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145 CC CNG Engine Design and Matching with Turbocharger

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***Abstract*: The main concept of this project is to design CNG engine and to match turbocharger with CNG engine and to find the possible output from CNG engine, which is studied on a single cylinder 145cc turbocharged engine. CNG has a higher octane number and knocking resistance as compared with gasoline and hence CNG engines can have higher compression ratios and therefore higher indicated efficiencies. Results shown that the combined injection of gasoline and CNG is much better than gasoline mode in terms of fuel consumption and raw HC and CO emissions.**

***Keywords*: CNG, Turbocharger, 145 CC, Pollution**

1. Introduction

This paper covers the new engine design of 145cc internal combustion engines burning natural gas (CNG) directly injected inside combustion chamber and matching turbocharger with CNG engine to increasing performance and in the modern one of its use for fuel consumption and pollution emission reduction. The advantages of turbocharging CNG engine are discussed to control air pollution emission and to improve power density and thermal efficiency on CNG engines.

A. Project details

Phase to process developing and a fabricating. Discuss about the theories review calculation project specification etc. in order to achieve all these, following methods are to be followed closely during the execution of the project to achieve the objective.

- Understand the objective of the project and search for the best result to solve the problems statement.
- Experimentation and simulation where certain experiments are needed to be done in order to collect and take note the data and record for improvement.
- Generate conceptual design and concept selection where meet the characteristics require and final conceptual design is obtained.
- Phase to detail design where concept will be enhanced and optimized if there is disability and problems to produce the final design.

2. CNG engine design

A new engine design delivers the supreme flexibility and perhaps the most operative design for process with gaseous fuel, but inclines to bear mounting prices, which avoid it from being a commercially practical option, because direct injection CNG engines are improbable to find large-scale commercial use in the future, due to the well-established invention lines of conventional petrol and diesel engines.

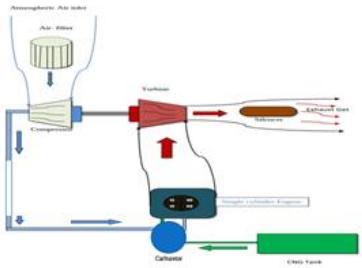

Fig. 1. Layout of project

In research section, there consists of the three elements input that can be used to conduct the project research. Where method to conduct for each one of element is different. Research through the website is the best alternative in which much information can be found and collected. In addition information regarding the competition date and venue last well-known also can be told. There are a number of books which related with research objectives and can be used as a guide for completing the report and the fabrication process. Also for validity, the journals are related than also be downloaded and taken as reference report. There are many websites that excess supply further information in respect of the project problems and how to overcome some of the problems can be found [9].

As we know that to obtain the accurate result of the experiment we need to know the function of the all of equipment's which are using in the project. The main objective of the project is to reduce the temperature and emission of CNG engine, matching with turbocharger. i.e., here we have discussed the major components which are using in project. The all parts of project is the equipped from the Bajaj 2 stroke Auto-Rickshaw.

A. CNG engine design

Engine is the main part of the system due to which system can run. The purpose of internal combustion engine is the

production of mechanical power from the chemical energy contained in the fuel. In internal combustion engines, as distinct from external combustion engines, this energy is released by burning or oxidizing the fuel inside the engine. The fuel-air mixture before combustion and the burned products after combustion are the actual working fluids. The work transfers which provide the desired power output occur directly between these working fluids and the mechanical components of the engine. The internal combustion engine is subjected of spark-ignition engines (sometimes called Otto engines, or gasoline or petrol engines, though other fuels can be used) and compression-ignition or diesel engines [10], [11].

Here we have selected 2 stroke 145 CC CNG engine for experiment. Which have main advantage that it is economically cheaper and light in weight which can help of mobility of project. Compared to four-stroke engines, two-stroke engines have a greatly reduced number of moving parts, and so can be more compact and significantly lighter.

The 3D design of 2 Stroke CNG engine is shown in fig. All designs are performed on Creo software.

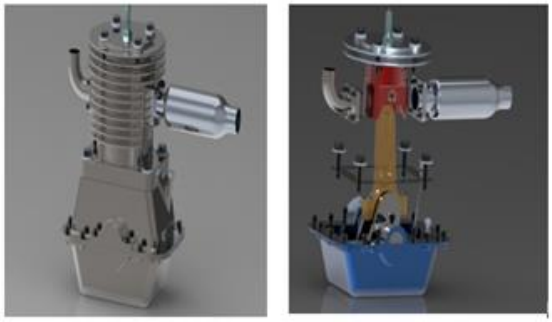

Fig. 2. 2 Stroke Single cylinder engine

Fig. 3. Design of single cylinder engine matching with Turbocharger

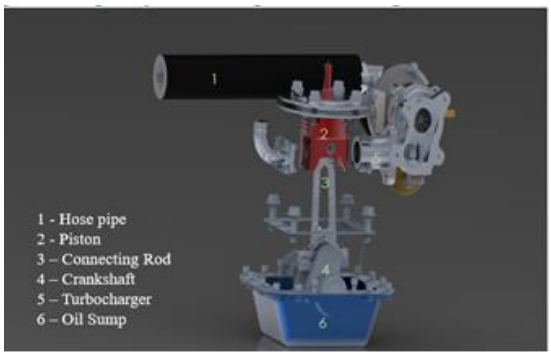

Fig. 4. Design of single cylinder engine matching with turbocharger

- As shown in figure we have to attach the turbocharger to the single cylinder engine. The fresh air coming-out from air filter which helps to clean the air from dust and convey the fresh air to the engine.
- Turbocharger's compressor wheel helps to suck the fresh air from air filter. Where the compressed air will cool down the temperature and mixed with the CNG gas in form of air fuel mixture and starts combustion process.
- The exhaust gas will travel to the turbine wheel, where the turbine wheel will rotate forcefully due to the thrust of exhaust gas and also rotates the compressor wheel to suck the fresh air in to the cylinder.
- After rotating the turbine wheel the exhaust gas will emit through the silencer to atmosphere.

3. An engine selection & turbo-matching

Table 1
Engine details- 145 CC

Engine	1 Cylinder
Engine CC	145
Max Power	7.25 @ 5500 +/- 250 (Kw @ RPM)
Max Torque	14.9 @ 3500 +/- 250 (Kw @ RPM)
No. of Port	2
Bore	57 mm
Stroke	58.70 mm
Firing Order	1
Compression Ratio	9.3
Fuel Spray	120 bar pressure
Boost Pressure	20 Kpa
Boost pressure peaks	8 psi

Table 2
Turbocharger analysis

Max Turbo RPM	
Compressor outlet	3 diameter (inches)
Max RPM	110772
Mass Flow Rate	
Inducer diameter	1.7 inches
Hub Diameter	0.9 inches

Table 3
Full analysis: Compressor & Turbine

Mass flow rate	0.388781
P2 (Psig)	32
Compressor efficiency	70%
Turbine efficiency	78%
Nozzle efficiency	90%
Ambient temperature	25^0 C
Ambient Pressure	14.7 bar
Compressor Temperature Rise	166.788^0 C
Compressor discharge temperature	191.788^0 C
Turbine temperature Drop	146.498^0 C
Turbine outlet temperature	641.502^0 C
Turbine Pressure ratio required	2.19367

A. Turbo Power Calculation

For the matching of turbocharger with CNG engine we have used given parameter:-

- Bore = Cylinder diameter in mm

Table 4
Full Analysis-Nozzle

Nozzle Pressure Ratio	1.40261
Nozzle Exit temperature	575.26^0 C
Nozzle velocity	1283.39 ft/sec
Jet nozzle outlet density	38.4698 cu ft/lb
Jet nozzle diameter	1.46145 inch
Jet nozzle area	1.67749 sq. in
Thrust	15.5016 lbs

- Stroke = Engine stroke in mm
- No. of cylinder = One
- Ambient Air temperature = Air temperature of the day
- Engine volumetric efficiency = 3000 rpm = 90% 6000 rpm= 60%
- Compressor efficiency = 60% to 70%

Deck height is distance top of piston stops from top of bore and for our calculation deck height is 1.9 mm.

- Gasket thickness= 0.55 mm

Table 5
Engine input data

Bore	57 mm
Stroke	58.7 mm
No. of cylinder	1
RPM	5500
Ambient Air temperature	28^0 C
Engine Volumetric efficiency	55 %
Boost pressure	20 bar
Compressor efficiency	60 %

Table 6
Engine input data

Engine Capacity	149.73cc
Naturally aspirated cm/min	0.23
Air temperature after intercooler	54.59
Turbocharged cm/min	0.24
Air-kg / minutes	0.28
Turbocharged Kw	4.94
Turbocharged torque Nm	8.58

B. Compression ratio

Table 7
Input Data

Bore	82.5 mm
Stroke	92.5 mm
Deck height	1.5 mm
Gasket thickness	0.55 mm
Head volume	20.1 mm
Results	
Compression ratio	6.91
Combustion chamber volume cc	12.81

Table 8
Turbo Compression ratio

Bore	57 mm
Stroke	58.7 mm
Engine volumetric efficiency	55 %
Standard compression ratio	9.3 %
Boost pressure	20 bar
Result	
Compression ratio under boost	6.48
Recommended fuel	84.93

Table 9
Turbocharger matching for CNG

Engine capacity cc	145
Max RPM	3200
Turbo Boost	20 KPa
Result	
Compressor TRIM	44
Air-kg / minutes	0.28

4. Pollution emissions

CNG has a minor adiabatic flame temperature than that of diesel or gasoline fuel. The NOx development increases exponentially with the adiabatic flame temperature. CNG engines therefore characteristically emit less NOx than diesel engines. The tailpipe NOx emission from a CNG engine is about half that from a diesel engine at the same operating condition. CNG engines tend to emit less PM or soot mass than a diesel engine. The leaning to form particulates from burning CNG is much weaker than from burning diesel fuel. CNG, which usually contains more than 90% methane, has a lower carbon hydrogen ratio than diesel fuel. For the same quantity of energy released, burning CNG forms less CO_2 than combustion of diesel fuel. A turbo CNG engine usually produces 25–30% less CO_2 as compared with diesel engine. In an IC engine, combustion typically can only be continued for less than 60° of crank angle before the flames are quenched by expansion of the in-cylinder charge. If the flame speed is not adequately high, a portion of the fuel or a portion of the intermediate products from combustion of the fuel will not be fully oxidized before the exhaust port open, and is emitted as unburnt hydrocarbon. The amount of unburnt hydrocarbons from a natural gas engine is higher than that from a diesel engine, but tends to be lower than that from a premixed natural gas engine.

A. Comparison

- CNG engines produce about 25% less Carbon Dioxide than Gasoline Engine.
- CNG has a higher octane number (110-130) and knocking resistance as compared with gasoline and hence CNG engines can have higher compression ratios and therefore higher indicated efficiencies.
- CNG has a minor adiabatic flame temperature than that of diesel or gasoline fuel.
- According to the obtained results at 16.2 bar BMEP, 3000 rpm full load condition with 30% CNG mass fraction, the BSFC, CO and HC emissions are improved by 16, 66 and 50%, respectively, compared to gasoline single mode.

5. Conclusion

The Turbo CNG engine performance were calculate and it was noted that for greatest cases the main attention has been on the mechanical and thermal performances. By a studies of combustion we calculated pollution emission and combustion phenomena of CNG engine. CNG has a higher octane number

and knocking resistance as compared with gasoline and hence CNG engines can have higher compression ratios and therefore higher indicated efficiencies. Results show that the injection of CNG is much better than gasoline mode in terms of fuel consumption and raw HC and CO emissions [9].

The advantages of fuel by providing both high volumetric efficiency and strong performance. So the turbo CNG engine can act as an octane booster to put on optimal spark timing and additional for gasoline fuel enhancement.

The combustion and matching of turbocharger showed that improvement in knock tendency, and CNG with turbocharger is much better than gasoline method in terms of fuel consumption and unburnt HC and CO emissions [9].

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