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Performance of a Compressed Air Engine

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Abstract*: The environmental pollution in the metropolitan cities is increasing mostly because of the increased number of fossil fuels powered vehicles. Compressed air driven engine is the one of the alternative for the IC engine. Main advantage of these engine is that no hydrocarbon fuel is required which means no combustion process is takes place, pollution is zero as well as it does not effect on global warming. In this project the SI engine is converted in to compressed air vehicle by changing the cam and valves. The performance of the engine is checked at various cylinder pressures and it is varied from 2 bar to 8 bar pressure at various gear ratios. From the results we are developed an application for the farmers and rural area people..
***Keywords*: CA engine, Performance, Emissions, Application**

I. INTRODUCTION

Compressed air engine is an air powered engine using compressed air as a fuel. Instead of air fuel mixture burning in the cylinder to drive the piston by expansion of flue gases, Compressed air vehicle uses expansion of compressed air in the cylinder to drive the piston. CA Engine is nothing but opposite to the air compressor working.
When inlet valve opens pressurized air is entered in to the cylinder (Induction) and pushes the piston in downward motion, this will be the power stroke for the CA Engine. The exhaust valve opened the expanded air is released to the atmosphere it will be the exhaust stroke.

II. DEVELOPING CA ENGINE BY USING TRADITIONAL SI ENGINE

The regular SI Engine which has been utilized for the bikes will be used for the CA Engine. In SI engine cam shaft is designed according to the working process of suction, compression, expansion and exhaust. But in CA Engine combustion process is not required. Just in the suction stroke pressurized air is entered into the cylinder and directly participating in expansion process. Now according to the requirements of the CA Engine cam shaft design has been changed as shown in the diagram.

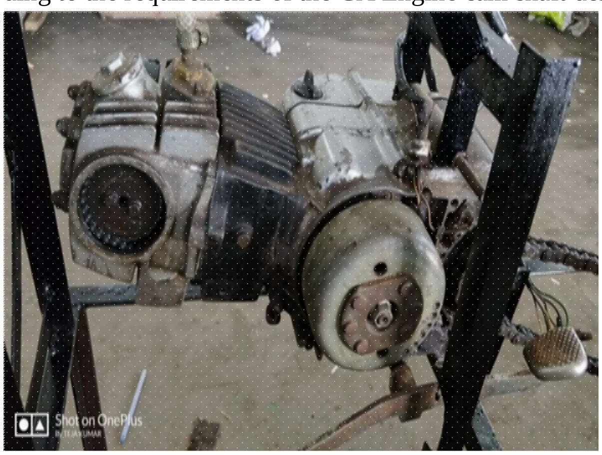

Fig1. CA Engine and Modified cam shaft

III. WORKING OF A CA ENGINE

the air is a working medium in CA Engine which is free of cost and plenty is available in nature. So no need of any costly and non renewable energy resources like petrol, diesel etc… The compressed air produced by the compressor is temporarily stored in a storage tank and which is utilized in where we required to run the engine. When suction stroke started inlet valve is opened by the designed time of the cam shaft. Now due to pressure difference in storage tank and combustion chamber compressed air is entered into the cylinder and apply the thrust force on the piston head. This is expansion stroke. Now exhaust valve is opened expanded air is released to the atmosphere. The CA Engine does not produce any pollution like convention engines and it doesnot cause for the

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global warming also.

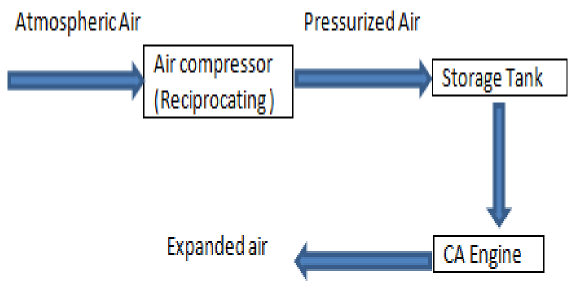


fig2. Circulation of working medium in the CA Engine

Experimentation: The experimentation has been done on the test rig at various loads and various cylinder pressures. Initially the experiment is started at a cylinder pressure of 2 bar and at a load of 25%, 50%, 75% and 100%. Further the experiment is carried at a cylinder pressure of 3 bar, 4bar, 5bar, 6bar, 7 bar and 8 bar at different loads and at different gears (I^{st}, II^{nd}, III^{rd}, IV^{th} gear) In each and every experiment required parameters like load, speed, exhaust gas temperature*e are noted down.

A. *Advantages*

Technical Benefits

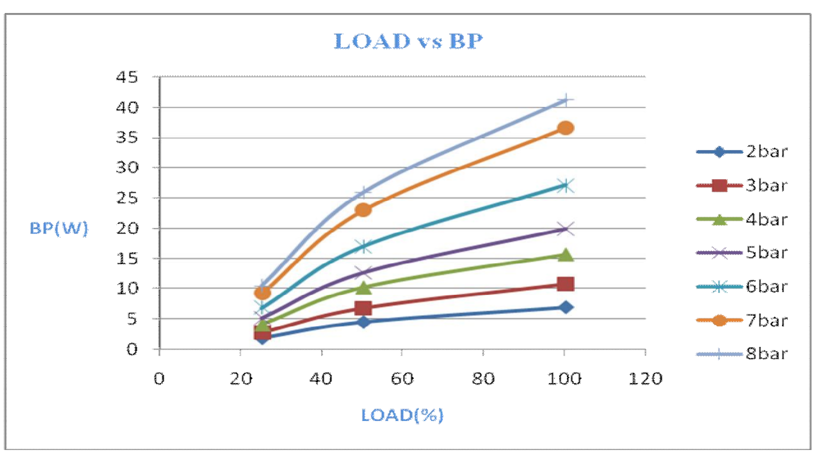
1) The exhausted air temperature is slightly less than the atmospheric temperature.
2) Smooth running of the engine due to very less wear and tear of the components.
3) There is no possibility of knocking, Detonation and abnormal combustion.
4) It does not require any engine systems like cooling systems, lubrication system, ignition system etc…
5) The engine runs on cold or warm air, so can be made of lower strength light weight material such as aluminum, plastic, low friction Teflon or a combination.

B. *Economic Benefits*

1) No need of any costlier fuels like petrol, diesel etc… only air is compressed and used.
2) For running of Compressors use electricity which is relatively much cheaper and widespread.
3) Smooth working will lead to less wear & tear, so lesser maintenance cost.
4) Compressed-air technology reduces the cost of vehicle production by about 20%, because there is no need to build a cooling system, fuel tank, Ignition Systems or silencers.
5) Low manufacture and maintenance costs as well as easy maintenance.
6) Lighter vehicles cause less damage to roads, resulting in lower maintenance cost.

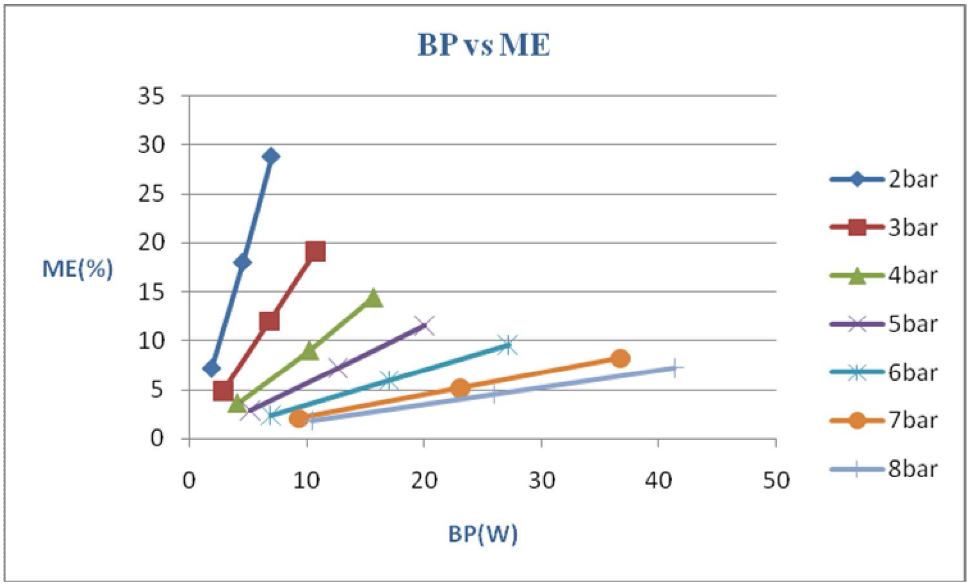
IV. RESULTS

A. *1st gear load vs bp*



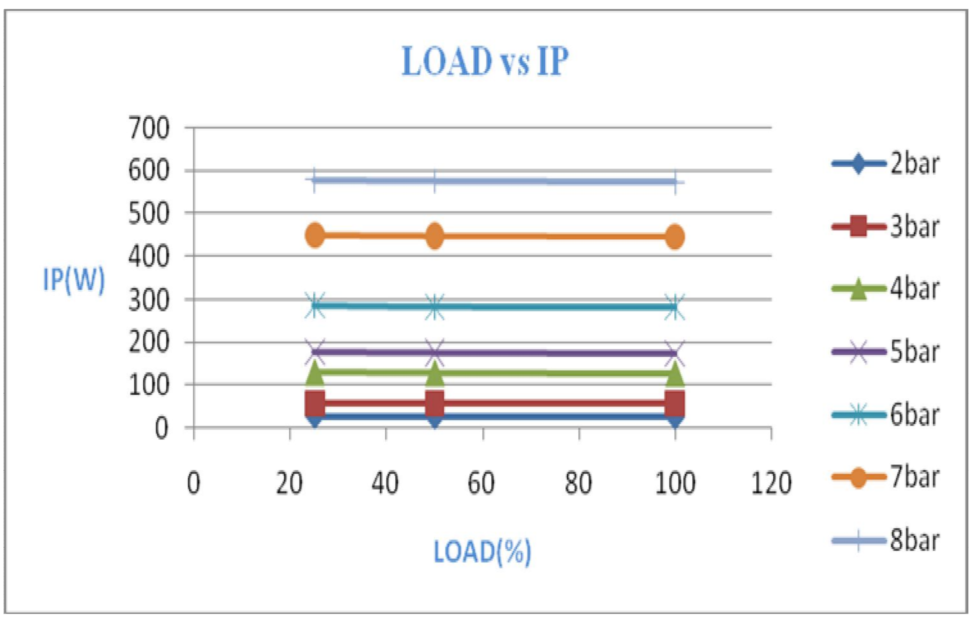
From the graph we have observed that
pressure because, If the pressure of the air increases thrust force applied on the piston is increased then B.P is increased.

B. BP vs ME



1) It is observed from the mechanical efficiency of the engine is decreasing with increasing the cylinder pressure.
2) At 2 bar cylinder pressure the mechanical efficiency is high and achieved a mechanical efficiency of 28.77%.
3) At 8 bar cylinder pressure the mechanical efficiency is low and its value is 7.2%.
4) The reason behind the decrement in mechanical efficiency by increasing the cylinder pressure is, if the cylinder pressure increases that will increase the speed of the engine and friction is increasing and reduces mechanical efficiency.

C. LOAD vs IP



1) Indicated power is the power available in inside the cylinder. From graph the 8bar cylinder pressure mode is producing more IP about 580W.
2) The IP is increasing linearly w.r.t cylinder pressure. Because if incoming air pressure is increases availability of energy inside the cylinder has been increased.

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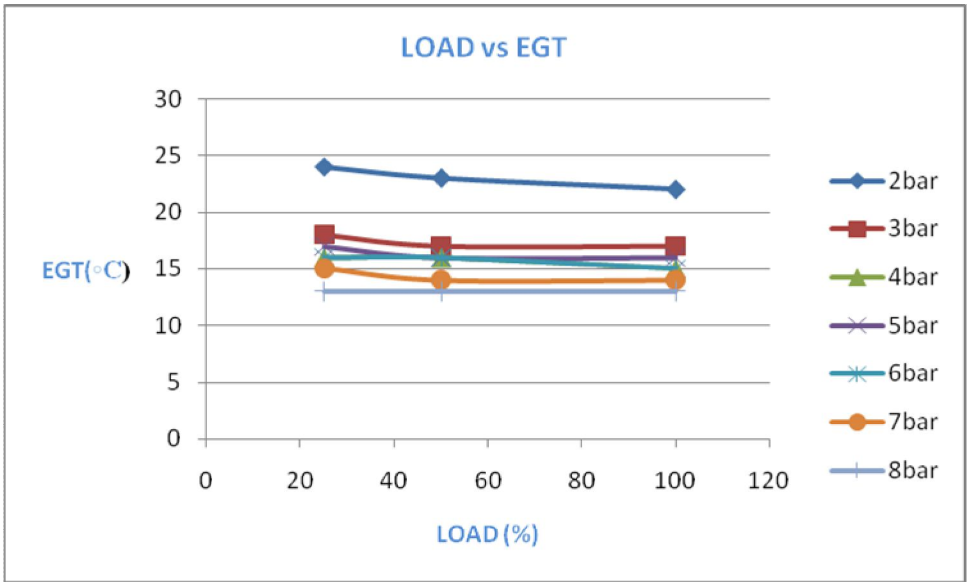
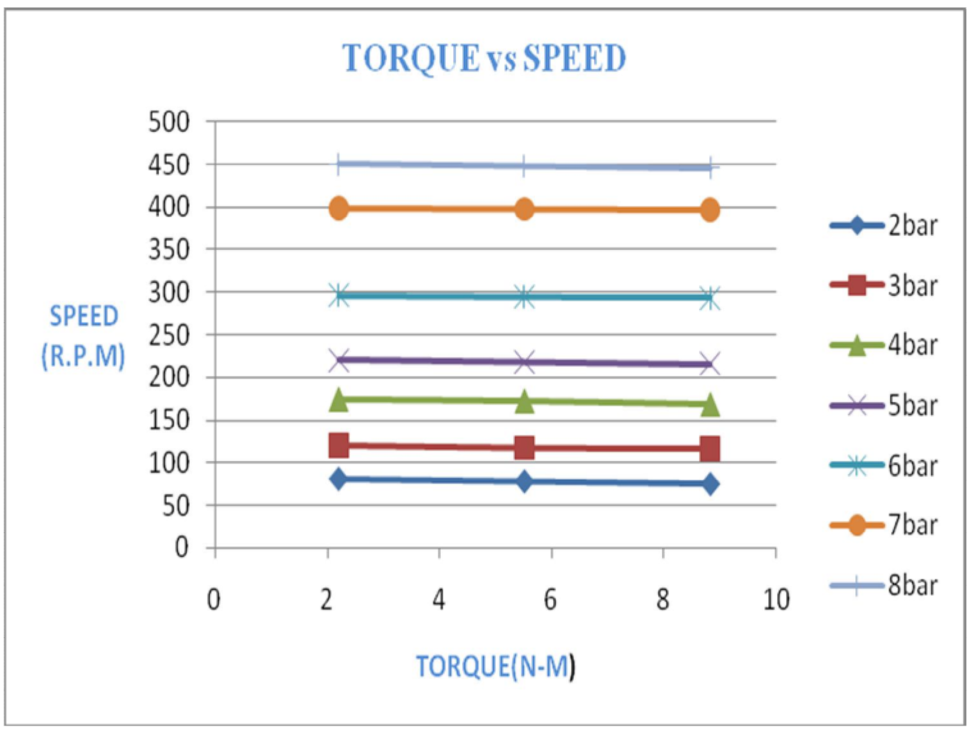
3) If load on the engine is increased IP is slightly reduced.

D. LOAD vs EGT



1) It is observed from the graph the exhaust gas temperature is reduced by increasing the cylinder pressure.
2) The 8 bar pressure mode is producing 13 ^{0}C(minimum), 2bar pressure mode is producing 24^{0}C(maximum) of exhaust gas temperature.
3) If the pressure of the incoming air is increases the expansion process is done very quickly and then it will cause sudden decrement in the temperature of exhaust air.

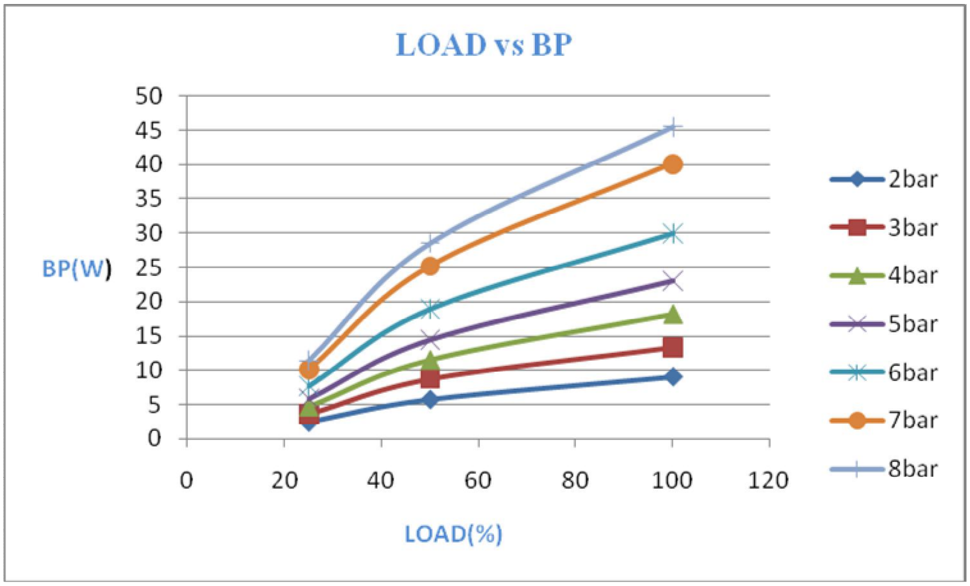
E. Torque vs speed



1) it is observed from the graph almost speed remains constant by increasing the load on the engine.
2) At all modes of operation the torque does not effecting on the speed of the engine.

3) 8bar cylinder pressure mode is producing 450 R.P.M of highest speed with a torque of 2 N-M, and 446 R.P.M with a torque of 8 N-M

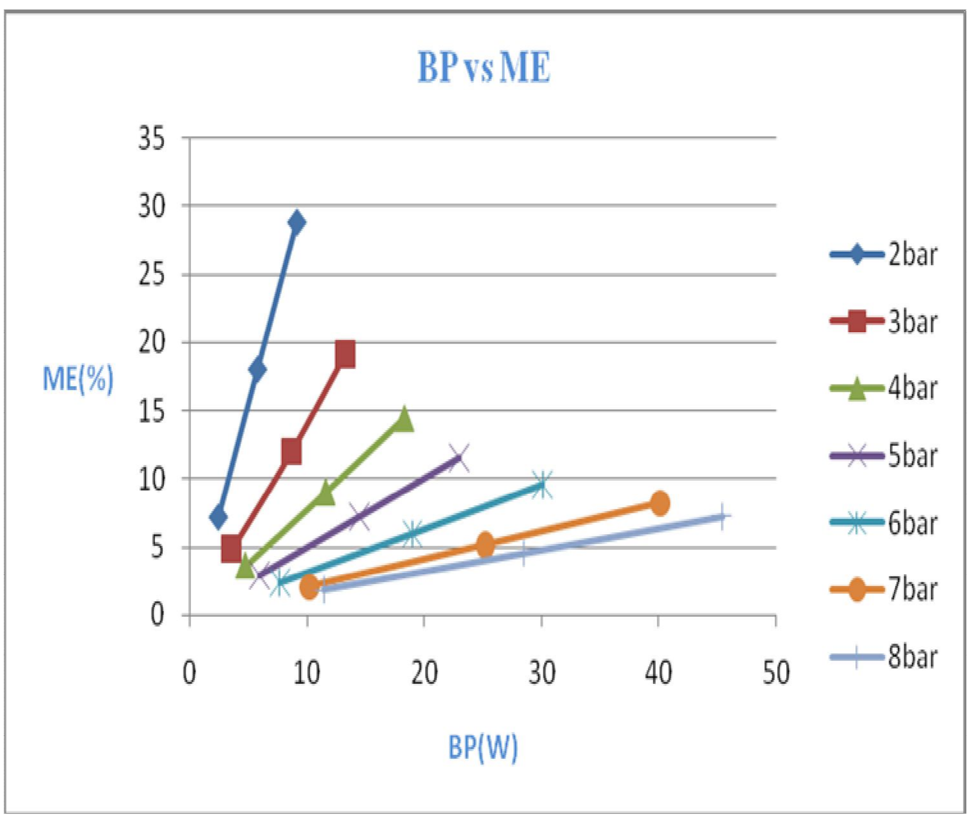
F. II GEAR: LOAD vs BP



From the graph we have observed that

1) Brake power is increasing linearly w.r.t. to load on the engine & Cylinder Pressure
2) At 8bar cylinder pressure engine is producing a highest B.P of 45.4W at 100% load.
3) At 2bar cylinder pressure engine is producing a highest B.P of 9.08W at 100% load.

G. BP vs ME



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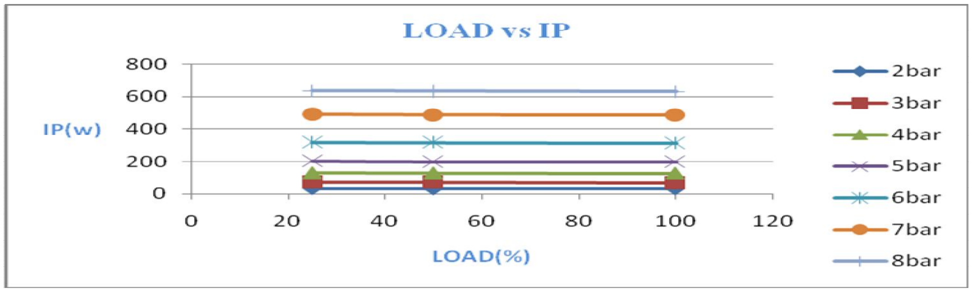
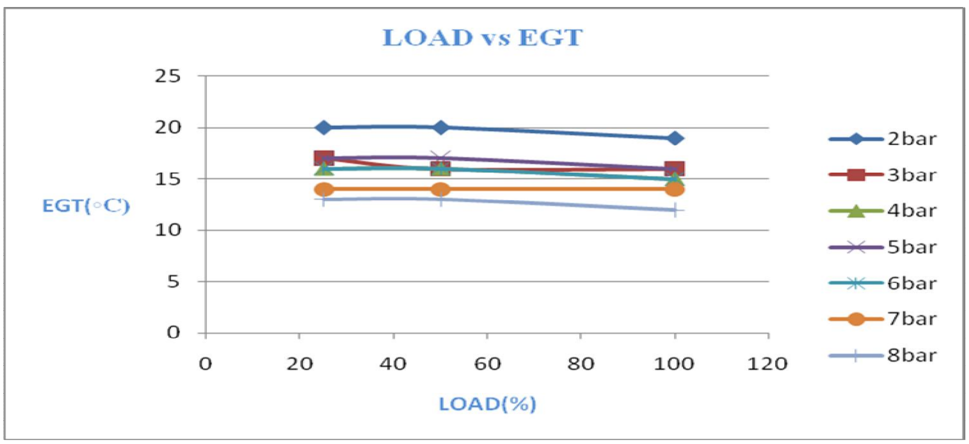
5) It is observed from the mechanical efficiency of the engine is decreasing with increasing the cylinder pressure.
6) At 2 bar cylinder pressure the mechanical efficiency is high and achieved a mechanical efficiency of 28.77%.
7) At 8 bar cylinder pressure the mechanical efficiency is low and its value is 7.2%.

H. LOAD vs IP



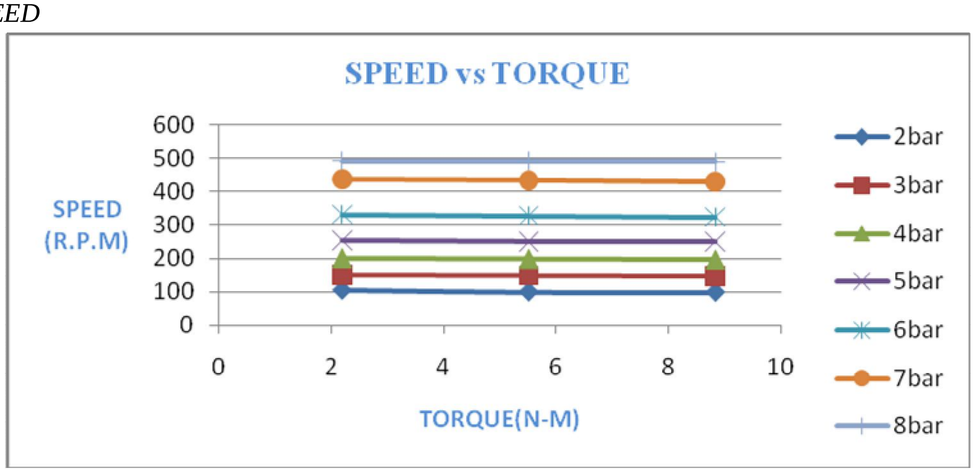
1) Indicated power is the power available in inside the cylinder. From graph the 8bar cylinder pressure mode is producing more IP about 635.08W.
2) The 2bar cylinder pressure mode is producing less IP of 31.56W.

I. LOAD vs EGT



1) It is observed from the graph the exhaust gas temperature is reduced by increasing the cylinder pressure.
2) The 8 bar pressure mode is producing 12 ^{0}C(minimum), 2bar pressure mode is producing 25^{0}C(maximum) of exhaust gas temperature.

J. TORQUE vs SPEED



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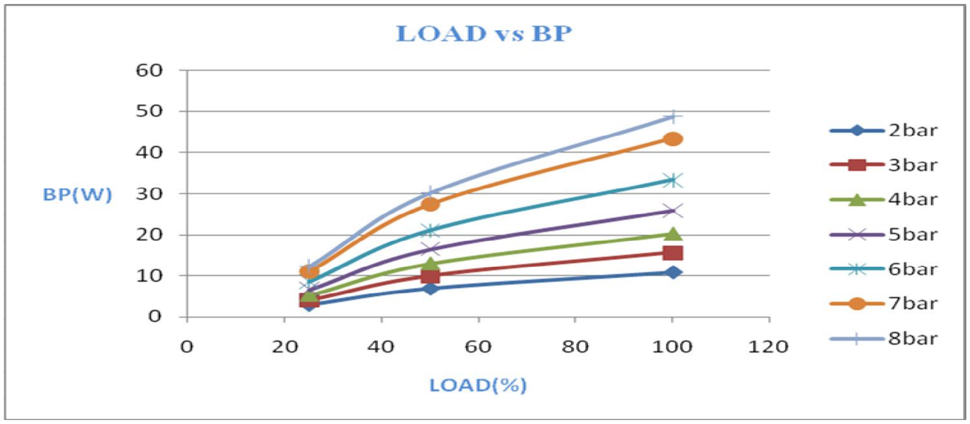
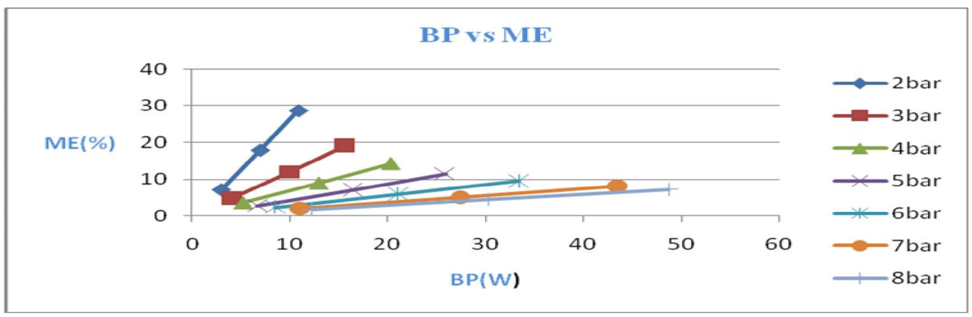
1) 8bar cylinder pressure mode is producing 493 R.P.M of highest speed with a torque of 2 N-M, and 490 R.P.M with a torque of 8.83 N-M
2) 2bar cylinder pressure mode is producing 104 R.P.M with a torque of 2 N-M, and 98 R.P.M with a torque of 8.83 N-M.

K. III GEAR: LOAD vs BP



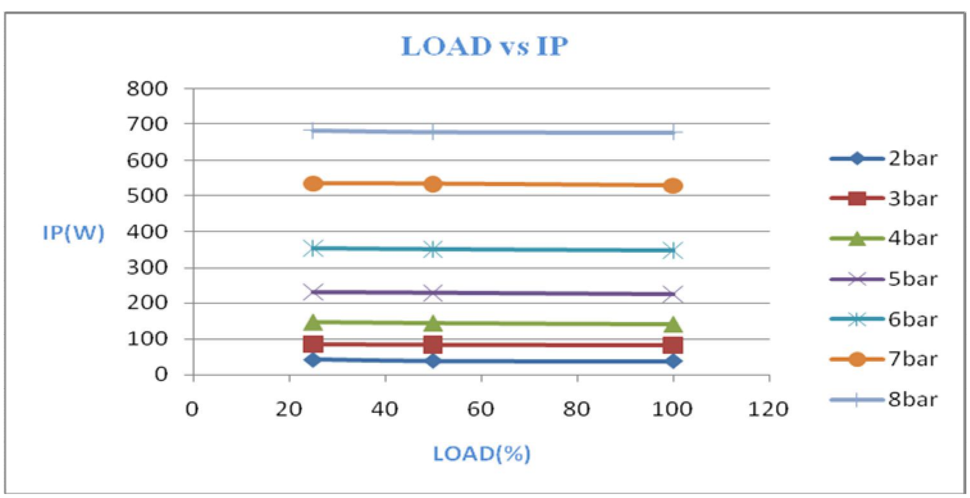
From the graph we have observed that
1) At 8bar cylinder pressure engine is producing a highest B.P of 48.74W at 100% load.
2) At 2bar cylinder pressure engine is producing a highest B.P of 10.84W at 100% load.

L. BP vs ME



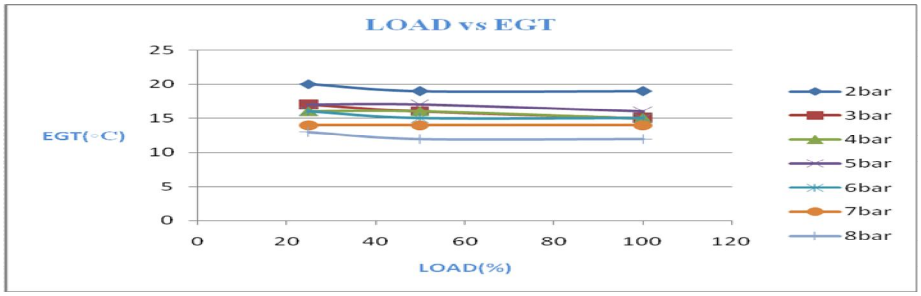
8) At 2 bar cylinder pressure the mechanical efficiency is high and achieved a mechanical efficiency of 28.77%.
9) At 8 bar cylinder pressure the mechanical efficiency is low and its value is 7.2%.

M. LOAD vs IP



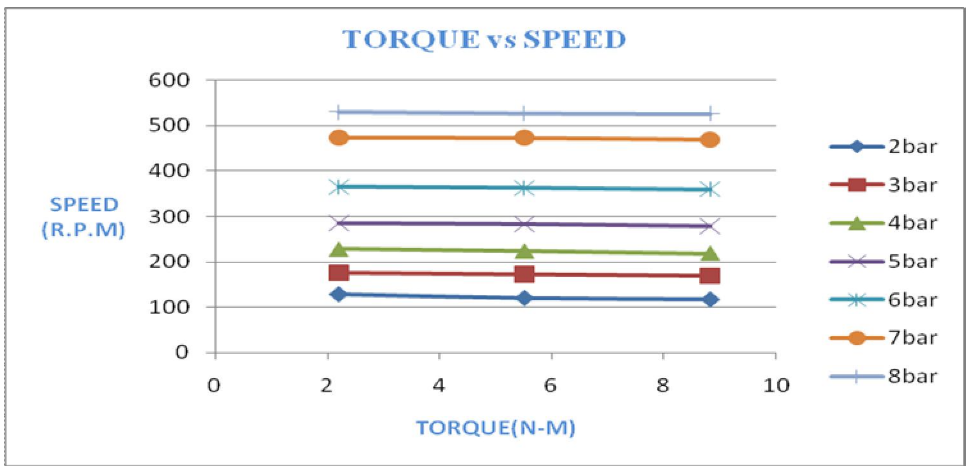
1) From graph the 8bar cylinder pressure mode is producing more IP about 681.44W.
2) The 2bar cylinder pressure mode is producing less IP of 37.68W.

N. LOAD vs EGT



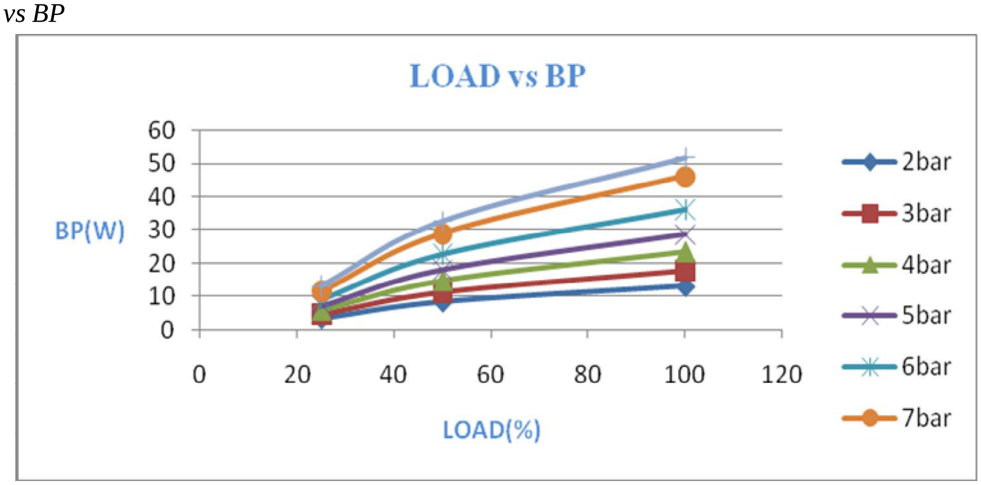
1) It is observed from the graph the exhaust gas temperature is reduced by increasing the cylinder pressure.
2) The 8 bar pressure mode is producing 12 ^{0}C(minimum), 2bar pressure mode is producing 20^{0}C(maximum) of exhaust gas temperature.

O. TORQUE vs SPEED



1) 8bar cylinder pressure mode is producing 529 R.P.M of highest speed with a torque of 2.21N-M, and 526 R.P.M with a torque of 8.83 N-M
2) 2bar cylinder pressure mode is producing 128 R.P.M with a torque of 2 N-M, and 117 R.P.M with a torque of 8.83 N-M.

P. IV GEAR: Load vs BP



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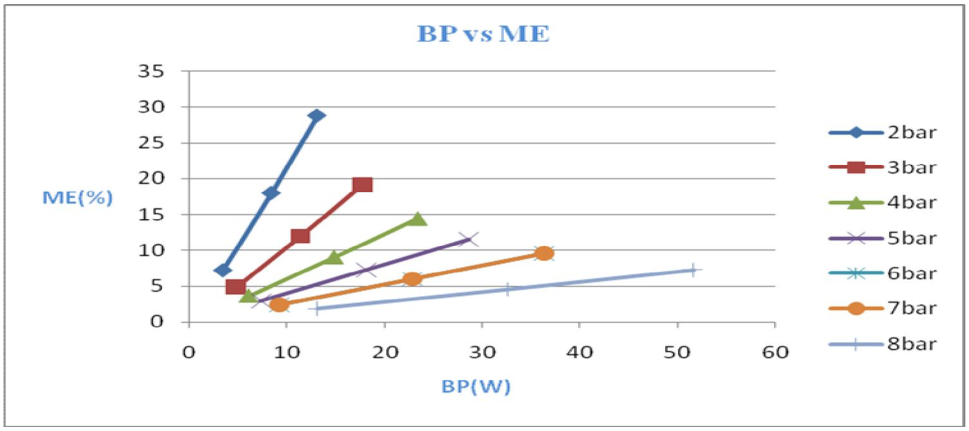
From the graph we have observed that

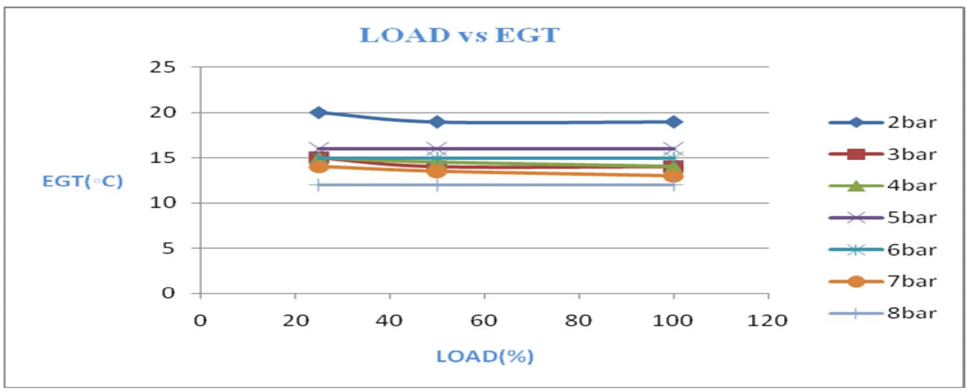
1) At 8bar cylinder pressure engine is producing a highest B.P of 51.6W at 100% load.
2) At 2bar cylinder pressure engine is producing a highest B.P of 13.06W at 100% load.

Q. LOAD vs BP



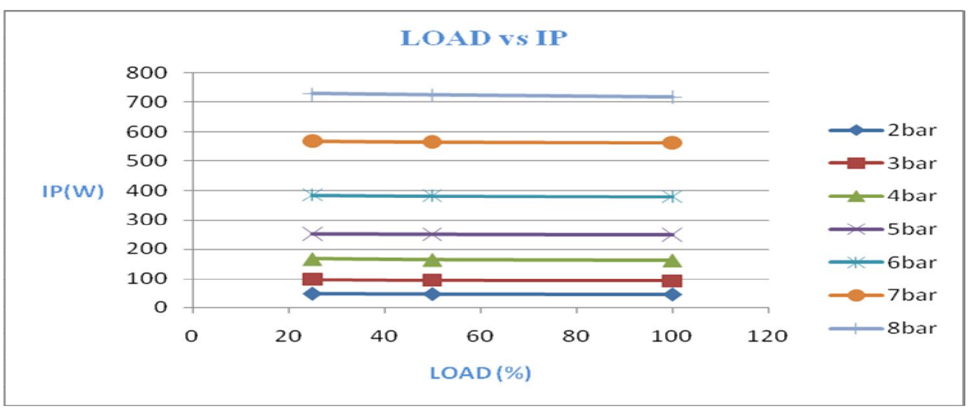
1) At 2 bar cylinder pressure the mechanical efficiency is high and achieved a mechanical efficiency of 28.77%.
2) At 8 bar cylinder pressure the mechanical efficiency is low and its value is 7.2%.

R. LOAD vs EGT



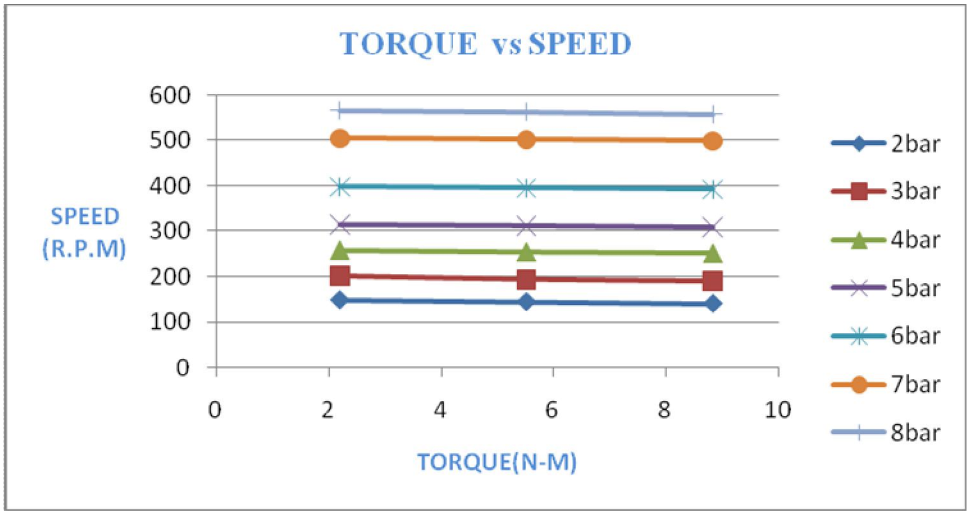
3) It is observed from the graph the exhaust gas temperature is reduced by increasing the cylinder pressure.
4) The 8 bar pressure mode is producing 12 ^{0}C(minimum), 2bar pressure mode is producing 25^{0}C(maximum) of exhaust gas temperature.

S. LOAD vs IP



1) From graph the 8bar cylinder pressure mode is producing more IP about 729.12W.
2) The 2bar cylinder pressure mode is producing less IP of 45.4W.

T. TORQUE vs SPEED



1) 8bar cylinder pressure mode is producing 566 R.P.M of highest speed with a torque of 2.21N-M, and 558 R.P.M with a torque of 8.83 N-M
2) 2bar cylinder pressure mode is producing 149 R.P.M with a torque of 2 N-M, and 141 R.P.M with a torque of 8.83 N-M.

V. CONCLUSION

A. It is observed from the total experiment the compressed air engine is applicable for the less distance mode with low load conditions.
B. The pollution from the engine is ‘0’
C. The temperature of the exhaust gases is less than the atmosphere temperature so, it does not cause for the global warming like traditional engine.
D. The efficiency of the engine is low in high pressures & high in low pressure. In high pressure modes the speed of the engine is high and friction is affecting so, effective design of the piston may reduce the friction.
E. The highest speed achieved by the engine is 566 R.P.M so it is a low speed engine.
F. Based on the results obtained by the experiment the CA Engine is sufficient prime mover for the running of a centrifugal pump. If the compressor is running on solar or wind power the CA Engine is a economic choice for the Indian farmers. If initial investment is reduced by the better design it is a good product for the farmers, industrial applications.

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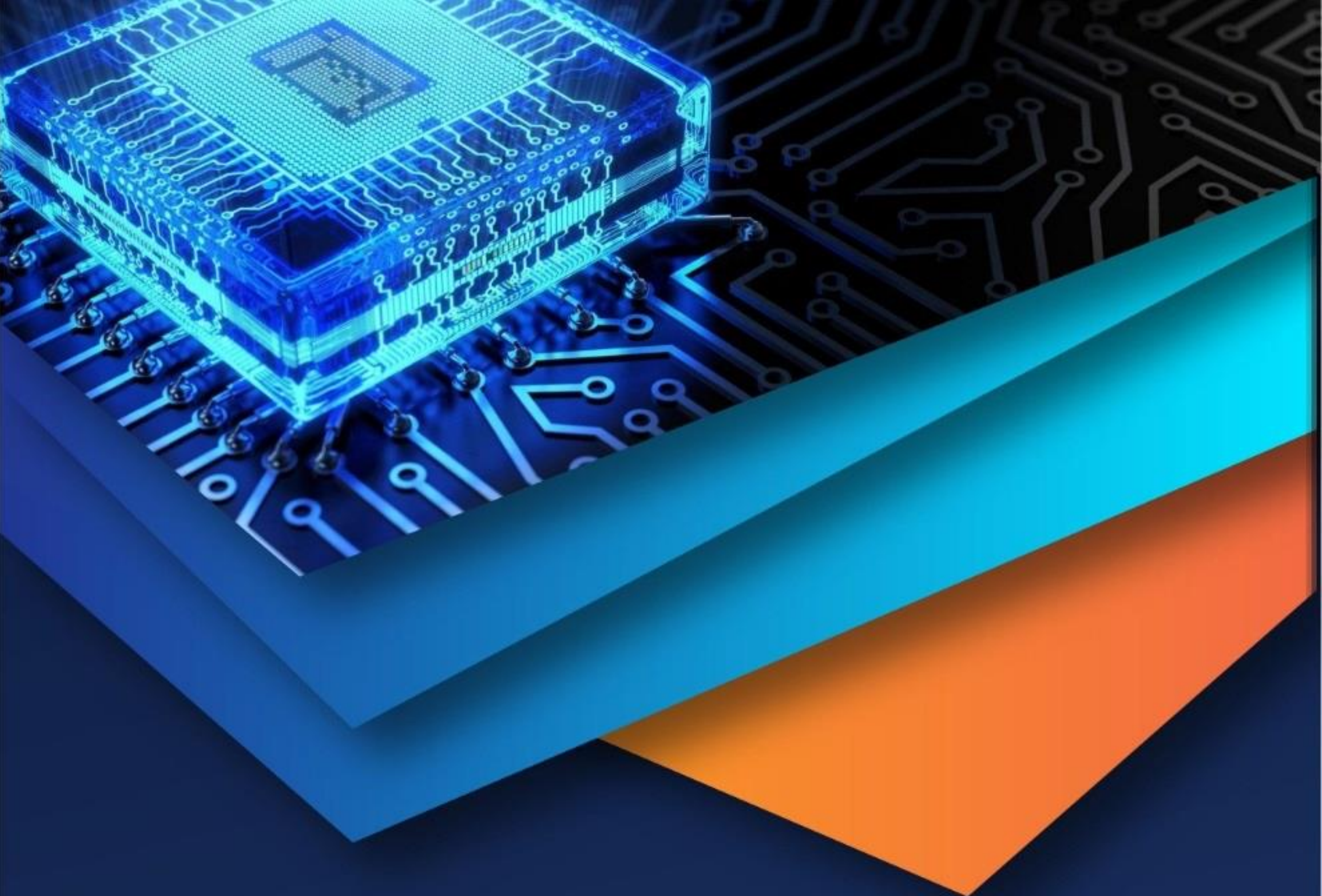

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