# CI Engine with Various Helical Threaded Performance

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***Abstract* -** Fuel economy remains the prime factor favoring the application of the diesel engines and the need to improve performance regarding power output or lower fuel consumption or preferably both, has led to research in the engine systems. This research includes design and orientation of the inlet manifold, which is a major factor effecting the performance of the engine. A four stroke compression ignition engine with power 9 H.P and rated speed 1500 rpm is selected for the present work to investigate the performance characteristics. The swirl motion of the air is an important parameter in optimizing the performance of the engine. For better turbulence it is a common practice to leave the surfaces of the inlet manifold rough and unpolished. To achieve this helical threads are arranged in the inlet manifold with variable pitches which creates swirl. The performance characteristics with normal manifold and helical threaded manifold were calculated and compared.

## I. INTRODUCTION

Thermal energy (heat) is one of the oldest forms of energy known to mankind. Thermal energy is usually evolved from energies such as chemical energy and electrical energy. The device for converting one form of energy to another is termed as engine. In an energy conversion process the conversion efficiency plays a vital role and it determines the efficient use of the supplied energy. Heat engine is the device that can transform chemical energy of a fuel into thermal energy and utilizes this thermal energy to perform useful work.

A diesel engine (also known as a compression-ignition engine) is one type of heat engine which comes under the category of internal combustion(I.C) engines uses the heat of compression to initiate ignition for burning the fuel injected into the combustion chamber during the final stage of compression. The diesel engine has the highest thermal efficiency of any regular internal or external combustion engine due to its very high compression ratio [7]. In Direct injection diesel engines fuel is injected directly onto the compressed air and gets mixed depending upon the motion of the air in the chamber. Air is directed into the cylinder through the inlet manifold and this air flow is one of the important factors controlling the combustion process. It governs the fuel-air mixing and burning rates in diesel engines. Air enters the combustion chamber of an I.C engine through the intake manifold with high velocity. Then the kinetic energy of the fluid results in turbulence and causes rapid mixing of fuel and air, if the fuel is injected directly into the cylinder [9]. The increased turbulence causes better cooling of the cylinder surfaces thereby reducing the heat loss to the surroundings. The heat from the cylinder walls gets absorbed by the air supplied during suction and used for reducing the delay period thereby increasing the thermal efficiency of the engine.

Here, in this work we have implemented the helical threaded manifolds by varying pitch for generating the swirl while entering the cylinder. The turbulence was created in the inlet manifold by threading the inlet manifold of size 4mm width and 3mm depth with different pitches to direct the air flow.

The tests are carried with different configurations by varying the pitch of the helical threads from 10mm to 25 mm in steps of 5mm inside the intake manifold. The measurements were done at constant speed of 1500 rpm. The results are compared among normal manifold and helically threaded manifold.

## II. PRESENT WORK

In an engine, there are many restrictions to get air into the cylinder: Air filter, tubing with bends, throttle body, Intake manifold, cylinder heads, valves, etc. The speed of the air is related to the pressure differential between the cylinder and the intake manifold. Piston speed have an impact on the speed of the air and the density simply vary based upon the amount of time

## III. RESULTS

The results obtained after conducting the experiments on the 9 H.P vertical cylinder air cooled engine showed better performance with 10mm helical threaded manifold than the remaining helical threaded manifolds(pitches 15mm, 20mm, 25mm) and normal manifold. And the experimental results were tabulated for normal manifold and 10mm helical threaded manifold:

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TABLE3. EXPERIMENTAL RESULTS WITH NORMAL MANIFOLD

| S.No | Item | Units | Load (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | 20 | 40 | 60 | 80 | 100 |
| 1 | Total fuel consumption | kg/h | 0.76 | 1.06 | 1.29 | 1.54 | 2.03 | 2.70 |
| 2 | Brake power | kW | 0.00 | 1.47 | 2.41 | 3.13 | 3.78 | 4.08 |
| 3 | Brake specific fuel consumption | kg/kW h | 0.00 | 0.72 | 0.54 | 0.49 | 0.54 | 0.66 |
| 4 | Frictional power | kW | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| 5 | Indicated power | kW | 3.00 | 4.47 | 5.41 | 6.13 | 6.78 | 7.08 |
| 6 | Mechanical efficiency | % | 0.00 | 32.94 | 44.54 | 51.05 | 55.75 | 57.64 |
| 7 | Heat input | kW | 8.90 | 12.38 | 15.06 | 18.00 | 23.63 | 31.55 |
| 8 | Brake Thermal efficiency | % | 0.00 | 11.91 | 15.99 | 17.39 | 16.00 | 12.94 |
| 9 | Indicated Thermal efficiency | % | 33.70 | 36.14 | 35.91 | 34.05 | 28.69 | 22.45 |
| 10 | Volumetric efficiency | % | 27.44 | 28.64 | 31.02 | 34.60 | 36.99 | 39.32 |
| 11 | Brake mean effective pressure | $kN/m^2$ | 0.00 | 124.40 | 203.34 | 264.11 | 319.03 | 344.49 |
| 12 | Indicated mean effective pressure | $kN/m^2$ | 253.20 | 377.60 | 456.54 | 517.31 | 572.23 | 597.69 |
| 13 | Exhaust gas temp | $^0C$ | 118.00 | 165.00 | 216.00 | 280.00 | 330.00 | 351.00 |

TABLE4. EXPERIMENTAL RESULTS WITH HELICAL THREADED MANIFOLD OF PITCH 10MM

| S.No | Item | Units | Load (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | 20 | 40 | 60 | 80 | 100 |
| 1 | Total fuel consumption | kg/h | 0.77 | 1.05 | 1.29 | 1.53 | 1.97 | 3.08 |
| 2 | Brake power | kW | 0.00 | 1.45 | 2.36 | 3.33 | 3.87 | 3.67 |
| 3 | Brake specific fuel consumption | kg/kW h | 0 | 0.72 | 0.55 | 0.46 | 0.51 | 0.84 |
| 4 | Frictional power | kW | 3.20 | 3.20 | 3.20 | 3.20 | 3.20 | 3.20 |
| 5 | Indicated power | kW | 3.20 | 4.65 | 5.56 | 6.53 | 7.07 | 6.87 |
| 6 | Mechanical efficiency | % | 0.00 | 31.12 | 42.46 | 51.00 | 54.74 | 53.42 |
| 7 | Heat input | kW | 8.94 | 12.20 | 15.09 | 17.91 | 23.02 | 35.99 |
| 8 | Brake Thermal efficiency | % | 0.00 | 11.85 | 15.64 | 18.60 | 16.82 | 10.20 |
| 9 | Indicated Thermal efficiency | % | 35.79 | 38.08 | 36.85 | 36.47 | 30.75 | 19.09 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | Volumetric efficiency | % | 25.06 | 27.44 | 29.83 | 31.02 | 32.81 | 33.41 |
| 11 | Brake mean effective pressure | $kN/m^2$ | 0.00 | 122.01 | 199.28 | 281.09 | 326.63 | 309.80 |
| 12 | Indicated mean effective pressure | $kN/m^2$ | 270.08 | 392.09 | 469.36 | 551.17 | 596.71 | 579.88 |
| 13 | Exhaust gas temp | $^0C$ | 135.00 | 205.00 | 245.00 | 300.00 | 324.00 | 345.00 |

TABLE5. EXHAUST EMISSIONS WITH NORMAL MANIFOLD

| S.No | Item | Units | Load (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | 20 | 40 | 60 | 80 | 100 |
| 1 | Hydro carbons | Parts per million | 25 | 26 | 29 | 30 | 32 | 33 |
| 2 | Carbon monoxide | % volume | 0.03 | 0.05 | 0.13 | 0.26 | 0.37 | 0.42 |
| 3 | Carbon dioxide | % volume | 0.8 | 0.9 | 1 | 1.3 | 1.4 | 1.5 |
| 4 | Oxygen | % volume | 19.45 | 19.28 | 19.02 | 18.55 | 18 | 17.4 |

TABLE6. EXHAUST EMISSIONS WITH HELICAL THREADED MANIFOLD OF PITCH 10MM

| S.No | Item | Units | Load (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 0 | 20 | 40 | 60 | 80 | 100 |
| 1 | Hydro carbons | Parts per million | 1 | 12 | 15 | 13 | 28 | 120 |
| 2 | Carbon monoxide | % volume | 0.02 | 0.07 | 0.08 | 0.16 | 0.3 | 0.62 |
| 3 | Carbon dioxide | % volume | 0.6 | 0.8 | 1.0 | 1.1 | 0.9 | 0.6 |
| 4 | Oxygen | % volume | 19.82 | 19.76 | 19.45 | 19.51 | 19.03 | 19.11 |

## GRAPHS

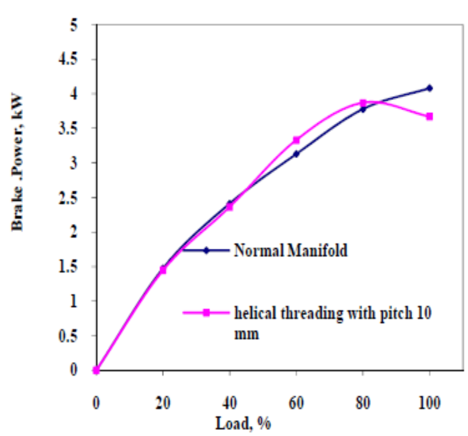



Figure3. Load versus Brake Power

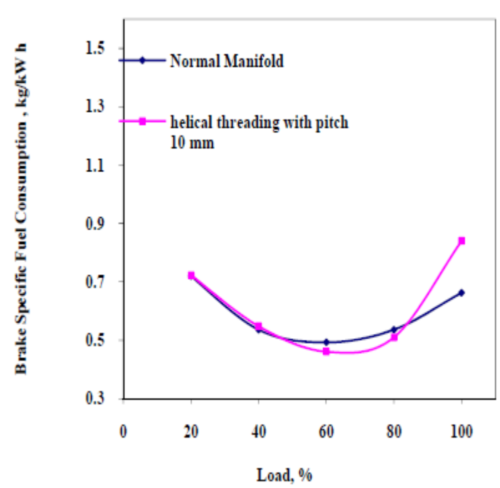



Figure4. Load versus Brake Specific Fuel consumption

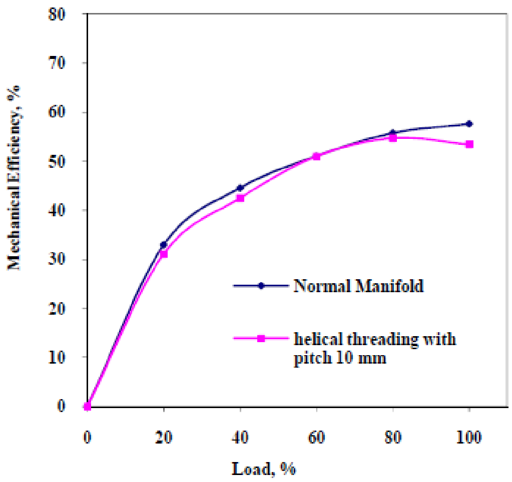
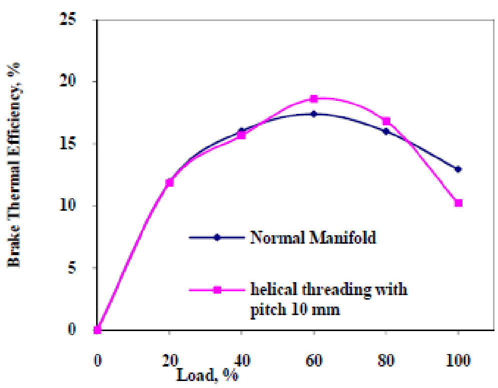
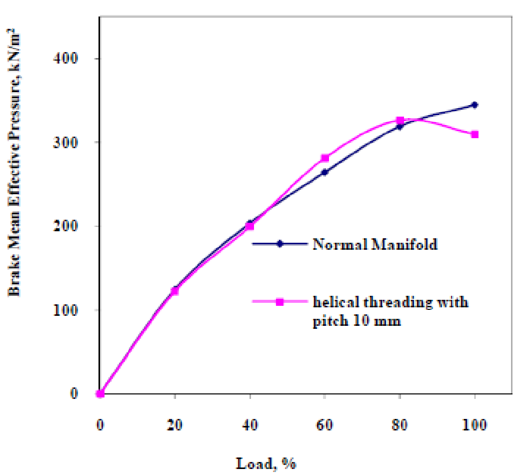



Figure5. Load versus Mechanical efficiency




igure6. Load versus Brake Thermal efficiency




ure7. Load versus Brake mean effective pressure

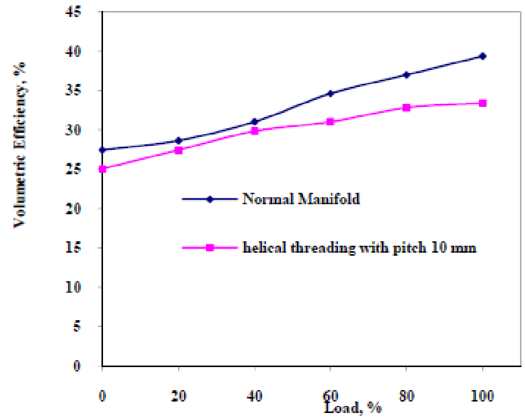



Figure8. Load versus Volumetric efficiency

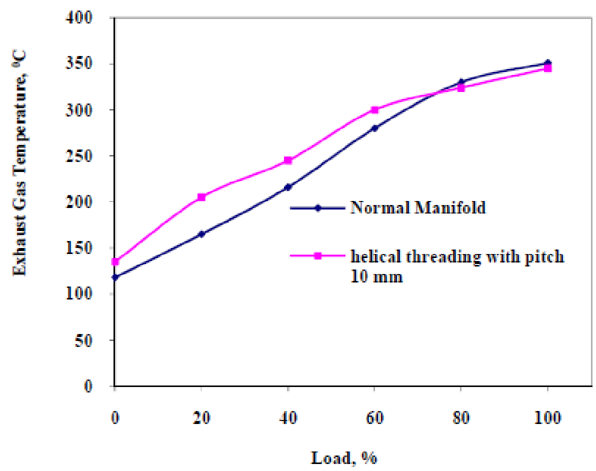



Figure9. Load versus Exhaust Gas Temperature

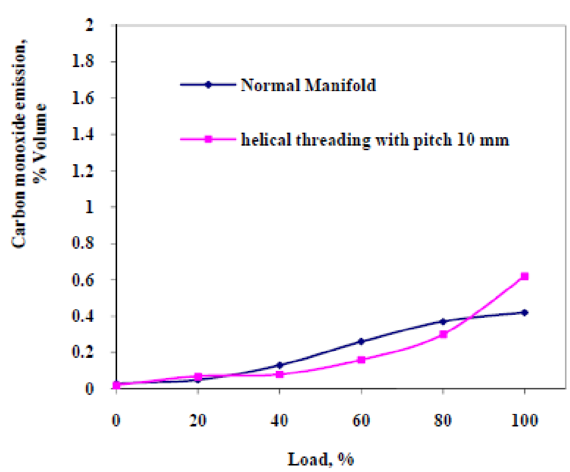



Figure10. Load versus carbon monoxide emission

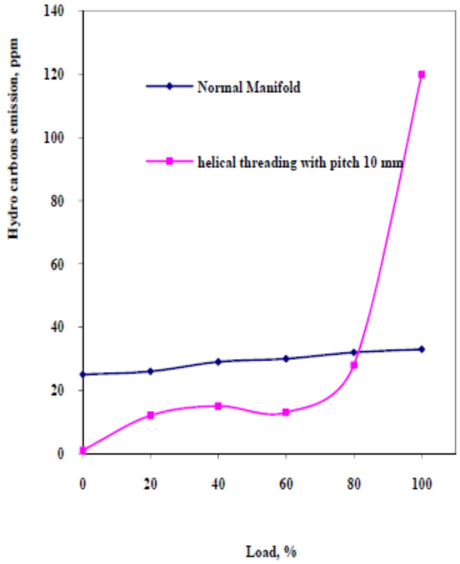



Figure11. Load versus Hydrocarbon emission

## CONCLUSION

The Performance characteristics of an engine with normal manifold and helical threaded manifolds were compared in the present work. Helical threaded manifold with pitch varying from 10mm to 25mm in steps of 5mm were used to evaluate the performance characteristics and among them it is found that10mm pitch manifold showed better performance. The performance parameters are presented below at $4/5^{th}$ of rated load (80%).

1. Brake power is increased by 2.38%.
2. Total fuel consumption is reduced by 2.91%
3. Specific fuel consumption is reduced by 5.55%
4. Indicated power is increased by 4.27%
5. Mechanical efficiency is reduced by 1.81%
6. Heat input is reduced by 2.58%
7. Brake thermal efficiency is increased by 5.13%
8. Indicated thermal efficiency is increased by 7.18%
9. Volumetric efficiency is reduced by 11.3%
10. Brake mean effective pressure is increased by 2.38%
11. Indicated mean effective pressure is increased by 4.28%
12. Exhaust gas temperature is reduced by 1.81%
13. Hydrocarbon emission is reduced by 12.5%
14. Carbon monoxide emission is reduced by 0.3%

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