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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 air cooled compression ignition engine with power 9 H.P and rated speed 1500 rpm was selected to investigate the performance characteristics. The swirl motion of the air is an important parameter in optimizing the performance of an engine. For better turbulence the surface of the inlet manifolds (C.I Engine) will be made rough and unpolished. Here, for obtaining better turbulence the helical threads were arranged in the inlet manifolds. The performance test was performed on the engine with the normal manifold and helical threaded manifolds of pitch 10mm, 15mm, 20mm, and 25mm. The performance characteristics with normal manifold and helical threaded manifolds were calculated and compared.

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 [4]. 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 [1]. 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.

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 available to fill the cylinder (RPM), restrictions, density of incoming air [4].

The time taken to fill the chamber would indeed depend on the inlet dimensions. There is enough time in each inlet stroke to allow the cylinder charge and atmosphere to gain a state of equilibrium, setting aside inlet rarefactions due to inlet obstacles, or compressions due to any turbo charging. Opening the valve for 1 nanosecond might let some air in, but (depending on the opening, and a couple of other things), the vacuum would be decreased. The amount by which the vacuum decreases will depend on the air quantity got back into the chamber. Although leaving the inlet valve open longer, having denser air or larger ports will allow more air into the cylinder [4].

The larger the opening of the valve lower will be the impedance (resistance) against airflow allowing more air entering the chamber.

In this present work the intake manifold of the CI Engine was modified and the helical threaded manifolds with different pitches were used. The performance characteristics and the emissions levels were verified with the helical threaded manifolds.

The manifolds were casted with appropriate dimensions. The threading is started at the inlet of the intake manifold parallel to the central axis of the manifold. This is made to guide the airflow along the threaded path which facilitates for generating swirl along the central axis of the manifold.

The width or thickness of the thread is about 4mm and the depth of the thread is about 3mm. The core diameter of the manifold is about 30mm. By considering the thread, the outer diameter is 30mm and inner diameter is about 24mm.

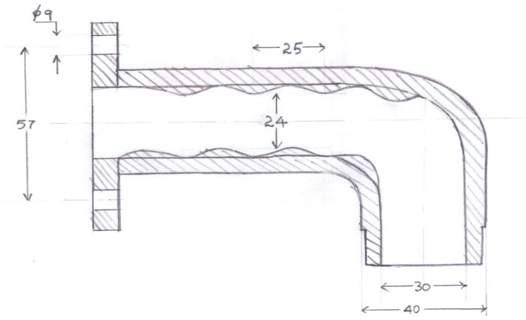

Fig.1 Threaded manifold

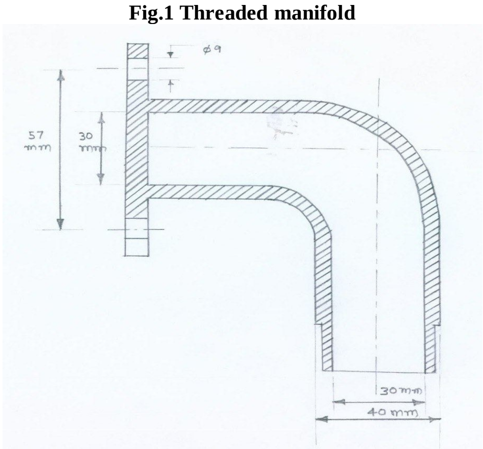

Fig.2 Normal manifold

Fig.3 Experimental Engine

OBSERVATIONS

TABLE.1 Observations with Normal Manifold

Load (Watts)	Speed (revolutions Per minute)	Time taken for 20cc of fuel consumption (Seconds)	Voltage (volts)	Current (amperes)	Air Flow (m/sec)
0	1500	80.21	270	0	4.6
1000	1500	57.68	260	5.0	4.8
2000	1500	47.4	250	8.5	5.2
3000	1500	39.67	230	12.0	5.8
4000	1500	30.21	215	15.5	6.2
5000	1500	22.63	200	18.0	6.6

TABLE.2 Observations with 10mm pitch Helical Threaded Manifold

Load (Watts)	Speed (revolutions Per minute)	Time taken for 20cc of fuel consumption (Seconds)	Voltage (volts)	Current (amperes)	Air Flow (m/sec)
0	1500	79.85	280	0	4.2
1000	1500	58.53	255	5.0	4.6
2000	1500	47.31	245	8.5	5.0
3000	1500	39.87	235	12.5	5.2
4000	1500	30.99	220	15.5	5.5
5000	1500	19.84	185	17.5	5.6

TABLE.3 Observations with 15mm pitch Helical Threaded Manifold

Load (Watts)	Speed (revolutions Per minute)	Time taken for 20cc of fuel consumption (Seconds)	Voltage (volts)	Current (amperes)	Air Flow (m/sec)
0	1500	70.1	275	0	4.2
1000	1500	50.18	260	5	4.5
2000	1500	41.73	250	8.5	4.7
3000	1500	29.81	230	12	5.0
4000	1500	17.94	210	15	5.2
5000	1500	12.4	170	17	5.4

TABLE.4 Observations with 20mm pitch Helical Threaded Manifold

Load (Watts)	Speed (revolutions Per minute)	Time taken for 20cc of fuel consumption (Seconds)	Voltage (volts)	Current (amperes)	Air Flow (m/sec)
0	1500	80.22	275	0	4.0

1000	1500	59.41	260	5	4.5
2000	1500	47.05	250	8.5	5.1
3000	1500	38.49	235	12	5.5
4000	1500	23.41	210	15	5.8
5000	1500	18.31	175	17	6.2

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(with pitch 15mm, 20mm, 25mm) and normal manifold at 80% of full load. And the experimental results were tabulated for normal manifold and helical threaded manifolds:

TABLE.5 Observations with25mm pitch Helical Threaded Manifold

Load (Watts)	Speed (revolutions Per minute)	Time taken for 20cc of fuel consumption (Seconds)	Voltage (volts)	Current (amperes)	Air Flow (m/sec)
0	1500	75.13	280	0	4.2
1000	1500	54.27	260	5	4.8
2000	1500	41.64	250	8.5	5.2
3000	1500	30.94	230	12	5.4
4000	1500	19.36	210	15	5.6
5000	1500	12.04	170	17	6.0

TABLE.6 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/kWh**	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

\TABLE.7 EXPERIMENTAL RESULTS WITH 10MM PITCH HELICAL THREADED MANIFOLD

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/kWh**	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**	**^{0}C**	135.00	205.00	245.00	300.00	324.00	345.00

\TABLE.8 EXPERIMENTAL RESULTS WITH 15MM PITCH HELICAL THREADED MANIFOLD

S.No	Item	Units	Load (%)					
			0	**20**	**40**	**60**	**80**	**100**
1	**Total fuel consumption**	**kg/h**	0.87	1.22	1.47	2.05	3.41	4.94
2	**Brake power**	**kW**	0.00	1.47	2.41	3.13	3.57	3.28
3	**Brake specific fuel consumption**	**kg/kW h**	0	0.83	0.61	0.66	0.96	1.51
4	**Frictional power**	**kW**	3.15	3.15	3.15	3.15	3.15	3.15
5	**Indicated power**	**kW**	3.15	4.62	5.56	6.28	6.72	6.43
6	**Mechanical efficiency**	**%**	0.00	31.88	43.34	49.83	53.13	50.99
7	**Heat input**	**kW**	10.19	14.23	17.11	23.95	39.82	57.58
8	**Brake Thermal efficiency**	**%**	0.00	10.36	14.08	13.06	8.97	5.69
9	**Indicated Thermal efficiency**	**%**	30.93	32.50	32.49	26.22	16.88	11.16
10	**Volumetric efficiency**	**%**	25.06	26.85	28.04	29.83	39.02	32.22
11	**Brake mean effective pressure**	**kN/m^2**	0.00	124.40	203.34	264.11	301.31	276.55
12	**Indicated mean effective pressure**	**kN/m^2**	265.86	390.26	469.20	529.97	567.17	542.41
13	**Exhaust gas temp**	**^{0}C**	125.00	175.00	237.00	302.00	345.00	346.00

TABLE.9 EXPERIMENTAL RESULTS WITH 20MM PITCH HELICAL THREADED MANIFOLD

S.No	Item	Units	Load (%)					
			0	**20**	**40**	**60**	**80**	**100**
1	**Total fuel consumption**	**kg/h**	0.76	1.03	1.30	1.59	2.61	3.34
2	**Brake power**	**kW**	0.00	1.47	2.41	3.20	3.57	3.37
3	**Brake specific fuel consumption**	**kg/kW h**	0	0.70	0.54	0.50	0.73	0.99
4	**Frictional power**	**kW**	3.10	3.10	3.10	3.10	3.10	3.10

5	**Indicated power**	**kW**	3.10	4.57	5.51	6.30	6.67	6.47
6	**Mechanical efficiency**	**%**	0.00	32.22	43.73	50.77	53.52	52.11
7	**Heat input**	**kW**	8.90	12.02	15.18	18.55	30.49	39.00
8	**Brake Thermal efficiency**	**%**	0.00	12.26	15.88	17.24	11.71	8.65
9	**Indicated Thermal efficiency**	**%**	34.83	38.06	36.30	33.95	21.88	16.60
10	**Volumetric efficiency**	**%**	23.86	26.85	30.43	32.81	34.60	36.99
11	**Brake mean effective pressure**	**kN/m^2**	0.00	124.40	203.34	269.85	301.31	284.68
12	**Indicated mean effective pressure**	**kN/m^2**	261.64	386.04	464.98	531.49	562.95	546.32
13	**Exhaust gas temp**	**^{0}C**	122.00	179.00	238.00	293.00	359.00	356.00

\TABLE.10 EXPERIMENTAL RESULTS WITH 25MM PITCH HELICAL THREADED MANIFOLD

S.No	Item	Units	Load (%)					
			0	**20**	**40**	**60**	**80**	**100**
1	**Total fuel consumption**	**kg/h**	0.81	1.13	1.47	1.98	3.16	5.08
2	**Brake power**	**kW**	0.00	1.47	2.41	3.13	3.57	3.28
3	**Brake specific fuel consumption**	**kg/kW h**	0.00	0.77	0.61	0.63	0.89	1.55
4	**Frictional power**	**kW**	2.75	2.75	2.75	2.75	2.75	2.75
5	**Indicated power**	**kW**	2.75	4.22	5.16	5.88	6.32	6.03
6	**Mechanical efficiency**	**%**	0.00	34.89	46.70	53.23	56.50	54.37
7	**Heat input**	**kW**	9.50	13.16	17.15	23.08	36.88	59.30
8	**Brake Thermal efficiency**	**%**	0.00	11.20	14.05	13.56	9.68	5.53
9	**Indicated Thermal efficiency**	**%**	28.94	32.11	30.09	25.48	17.14	10.16
10	**Volumetric efficiency**	**%**	25.06	28.64	31.02	32.22	33.41	35.80
11	**Brake mean effective pressure**	**kN/m^2**	0.00	124.40	203.34	264.11	301.31	276.55
12	**Indicated mean effective pressure**	**kN/m^2**	232.10	356.50	435.44	496.21	533.41	508.65
13	**Exhaust gas temp**	**^{0}C**	104.00	178.00	255.00	295.00	337.00	342.00

TABLE.**11** 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

TABLE.12 EXHAUST EMISSIONS WITH10MM PITCH HELICAL THREADED MANIFOLD

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	0.7	0.8	1.0	1.1	1.3	1.2
4	Oxygen	% volume	19.52	19.24	19.07	18.43	17.79	17.6

TABLE.13 EXHAUST EMISSIONS WITH15MM PITCH HELICAL THREADED MANIFOLD

S.No	Item	Units	Load (%)					
			0	20	40	60	80	100
1	Hydro carbons	Parts per million	2	2	2	16	76	239
2	Carbon monoxide	% volume	0.03	0.05	0.1	0.32	0.63	0.88
3	Carbon dioxide	% volume	0.8	0.9	1.0	1.1	0.9	0.7
4	Oxygen	% volume	19.44	19.32	19.07	18.57	18.81	18.61

TABLE.14 EXHAUST EMISSIONS WITH20MM PITCH HELICAL THREADED MANIFOLD

S.No	Item	Units	Load (%)					
			0	20	40	60	80	100
1	Hydro carbons	Parts per million	1	7	12	11	45	181
2	Carbon monoxide	% volume	0.02	0.05	0.13	0.25	0.46	0.71
3	Carbon dioxide	% volume	0.8	1.0	1.1	1.0	0.8	0.6
4	Oxygen	% volume	19.48	19.41	19.24	18.87	19.09	19.03

TABLE.15 EXHAUST EMISSIONS WITH25MM PITCH HELICAL THREADED MANIFOLD

S.No	Item	Units	Load (%)					
			0	20	40	60	80	100
1	Hydro carbons	Parts per million	0	0	0	8	43	261
2	Carbon monoxide	% volume	0.02	0.03	0.06	0.28	0.51	0.84
3	Carbon dioxide	% volume	0.7	0.8	0.9	1.0	0.9	0.6
4	Oxygen	% volume	19.67	19.70	19.40	18.73	18.79	18.86

GRAPHS

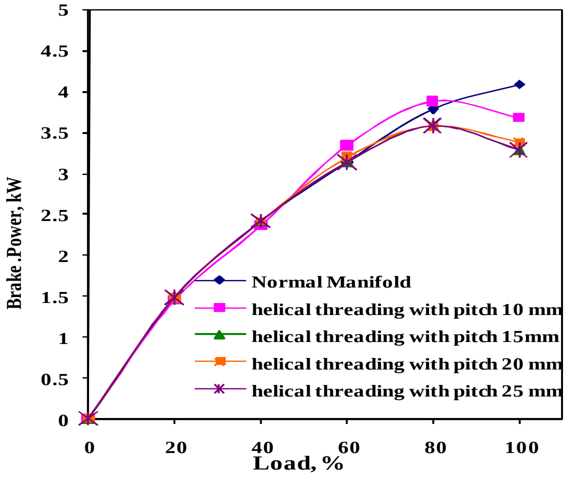

Figure.4 Load versus Brake Power

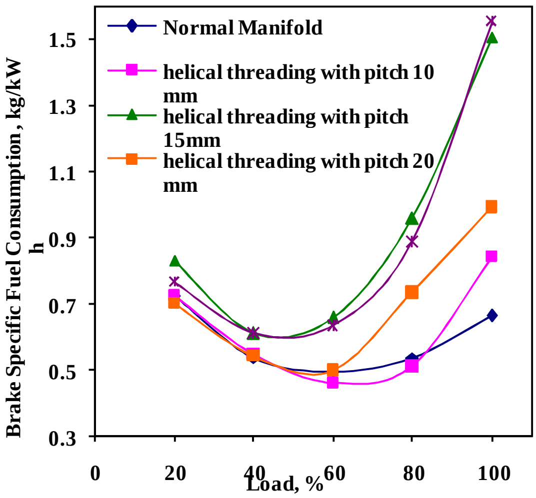

Figure.5 Load versus Brake Specific Fuel consumption

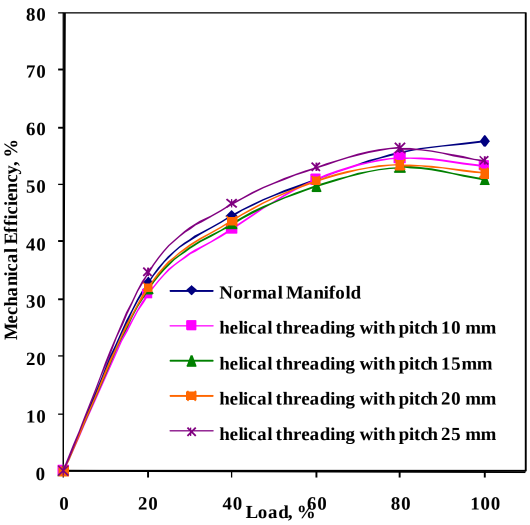

Figure.6 Load versus Mechanical efficiency

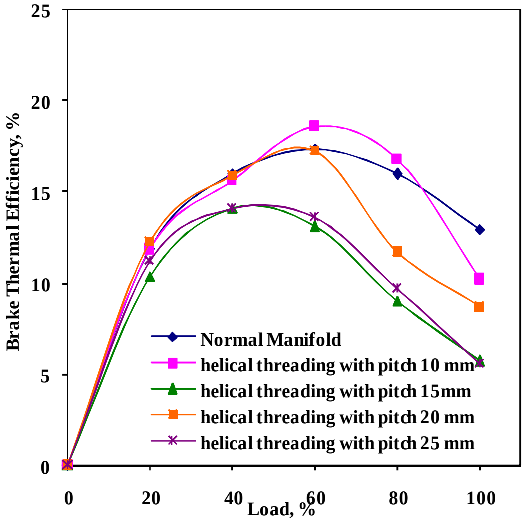

Figure.7 Load versus Brake Thermal efficiency

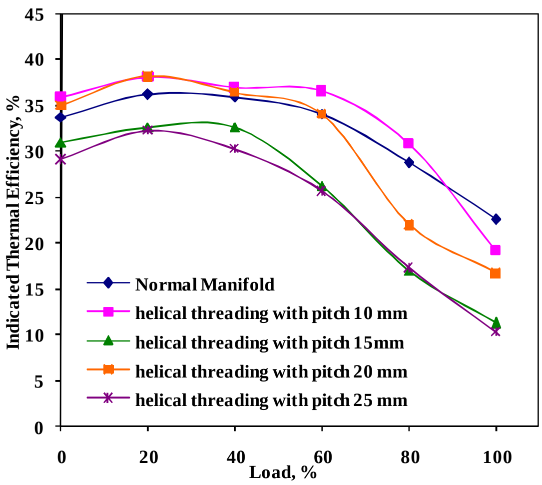

Figure.8 Load versus Indicated Thermal efficiency

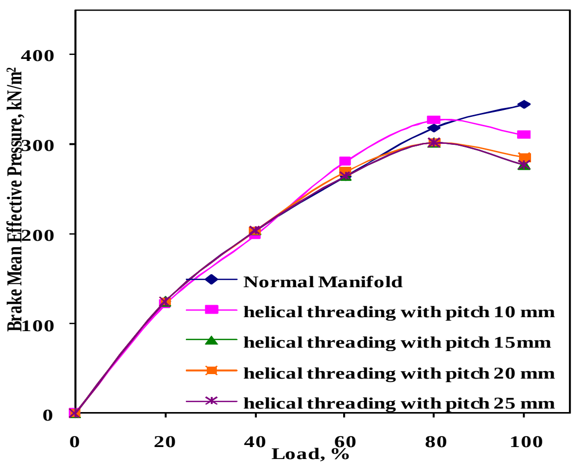

Figure.9 Load versus Brake mean effective pressure

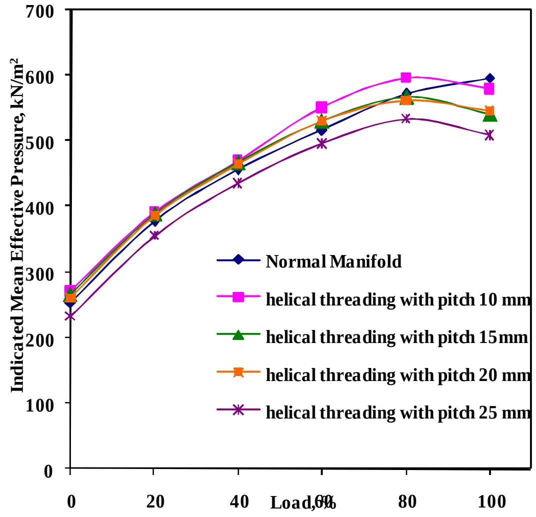

Figure.10 Load versus Indicated mean effective pressure

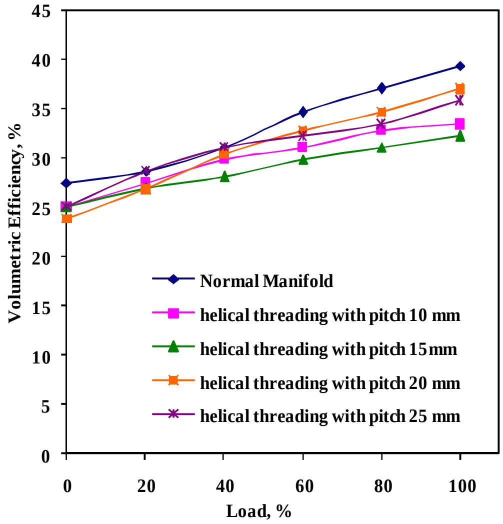

Figure.11 Load versus Volumetric efficiency

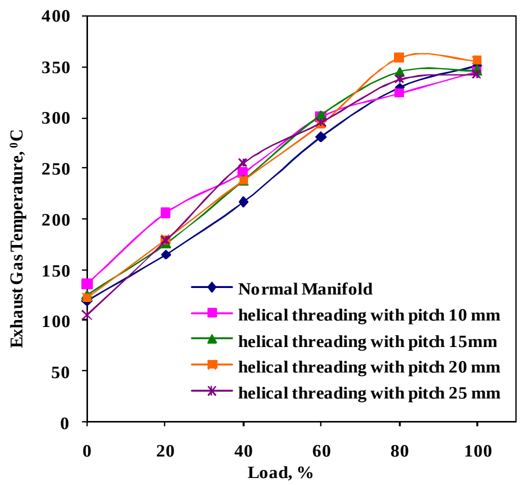

Figure.12 Load versus Exhaust Gas Temperature

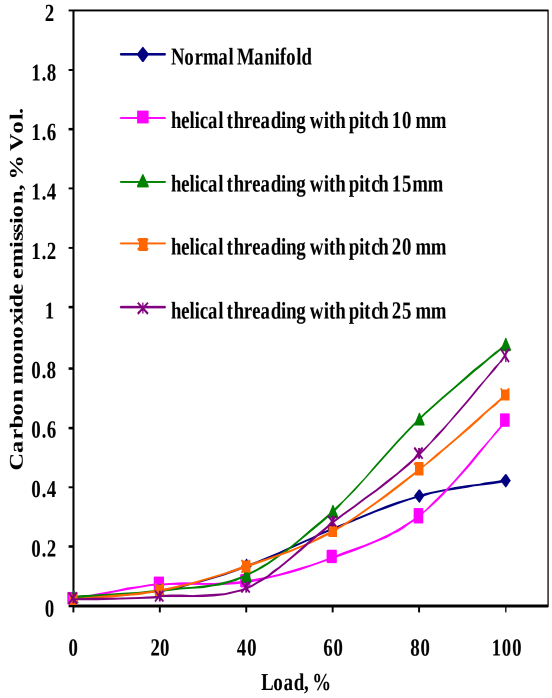

Figure.13 Load versus carbon monoxide emission

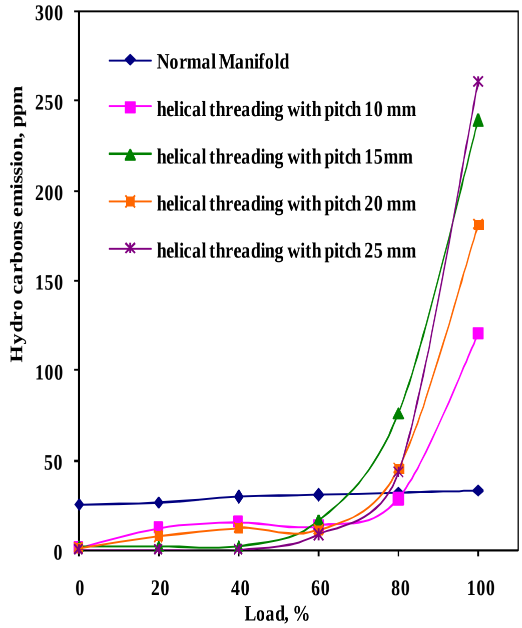

Figure.14 Load versus Hydrocarbon emission

CONCLUSION

The Performance characteristics of the engine with normal manifold and helical threaded manifolds were compared. 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 4/5th 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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