International Journal of Mechanical and Industrial Engineering

Volume 3 | Issue 3 Article 8

January 2014

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Recommended Citation

DIINESH, N.S.; PADMANABHAN, K.S.ANANTHA; and Mathew, S. Anish (2014) "SPECIES TRANSPORT IN DIFFUSER INDUCED CYLINDER," *International Journal of Mechanical and Industrial Engineering*: Vol. 3 : Iss. 3 , Article 8.
DOI: 10.47893/IJMIE.2014.1152
Available at: https://www.interscience.in/ijmie/vol3/iss3/8

SPECIES TRANSPORT IN DIFFUSER INDUCED CYLINDER

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Abstract- Engines are the devices which can produce a huge amount of energy and can move heavy things such as automobiles and ships. Usually the power which is being produced by a engine varies directly with the amount of fuel combusted in the combustion chamber. Over the years much new technological advancement were made to increase the power output from the engine. This includes the incorporation of systems such as turbochargers, superchargers, ECU's etc. These devices consume some power to increase the output from the engine. The modification proposed will increase the torque and the power output from the engine without consuming any power. This is achieved by incorporating a diffuser shape in the cylinder block which increases the pressure acting on the piston head thus increasing the engine rating without the help of external devices. In this paper the modified cylinder block has been created using CATIA and then its flow properties are analysed using CFD and the results are compared with a engine having a normal cylinder block .It is seen that the ratings of the modified cylinder are higher than the ratings of the unmodified cylinder.

Keywords-*Engine, cylinder, Piston, diffuser, power output.*

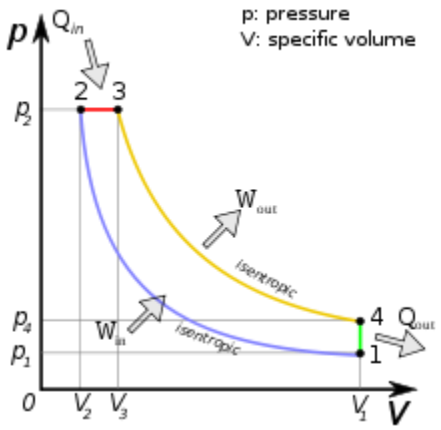
I. INTRODUCTION

Engines have always propelled man and equipment from one place to another. Over the years people have tried successfully to increase the power ratings and the efficiency of the engines they use. This has lead to smarter less fuel guzzling economical and high powered engines a few examples of advancements being CRDI, the use of turbochargers, the use of superchargers. Even though these methods increase the power ratings and efficiency of the engines it is to be noted that these devices consume some power in order to operate. For example in common rail direct injection technique (CRDI) the fuel passageway is to be kept at very high pressures .This increases the power required by the particular device. Compressors which compress the air before its entry into the cylinder also require some power to operate. This requires extra power which is too be supplied in order to run the extra additional devices which are used to increase the engine performance. The modification proposed will increase the power output from the engine without the use of any external power sources. This is done by changing the shape of the clearance area of the cylinder from a cylindrical volume to a diffuser shape .

II. PRINCIPLE

The principle behind the working of a diesel engine is the diesel cycle. In the diesel cycle combustion occurs at constant pressure and the exhaust occurs at constant volume. The pressure volume diagram of the diesel cycle is shown below. The process 1-2 is isentropic compression. In this process the air which has been sucked into the cylinder is compresses isentropically to a certain pressure .the process 2-3 is constant pressure heat addition .During this process fuel is sprayed into the compressed air in the form of fine droplets by using fuel injectors which are nothing but nozzles. The process 3-4 is isentropic expansion or the power stroke during which the piston is forced down by the force of the air fuel mixture acting on it.

Figure 1



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coming out of it by decreasing the velocity of the fluid leaving the nozzle. The velocity of the fluid leaving continuously reduces and becomes minimum at the outlet of the diffuser. The cross-sectional area of a nozzle decreases in the flow direction for subsonic flows and increases for supersonic flows. The reverse is true for diffusers. The kinetic energy of the fluid is converted into pressure energy.

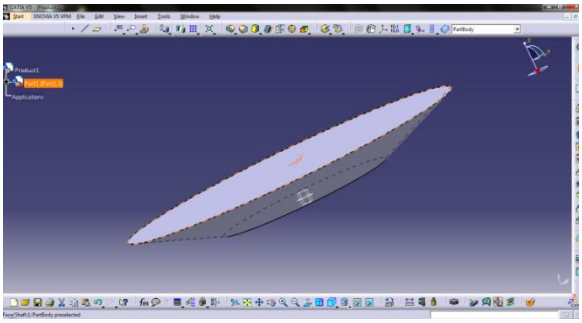
III. VIEW OVER CONVENTIONAL SYSTEMS

The conventional diesel engine works on the principle of diesel cycle which takes in air during the suction stroke, compresses it during the compression stroke, sprays the fuel and ignites the air fuel mixture during the power stroke and exhausts the remaining waste gases in the exhaust stroke. Clearance volume is the volume between the top dead centre of the piston to the top of the cylinder which is the cylinder head. The clearance area of conventional engines is usually cylindrical in shape. The modification proposed changes the shape of the clearance volume. The modified clearance area is in the shape of a frustum of a cone. This frustum of a cone which is nothing but a cone cut at a certain height will act like a diffuser which increases the pressure of the air fuel mixture during the power stroke. Thus the air fuel mixture will hit the top of the piston and as this mixture is at a higher pressure more pressure acts on the top of the piston which is the head thus increasing the rotational speed of the crankshaft which in turn leads to increased power and torque output from the engine without having to introduce any more amount of fuel or by using any external devices such as compressors.

IV. WORKING

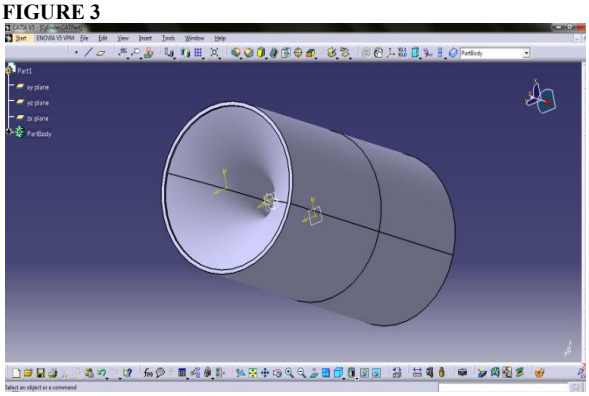
The working of the modified piston cylinder arrangement is clearly explained below. The diffuser is incorporated into the cylinder clearance volume. The shape of the clearance volume will look like the figure which is given below

FIGURE 2



As we can see the combustion chamber is designed in the shape of a diffuser which has been modelled using CATIA V5R20.

FIGURE 3



The bigger diameter is equal to the bore of the cylinder while the diameter of the smaller side is to be calculated using the formulas of diffuser and the cone frustum as the shape of the designed profile looks like a cone. The entire assembly of the combustion chamber along with the rest highly compressed. Now the compressed air is entirely forced into the combustion chamber. The fuel is then sprayed into the cylinder using a injector. Now the air fuel mixture combusts and forms a fiery mass which is the pushed into the rest of the cylinder through the diffuser where its pressure increases. This results in a increase in pressure of the combusted air fuel mixture at the diffuser outlet. This higher pressure air fuel mixture pushes down the piston with an increased force which increases the number of rotations per minute of the crank shaft thus leading to a increase in torque and power of the engine without using any external devices such as compressors or fuel or battery. The profile of the cylinder has been modelled using CATIA V5R20.

V.CALCULATION

For calculation purposes the engine of a Maruti Swift (Diesel) was taken and all the engine parameters were noted. Some of the few important parameters were

TABLE 1.

Cylinders	4
Bore	69 mm
Stroke	82 mm
Displacement	1248 cc
Compression Ratio	17.5:1

This engine has a clearance volume in the shape of a cylinder and the clearance volume of the combustion chamber was found out using the formula.

$$\text{Compression Ratio} = \frac{swept\ volume + combustion\ chamber\ volume}{combustion\ chamber\ volume}$$

From this the volume of the combustion chamber was determined and then the smaller diameter of the combustion chamber was determined using the nozzle equations. Once the values of the smaller and bigger diameters of the modified combustion chamber are determined, the combustion chamber was modelled

and then assembled in CATIA.The specifications of the combustion chamber were calculated and they are TABLE 2.

Bigger Diameter	69.9 mm
Smaller Diameter	34.95 mm
Length	6.9 mm

VI. RESULT

After analysis in CFD it is seen that the power obtained from the engine with the modified combustion chamber is much more than the engine having a non modified combustion chamber . The torque obtained is also higher than the unmodified cylinder. This is due to the higher pressure exerted on the face of the piston due to the diffuser shaped cylinder structure.

VII. CONCLUSION

It is seen from the calculations and analysis that the output parameters of the modified engine exceeds the output of the unmodified engine .This is a clear indication that this design will be successful when implemented by increasing the engine output without having to add more fuel or any other external components. The power produced by this engine can further be enhanced by adding turbo boosters which compresses the air before it is sent into the cylinder for compression. A engine which produces a higher amount of power for the same clearance volume fuel consumed and dimensions than a conventional engine with the same parameters is certainly more attractive and more cost effective than adding more components or introducing more fuel. This modification if installed will lead to more efficient and powerful cars in the future.

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