INCREASING A MOTORCYCLE ENGINE PERFORMANCE BY USING A NON CONVENTIONAL SUPERCHARGER

A Project & Thesis

By

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ABSTRACT

The information of this paper provides the instructions to improve engine performance using non conventional super-charger at a low cost. In this study a new designed non-conventional super-charger was tested in a small petrol engine. From those results it can be concluded that the performance of a traditionally manufactured motor bike can be increased significantly by this newly designed super-charger with some modifications. When engine was at stable condition then minimum 257.4 rpm and maximum 2095 rpm were 257.4 respectively. When using non conventional super-charger minimum 310.3 rpm and maximum 2548 rpm. When engine was at stable condition then without non conventional super-charger voltage 12 V and when using non conventional super-charger voltage 14 V. When engine was stable condition then without non conventional super-charger torque 4 N-m and using non conventional super-charger torque 5.46 N-m.

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CHAPTER I
INTRODUCTION

1.1 General:

The power output of an engine depends upon the amount of air indicated per unit time, the degree of utilization of the air and the thermal efficiency of the engine. The amount of air inducted per unit time can be increased by increasing the engine speed or by increasing the density of air at intake. The increasing the engine speed calls for rigid and robust engine as the inertia loads increase. The engine friction and bearing loads also increase and the volumetric efficiency decreases when the speed is increased. The method of increasing the inlet air density, called supercharging, is usually employed to increase the power output of the engine. This is done by supplying air at a pressure higher than the pressure at which the engine naturally aspirates air from the atmosphere by using a pressure boosting device called a supercharger. The power output can also be increased by increasing the thermal efficiency of the engine, say, by increasing the compression ratio. However, this increases the maximum cylinder pressure. The rate of increase of maximum cylinder pressure is less than rate of increase of break mean effective pressure in case of supercharged engine. This means that for a given maximum cylinder pressure more power can be obtained by increasing the compression ratio. The rate of increase of maximum temperature is also low in case of supercharging. This results in lower thermal loads. [1]

The **supercharger** is a kind of forced induction system that pushes more air into the engine, thereby generating more engine power. It is similar to the turbocharger, except that it is driven mechanically by a belt-pulley mechanism powered by the engine, while the turbo is powered by the exhaust gases. [2]

1.2 Objectives

1. Design and fabricate non convention supercharger.
2. To increase the power output for an amount of air and fuel.
3. To increase engine R.P.M.
4. To increase engine torque.

CHAPTER II

LITERATURE REVIEW

2.1 History of Super-charging in motorcycle engine

While Kawasaki sold a turbocharged Z1R-TC made by the Turbo Cycle Corporation in the late 70's, the first true production forced induction motorcycle was released by Honda.

The Honda CX500 Turbo was released in 1982 and based upon the technologically advanced (at the time) CX500. In addition to its turbocharger, it also featured computer controlled fuel injection, ignition and turbo control. The base CX500 featured the first V-twin ever built by Honda and it became the perfect base for its turbo charging experiment. According to Motorcycle Classics, air was routed from the front of the CX through an oiled foam air filter and then into the compressor part of the turbocharger. From the turbo mounted in front of the engine, air traveled to a plastic box (called a surge tank), and then through reed valves and intake tubes into the cylinder head. Fuel passed through a fuel filter before being pushed under pressure by an electric fuel pump, where it was fed to fuel injectors that released a precisely calibrated flow of fuel to the intake tubes.

Fig1: Testing engine demo.

Reactions to the CX500 Turbo were mixed. Most journalists either loved or loathed the turbo sensation. Detractors stated that the bike became too hard to control when the boost came on, especially in the corners. The following year Honda bumped the capacity of the engine up to 674cc and increased the compression ratio to 7.2:1 which increased power to 97 HP, but it was short lived. The turbocharged model was discontinued by the end of the year.

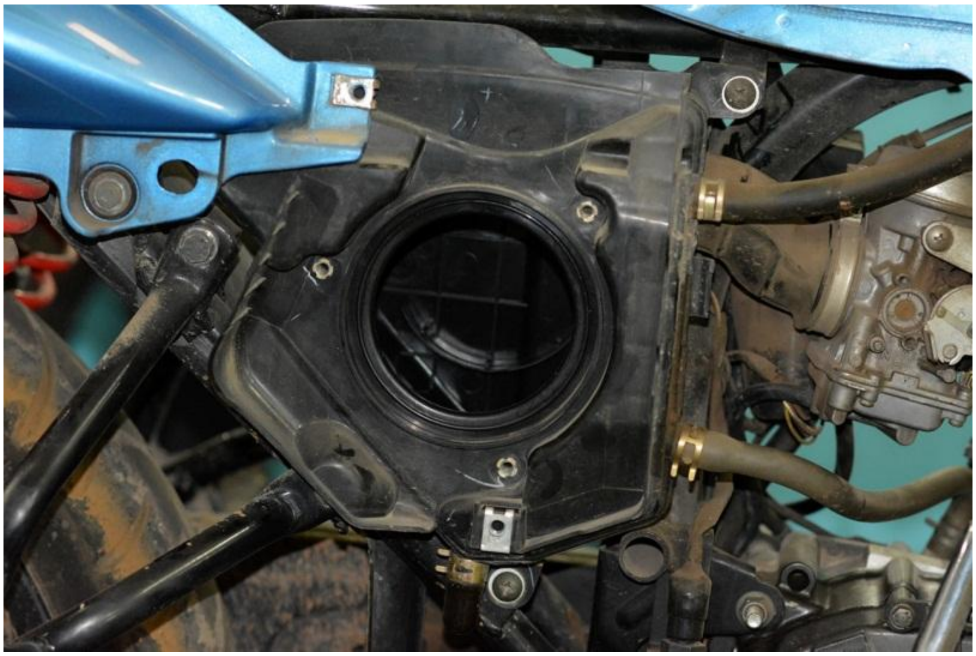


Fig2: Installation position of non conventional supercharger.

Soon following Honda's release of the CX500 Turbo was Yamaha's response – the XJ650LJ Sea which had the distinction of featuring in the Bond film *Never Say Never Again.* It featured a four stroke transverse four cylinder turbocharged DOHC, 2 valves per cylinder engine with a capacity of 653 cc. Unlike the Honda CX500 turbo, it was air cooled and pumped out 90 HP at 9,000 rpm. It was also far more low-tech than the Honda – something that many actually preferred – using carburetors instead of electronic fuel injection.

Last to the party and last to offer a turbocharged motorcycle for sale was Kawasaki with their E1 and E2 GPz750 Turbo bikes. As far as performance went, the GPz750 was the king of the turbocharged bikes thanks to its larger displacement –9,000 rpm and a massive 99.1 nm @ 6,500 rpm. Upon its release it was claimed to be the fastest production bike in the world. In addition to having the best performance figures, it was generally regarded as the best example of a turbo motorcycle. Lag was down and the turbocharger actually did what it was intended for – to make it quicker than a comparable normally aspirated machine. Commercially it did well too – being sold for three years in comparison to the other makes one year stint.

But economics of production and cost of ownership meant that even Kawasaki's machine was eventually withdrawn and we wouldn't see another forced induction motorcycle until the announcement of the Kawasaki Ninja H2 and H2R last year.

2.2 Present Situation Of Super-charging In Motorcycle Engine

The year is 2014 – 32 years after Honda released the CX500 Turbo and Kawasaki announces the Kawasaki Ninja H2, the world's first production supercharged motorcycle. The Ninja H2R would be for the track only.

We've talked in great length about both the Ninja H2 and H2R and while we're extremely impressed by the specifications of the H2R, we're a little less enthused about the road legal H2 which suffers from excessive weight. The H2R makes nearly 300 HP from one liter of engine capacity and it does so by forcing far more air into the system than a normally aspirated engine can. And that's probably the reason why the H2 is so heavily detuned – that process will create a lot of heat. That's not good for longevity and ironically; heat will actually decrease air density and therefore reduce power. Kawasaki have innovated a whole host of new technologies to overcome these issues, but that's not cheap. Nor is tested in the real world and Kawasaki probably don't want a lot of money on warranty claims eating into their profits.

But Kawasaki aren't alone in looking at supercharging. Patents were discovered late last year showing Honda is seriously looking at a supercharged bike based on the NC750. The Honda

NC750S and NC750X are unique motorcycles as they stand, with huge amounts of luggage space located where the fuel tank usually sits. This makes it an ideal candidate for forced induction as it provides an easy solution to placing a supercharger, related plumbing and an intercooler.

Then we have Suzuki and their Recursion concept which if the rumors are correct is heading into production this year as the Katana. Unlike Kawasaki and Honda though, the Suzuki Recursion makes use of a turbocharger. If and how Suzuki has overcome the issue of turbo lag remains to be seen.

Fig 3: **present supercharging testing figure singer 125cc engine**

So why after three decades of absence is forced induction making a comeback? The reason for it is renaissance is actually quite boring but very important – the environment.

Yes, forced induction, whether it be provided by either a turbocharger or supercharger gives an increase in performance. But increasing performance isn't really necessary for most motorcycles today. Just take a look at the specifications for the latest normally aspirated superbikes like the 1299 Pan gale and Yamaha R1 and you can quickly see that a turbocharger or supercharger would just add unnecessary weight, complexity and cost to the machines for probably little gain. Where they do improve things dramatically is in emissions.

And that's going to become increasingly important. It's expected that by 2017, the European Union will require all motorcycle manufacturers to quote C02 emissions for their bikes which will lead to tax implications. Governments will continue to pressure vehicle manufacturers to lower their emissions which contribute a sizable percentage to most western nations overall carbon emission figures.

The Ninja H2 has the exact same output as the current Kawasaki ZX-10R. But the H2's carbon monoxide emissions are 1g/km compared to 3g/km for the ZX-10R – a reduction of 66 per cent. Similarly, the hydrocarbon emissions of the H2 compared to the ZX-10R reduce from 0.3g/km to 0.2g/km – 33 per cent down. Just imagine the reductions when the technology becomes more mature. Like it or not, motorcycle manufacturers ignoring both emissions and fuel consumption of their machines is coming to an end which means this time, forced induction is likely to not be a small flash in the pan but part of the ongoing motorcycle landscape – just like electric bikes. And for that, we're more than happy as the more choice available to consumers, the more riders we'll get on our roads**.** [3]

2.3 Supercharger

It is kenned fact that the potency output of an engine increases with an incrimination in amount of air or amalgamation in the cylinder at the commencement of compression stroke because it allows the burning of more quantity of fuel. The amount of air induced per unit time can be incremented by incrementing engine speed or incrementing air density during suction stroke. The incrimination in engine speed requires rigid and robust engine as the inertia load increases rapidly with increases celerity. The engine friction and bearing loads additionally increase and volumetric efficiency. Falls with incrementing speed of engine. Consequently this is not possible. Now another method in which we have to increment the suction pressure is called supercharging. Equipment utilized for this is called Supercharger. The puissance output is withal be incremented by incrementing the compression ratio, but is withal not desirable as it increase the maximum cylinder pressure. The rate of incrimination in maximum Pressure in cycle with incremented compression ratio is less than the rate of incrimination in BMEP in case of supercharged engine.

Ergo more power can be obtained by supercharger compared with by incrementing the compression ratio for given maximum cycle pressure. In advisement to this the rate of Incrementing maximum temperature is withal low in supercharger engine and this result in lower thermal loads. In the un supercharged car engine, when a piston is drawn by the connecting rod to the bottom of the cylinder, an amalgamation of petrol and air enters the cylinder via the inlet valve And manifold, from the carburetor. This charge is compressed by the piston during the upward peregrinate, and is conclusively ignited by the spark plug and burning, exerts a pressure on the piston on its 'work' stroke. Now this charge which was 'drawn in' by the piston can vary in size for a number of reasons. The piston moving down the cylinder does not draw in the charge. It sanctions it to Enter by getting out of the way.[4]

2.4 Types of supercharger

There are three types of supercharger.

a. Centrifugal superchargers.
b. Root's type supercharger.
c. Vane type supercharger

1. Centrifugal superchargers

These are commonly used in the vehicles & are powered by the engine via a belt-pulley system. The air-fuel mixture enters the impeller at the centre. The air is then passed through diffuser, which increases the pressure. Finally the air makes it way through the volute casing to the engine.

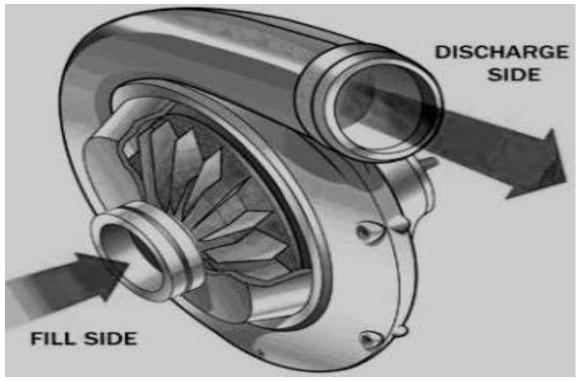


Fig4: Centrifugal supercharger

2. Root’s type supercharger

Root’s type contains two rotors of epicycloids shape. The rotors are of equal size inter-meshed & are mounted and keyed on 2 different shafts. Any one shaft is powered by the engine via a V-belt or gear train (depending on the distance). Each rotor can have 2 or more than 2 lobes depending upon the requirement. The air enters through the inlet & gets trapped on its way to outlet. As a result, pressure at outlet would be greater than the inlet.

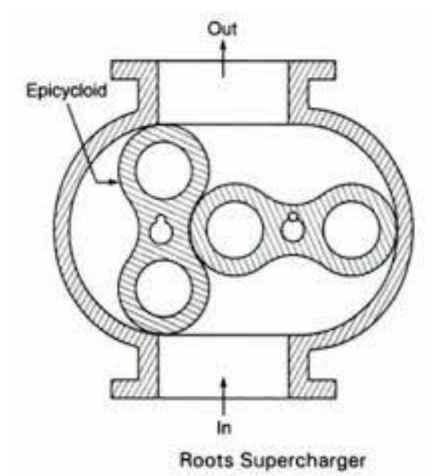


Fig 5: Roots Supercharger

3. Vane type supercharger

A number of vanes are mounted on the drum of the supercharger. These vanes are pushed outwards via pre-compressed springs. This arrangement helps the vane to stay in contact with the inner surface of the body.
Now due to eccentric rotation, the space between two vanes is more at the inlet & less at the outlet. In this way, the quantity of air which enters at the inlet decreases it's volume on its way to outlet. A decrease in volume results in increment of pressure of air. Thus the mixture obtained at the outlet is at higher pressure than at the inlet. [5]

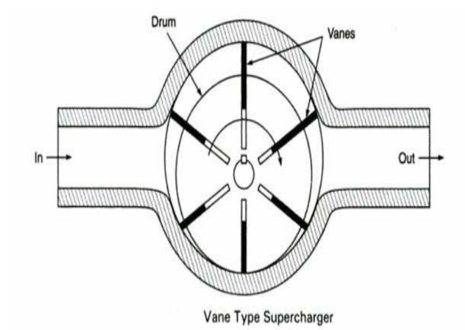
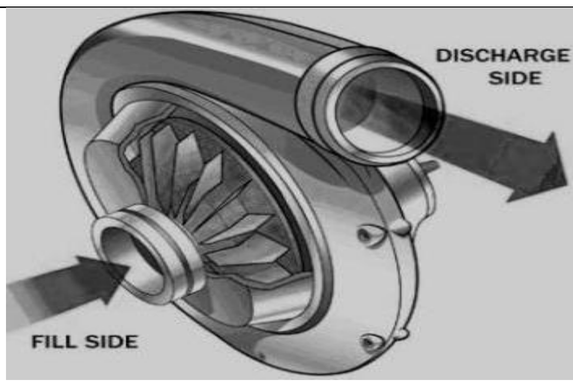
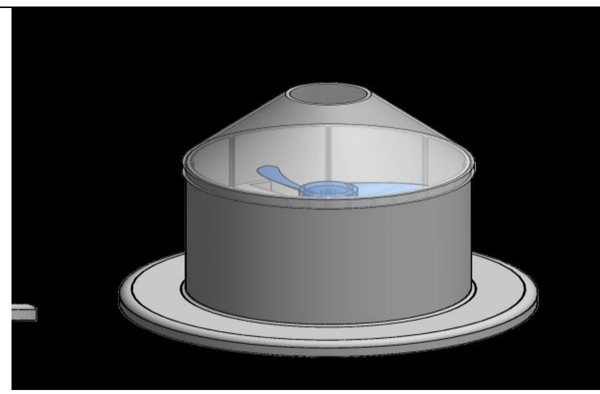


Fig6: Vane Type Supercharger

2.5 Comparison between conventional Supercharger & non-conventional Supercharger

Conventional	Non-conventional
1. It moves from engine power.	1. It moves from Battery power.
2. This type decrease engine power.	2. It doesn’t decrease Battery & Engine power.
3. Normally it is connect to Flat-Belt & V- Belt.	3. It is connect to wire/Cable
4.High them non-conventional	4. Making & maintenance cost low
5.Use high weight engine	5 Use light weight engine
	

2.6 Advantages for non-conventional Supercharge?

1. It moves from Battery power.
2. It doesn’t decrease Battery & Engine power.
3. It is connect to wire/Cable.
4. Manufacturing and maintenance cost low.
5. Low installation cost.
6. Low noise.

2.7 Disadvantages for non-conventional Supercharger?

1. It gave low pressure then conventional supercharger charger.
2. It is for only light weight engine.

2.8 Motorcycle Engine

A motorcycle engine is an engine that powers a motorcycle. Motorcycle engines are typically two-stroke or four-stroke internal combustion engines, but other engine types, such as Wankels and electric motors, have been used. [6]

2.9 Types of Motorcycle Engine

There are two categories of petrol engine bikes: 2 Stroke and 4 Stroke. Both are very popular in our country. Both of them uses near the same type of (internal) combustion to produce power from fuel.[7]

2.10 Comparison of Two Stroke and Four Stroke Engine [8]

Four Stroke Engine	Two Stroke Engine
Four piston strokes require to complete one cycle	Only two piston strokes require to complete one cycle
Two complete revolutions of crankshaft is required to complete one cycle	Only one complete revolutions of crankshaft is required to complete one cycle
Power is developed in every alternate revolution of crankshaft	Power is also developed in every revolution of crank shaft hence for same cylinder
These engines are heavier larger and required more space	These engine are lighter more compact and require less space
Thermal efficiency is higher	Less thermal efficiency
Mechanical efficiency is low because of more number of moving parts.	Mechanical efficiency is high because of less number of moving parts.

CHAPTER III

THEORITICAL ASPECTS

3.1 Brake Power

The brake power (briefly written as B.P) is the power available at the crank shaft. The brake power of an I.C engine is, usually, measured by means of brake mechanism.

Brake Power of the engine, B.P = $\frac{2\pi NT}{60}$ watts

T = Torque in N-m.

N = Speed of the engine in rpm.

3.2 Overall Efficiency

It is the ratio of work obtained at the crankshaft in a given time to the energy supplied by the fuel during the same time.

Overall efficiency = $\frac{B.P\times 3600}{M_f \times C}$

B.P= Brake Power.

M_f = Mass of fuel consumed in kg per hour.

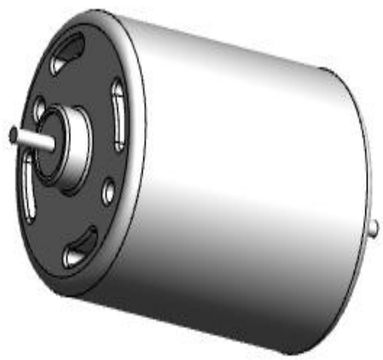
C= Calorific value of fuel in KJ/kg of fuel. [9]

CHAPTER IV

DESIGN OF NON- CONVENTIONAL SUPERCHARGER

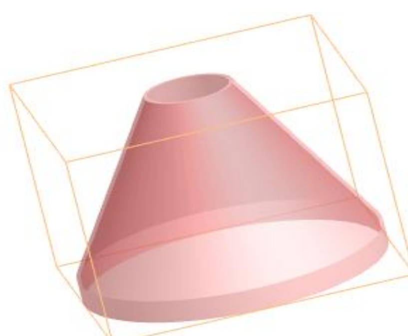
4.1 All Components of non-Conventional Supercharger

1. **Electric motor**



Electric motor is the main components of non-conventional supercharger. It flow pressurized air into cylinder from atmospheric pressure. It moves from battery source.

2. **Air Compression cap**



The air compression cap maintains air flow direction and compressed flow area. It direct air flow in carburetor. It's an axial flow direction.

3. Carburetor

The carburetor is one of the part of non-conventional device, and also main components of engine. Carburetor mixed air fuel and flow the cylinder.

4. Control switch

The control switch controlled all of the non-conventional supercharging system

4.2 Modification of an Engine for Supercharging

The more power output for every engine should be some modification. A naturally-aspirated engine can be increased by supercharging. We install Non-conventional supercharger in air cleaner. It use for light weight engines. It gave low pressure air flow for conventional supercharger. Conventional superchargers install behind the engine and gave power from engine by chain/belt. Different types of conventional supercharger and for its install type different.

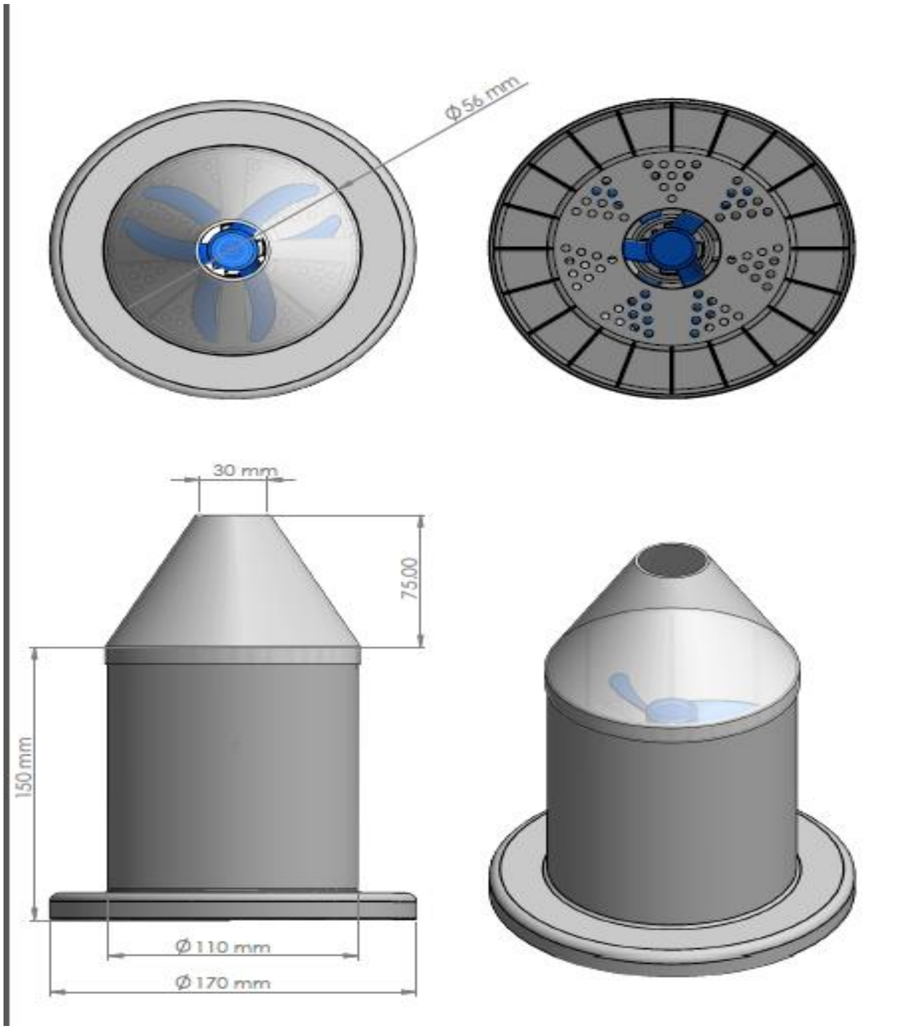


Fig 7: All components of Non-conventional supercharger

4.3 Working Principle of a non-Conventional Supercharger

This is a non-conventional Supercharger, All of The supercharger Work from Engine Power, But It Work from Battery Source. But it does not Decrease Battery Power. Its working looks like a centrifugal Supercharger. It increased engine performance & Battery power.

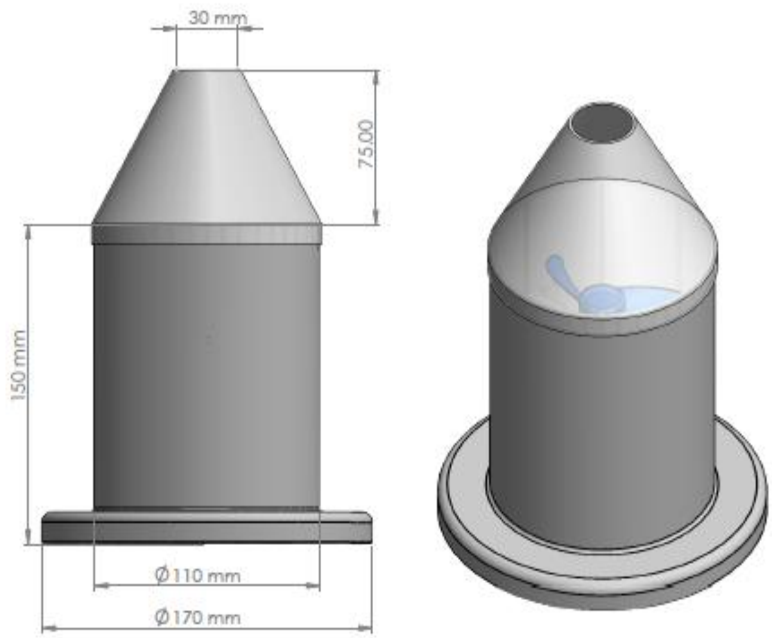


Fig 8: Non-conventional supercharger

As the air is compressed at the end of supercharger, compressed more air and fuel mixture flow into the cylinder. Then engine burned more mixture and gave high performance. For we gave high battery voltage and engine RPM. It is use for high performing engine such as, air craft, automobiles etc. [10]

4.4 Operation System

At first air cleaner should be opened, then installation non-conventional supercharger inside air cleaner. Electric motors two point set in battery terminal, and start to control switch.

At first engine start, then non-conventional supercharger on then we get output better performance.

1. Minimum RPM Testing Non-Conventional Supercharger

Before Supercharger (125cc) And After Supercharger (125cc)

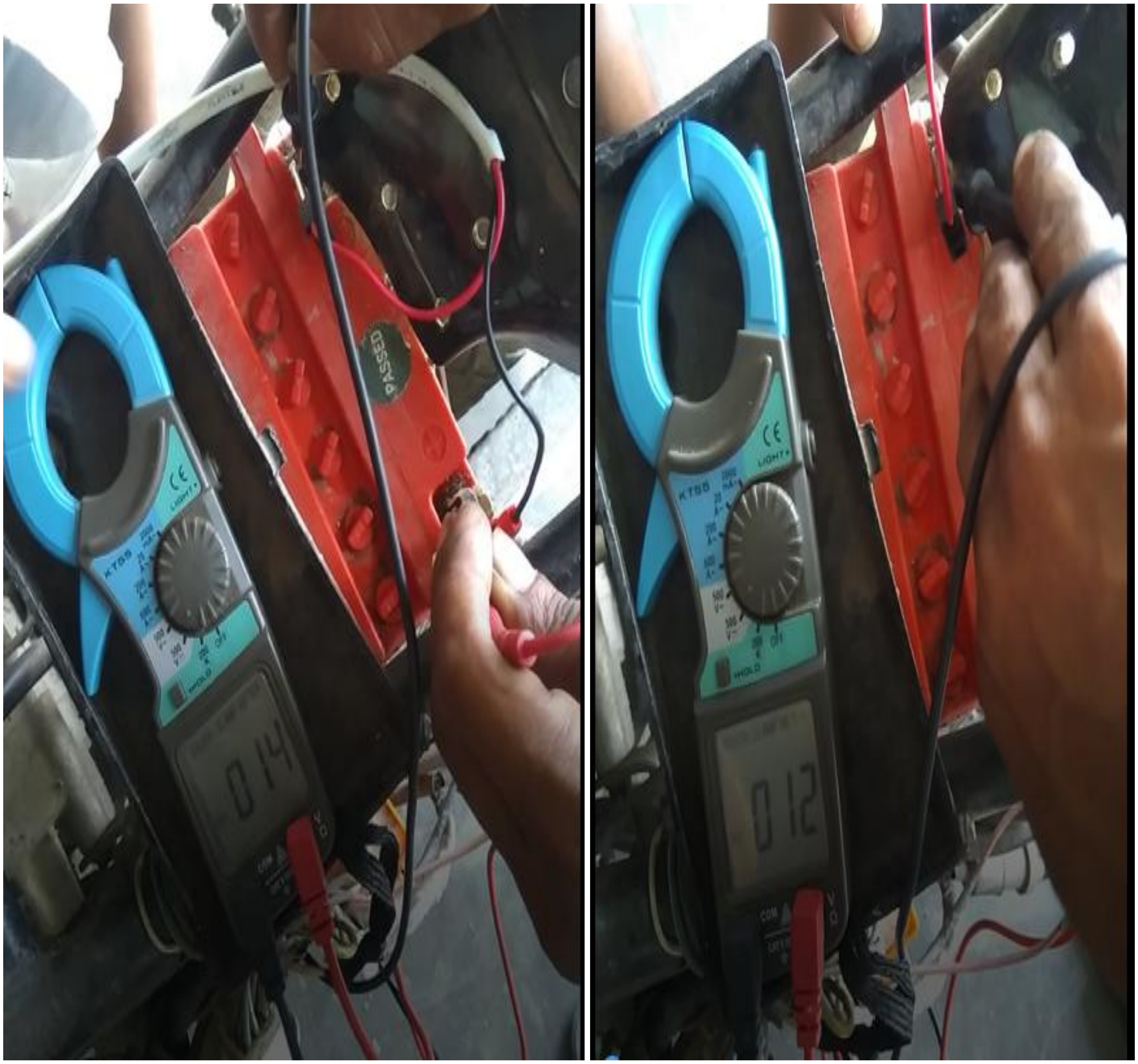
Fig 9: **Minimum RPM Testing Non-Conventional Supercharger**

2. Maximum RPM Testing Non-Conventional Supercharger

After Supercharger (125cc) and Before Supercharger (125cc)

Fig 10: **Maximum RPM Testing Non-Conventional Supercharger**

3.Voltage Testing Non-Conventional Supercharger



After Supercharger (125cc) and Before Supercharger (125cc)

Fig 11: Voltage Testing Non-Conventional Supercharger

4.Torque Testing Non-Conventional Supercharger

After Supercharger (125cc) and Before Supercharger (125cc)

Fig 12: **Torque Testing Non-Conventional Supercharger**

Fig 13: Operational system of non-conventional supercharger

4.5 Significant features of the technology

1. Engines equipped with this Supercharger have higher (40% to 75%) torque at lower RPM
2. Manufacturing cost is 5 to 10 times lower than similar products available on the market
3. The Supercharger is easily adapted to a broad range of power train designs, requiring simple installation to provide an optimal fresh air supply. [11]

CHAPTER V

ANALYSIS AND RESULT

5.1 RPM Data Table For 125 CC Engine

Rpm Comparison Table of 125 Cc Engine

	Without Super-charger	With Super-charger
Minimum	257.4 rpm (Approx.)	310.3 rpm (Approx.)
Maximum	2095 rpm (Approx.)	2548 rpm (Approx.)

When engine was at stable condition then minimum rpm and maximum rpm were 257.4 and 2095 respectively. Within using the non conventional supercharger minimum rpm and maximum rpm were 310.4 and 2548 rpm.

Bar Chart of 125cc Motorcycle Engine Rpm

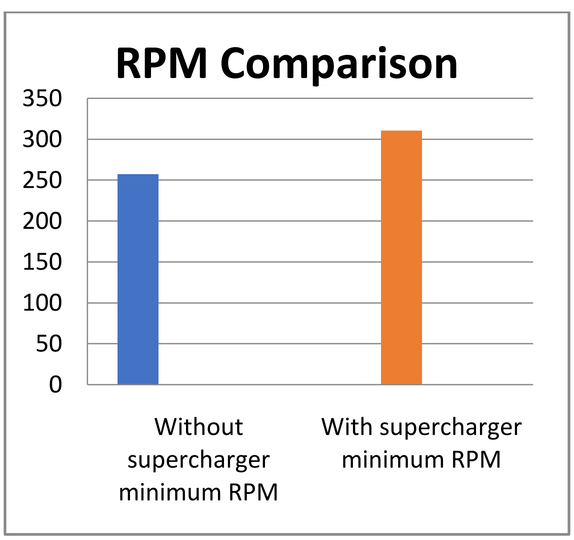


Fig14: for minimum rpm

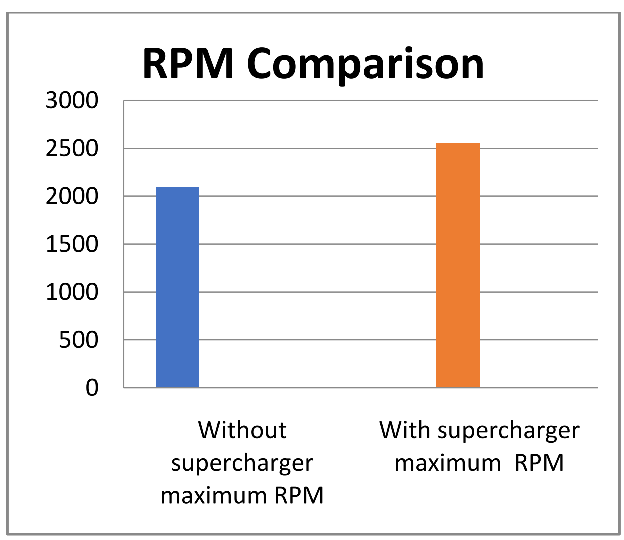


Fig15: for maximum rpm

5.2 Voltage Data Table for 125 cc Engine

Battery Voltage Comparison Table of 125 Cc Motorcycle Engine

	Without Super-charger	With Super-charger
Battery Voltage	12 V	14 V

When engine was at stable condition then without non conventional supercharger volt 12V. Within non conventional supercharger respectively 14V.

Bar chart of 125cc Motorcycle Engine battery voltage

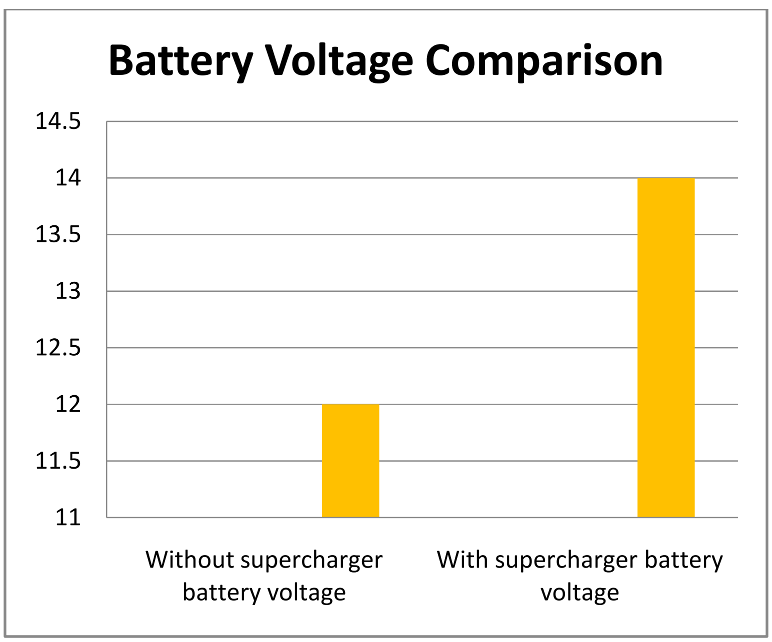


Fig16: Battery voltage comparison

5.3 Torque Data Table for 125cc Engine

Torque Comparison Table of 125 CC Engine

	Without Super-charger	With Super-charger
Torque = Force × Distance	T = (2.72 kg × 9.81) × 0.15 m = 26.68 N × 0.15 m = 4 N-m	T = (3.71 kg × 9.81) × 0.15 m = 36.40 N × 0.15 m = 5.46 N-m

When engine was at stable condition then without non conventional supercharger torque 4 N-m. Within nonconventional supercharger respectively torque 5.46 N-m.

Bar chart of 125cc Motorcycle Engine Torque

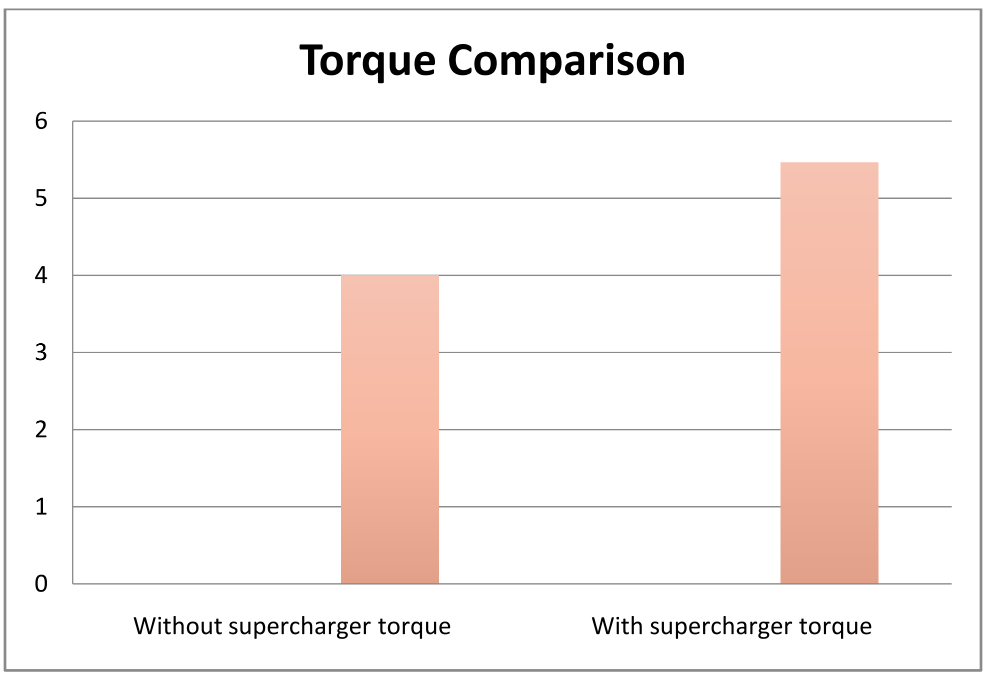


Fig17: Torque Comparison

5.4 Calculation

A motor cycle engine uses 0.315 kg of oil per hour of calorific value of oil 42000 KJ/kg. If the engine speed 2095 rpm and engine torque 4N-m. Determine the overall efficiency?

Given data,

N= 2095 rpm

m_f = 0.315 kg/hr

C= 42000 KJ/kg

T= 4 N-m

We know,

B.P= $\frac{2\pi NT}{60}$ watts

B.P= $\frac{2\times\pi\times2095\times4}{60}$ = 878 W = 0.878 KW

Overall Efficiency = $\frac{B.P\times3600}{M_f\times C}$

Overall Efficiency = $\frac{0.878\times3600}{0.315\times42000}$ $\times100\%$

Overall Efficiency = 0.24$\times100\%$

Overall Efficiency = 24%

Using non conventional supercharger by motor cycle and motor cycle engine uses 0.315 kg of oil per hour of calorific value of oil 42000 KJ/kg. If the engine speed 2548 rpm and engine torque 5.46 N-m. Determine the overall efficiency?

Given data,

N= 2548 rpm

m_f = 0.315 kg/hr

C= 42000 KJ/kg

T= 5.46 N-m

We know,

B.P= $\frac{2\pi NT}{60}$ watts

B.P= $\frac{2\times\pi\times2548\times5.46}{60}$ = 1456 W = 1.46 KW

Overall Efficiency = $\frac{B.P\times3600}{M_f\times C}$

Overall Efficiency = $\frac{1.46\times3600}{0.315\times42000}\times100\%$

Overall Efficiency = 0.39$\times100\%$

Overall Efficiency = 39%

5.5 Result Comparison

Result Comparison Table

	Without Super-charger	**With Super-charger**
Minimum R.P.M	257.4 rpm	310.3 rpm
Maximum R.P.M	2095 rpm	2548 rpm
Battery Voltage	12 V	14 V
Torque	4 N-m	5.46 N-m
Overall Efficiency	24%	39%

CHAPTER VI

CONCLUTION AND DISCUSSION

6.1 CONCLUSION

From the analysis of experimental results, the effects of non conventional supercharging on the engine performance can be summarized. Experimentation and competition results have proven that the non-conventional supercharger will increase the engine rpm as well as the battery voltage. Inspire of taking power from the battery, the non conventional supercharger does not decrease battery power, since the manufacturing and the maintenance cost is lower than the conventional supercharger, however as this type of device is being used in heavy vehicles, I hope our nonconventional supercharger will be better because we have test and used it effectively. It can be used to get a little bit increased power within a low budget.

6.2 DISCUSSION

The devise is successfully worked. This device compressed air from atmospheric pressure to high pressurized air and helps keep the flow of air in a consistent manner. So if we used this device in our light weight vehicle then we can better performance from previous system.

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