSFC values are 0.91kg/kw hr and for CD1500, 0.8 kg/kW hr. for CD1400 and 0.92kg/kW hr for CD 1600. Compare with normal nozzle values slightly give better results with convergent divergent nozzle.
2. Brake thermal efficiency gives an idea about output produced by the IC engine with respect to heat supplied in the form of fuel. Brake thermal efficiency increases with load at all the fuels. The brake thermal efficiency values at maximum loads are 11.2% for N1400, 12.54% for N1500 and 11.2% for N1600, 12.1% for CD 1400, 12.9% for 1500 and 12.6% for CD1600. Compare with normal manifold values, convergent divergent nozzle values are improves.
3. The variation of volumetric efficiency with load at various speeds volumetric efficiency is measures the success with air supply, and thus the charge is inducted in to the engine. It indicates the breathing capacity of the IC engine.
4.The definition of the Mean effective Pressure is the mean Pressure inside the cylinders of an engine. From the figure it can be shown that the Brake mean effective pressure of Convergent Divergent manifold is slightly less than normal manifold
5.The definition of Mean effective Pressure is the average Pressure inside the cylinders of a compressed ignition engine. It can be shown that, indicated mean effective pressures of Convergent Divergent manifold are slightly less than normal manifold
6.The variation of exhaust gas temperature with load at various test fuels. It is observed that the exhaust gas temperature increases with increasing the load because more fuel is burnt at higher loads to meet the power requirement. It is also observed that the exhaust temperature increases at all loads.This may be due to the oxygen content it improvescombustion and thus may increase the exhaust gas temperature.
7. Mechanical efficiency indicates how good an engine is inverting the indicated power to useful power. The mechanical efficiency of normal manifold is less than Convergent Divergent manifold of the pure diesel at full load. Because higher fuel injection pressures increases the decrease of atomization. The fitness of atomization reduces ignition lag.
8. Brake power is improved by 2.38%.

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