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PERFORMANCE CHARACTERISTICS OF A FOUR STROKE COMPRESSION IGNITION ENGINE BY VARYING DIAMETER OF THE INTAKE MANIFOLD

K.Raju*, N.Balaji Ganesh
* Lecturer ,Mechanical Department, JNTU KALIKIRI , Andhra pradesh
Assitant professor, Mechanical Department, Aditya college of Engineering, Madanapalle, Andhra pradesh

ABSTRACT
In automobiles an intake manifold is a part of engine that supplies and evenly distributes the air to the cylinder. The rate of airflow through an internal combustion engine is an important factor determining the amount of power the engine generates. A four stroke compression ignition engine with power 9 H.P and rated speed 1500 rpm is selected for performance calculation. With the change of intake manifold diameter the final velocity of the air entering the engine cylinder gets altered leading to the variation of many engine parameters which includes fuel consumption, power output, etc. For wide varying intake manifold diameters the performance characteristics of an engine are analyzed and compared with conventional diesel engines.

KEYWORDS: Intake manifold, Diesel engine.

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 in other words the engine that can convert the basic thermal energy into the useful mechanical work is the heat engine.

A diesel engine (also known as a compression-ignition engine) is one type of heat engine which comes under the category of internal combustion 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. 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.

The in-cylinder fluid motion in internal combustion engines is one of the most important factors controlling the combustion process. It governs the fuel-air mixing and burning rates in diesel engines. In-cylinder flow field structure in an internal combustion (I.C) engine has a major influence on the combustion, emission and performance characteristics. Fluid 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. With optimal turbulence, better mixing of fuel and air is possible which leads to effective combustion. 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.

Air is directed into the cylinder through the inlet manifold and this air flow is one of the important factors, which governs the engine performance and emissions. It is quite familiar that a designed intake manifold is essential for the optimal performance of an internal combustion engine. Hence the flow phenomenon inside the intake manifold should be fully optimized to produce more engine power with better combustion and further reduces the emission. In general the position of the intake valve is designed in such a way to generate better swirl when the air is induced into the cylinder.

Here, in our context we are implementing the inlet manifold with different inlet diameters for varying the velocity and pressure of air entering the engine cylinder. The inlet manifold with inlet diameters 26mm, 28mm, 32mm, 34mm and with outlet diameter 30mm constant in all cases are used for directing the air flow into the engine cylinder.

The measurements were done at constant speed of 1500 rpm. The results are compared among normal manifold and inlet diameter changed inlet manifold. The results of test show an increase in the brake thermal efficiency, mechanical efficiency and decrease in HC and CO2 emissions. On the other hand the volumetric efficiency is dropped by about 5%.

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.

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 how much air 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.

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 its inlet diameter is changed by keeping the outlet diameter constant at 30mm.. The performance characteristics and the emissions levels were verified with the changed inlet diameters of the intake manifold.

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 grooved path which facilitates for generating swirl along the central axis of the manifold.

The diameter at the inlet of the intake manifolds is 26mm, 28mm, 32mm and 34mm. The outlet diameter of the inlet manifold is about 30mm. The experiments were conducted by considering various parameters. The tests were conducted for cashew nut oil, cottonseed oil and its blends at different proportions (10%, 20%, 30% and 40%) for conventional engine. The tests were conducted from no load to maximum load conditions. The readings such as time taken to consume 20cc of fuel consumption, speed of the engine, temperatures, etc, were noted. The observations were recorded in tabular column and calculations are made using appropriate equations.

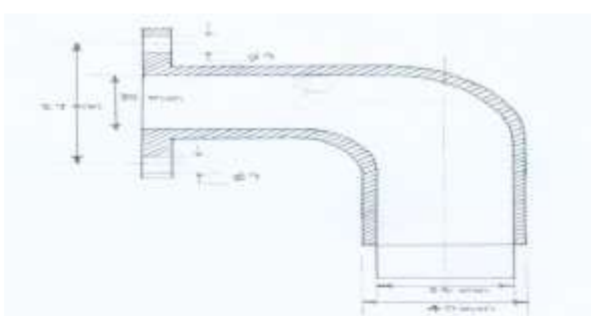

Fig1: Changed Intake Manifold

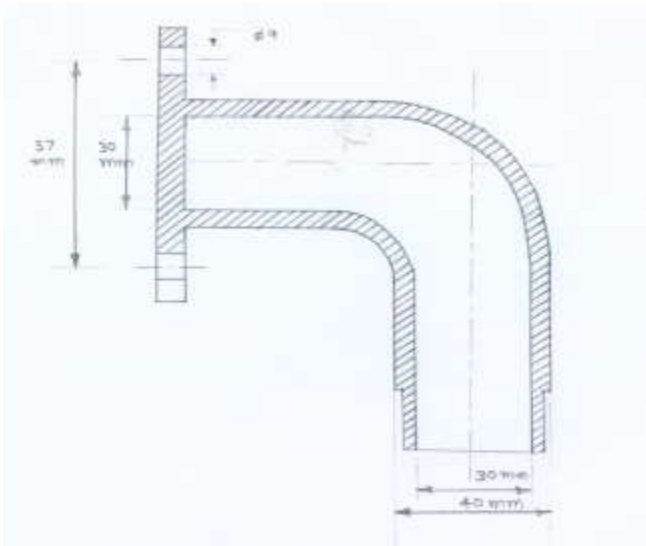

Fig 2: Normal Manifold

OBSERVATIONS

Table 1: Observations with normal manifold

S.No	Item	Units	Trail					
			1	2	3	4	5	6
1	Load	W	0	1000	2000	3000	4000	5000
2	Speed	rpm	1500	1500	1500	1500	1500	1500
3	Time taken for 20 cc of fuel consumption (t)	Seconds	80.21	57.68	47.4	39.67	30.21	22.63
4	Voltage	V	270	260	250	230	215	200
5	Current	A	0	5	8.5	12	15.5	18
6	Air flow	m/s	7.1	7.1	7.1	7.1	7.1	7.1

Table 2: Observations with 26mm diameter at inlet

S.No	Item	Units	Trail					
			1	2	3	4	5	6
1	Load	W	0	1000	2000	3000	4000	5000
2	Speed	rpm	1500	1500	1500	1500	1500	1500
3	Time taken for 20 cc of fuel consumption (t)	Seconds	77.7	53.8	43.7	34.7	24.9	15.2
4	Voltage	V	280	260	250	235	215	190
5	Current	A	0	5	8.5	12	15.5	18
6	Air flow	m/s	5.8	5.8	6.8	6.8	6.8	6.8

S.No	Item	Units	Load (%)					
			0	20	40	60	80	100
1	T.F.C	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	B.S.F.C	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

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Table 3: Experimental results with normal manifold

5	**Indicated power**	**kW**	3.00	4.47	5.41	6.13	6.78	7.08
6	**ηmech**	**%**	0.00	32.94	44.54	51.05	55.74	57.64
7	**Heat input**	**kW**	8.90	12.38	15.06	18.00	23.63	31.55
8	**ηbth**	**%**	0.00	11.91	15.99	17.39	15.99	12.94
9	**ηith**	**%**	33.70	36.14	35.91	34.05	28.68	22.45
10	**ηvol**	**%**	57.65	57.65	57.65	57.65	57.65	57.65
11	**BMEP**	**kN/m2**	0.00	124.40	203.34	264.11	318.89	344.49
12	**IMEP**	**kN/m2**	253.20	377.60	456.54	517.31	572.09	597.69
13	**Exhaust gas temp**	**0C**	118.00	165.00	216.00	280.00	330.00	351.00

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Table 4: Experimental results with normal manifold

S.No	Item	Units	Load (%)					
			0	20	40	60	80	100
1	T.F.C	kg/h	0.79	1.14	1.40	1.76	2.45	4.03
2	Brake power	kW	0.00	1.47	2.41	3.20	3.78	3.77
3	B.S.F.C	kg/kWh	0	0.77	0.58	0.55	0.65	1.07
4	Frictional power	kW	2.95	2.95	2.95	2.95	2.95	2.95
5	Indicated power	kW	2.95	4.42	5.36	6.15	6.73	6.72
6	η_{mech}	%	0.00	33.32	44.96	52.01	56.16	56.10
7	Heat input	kW	9.18	13.27	16.33	20.55	28.59	46.97
8	η_{bth}	%	0.00	11.11	14.75	15.56	13.21	8.03
9	η_{ith}	%	32.12	33.34	32.81	29.91	23.53	14.31
10	η_{vol}	%	25.99	25.99	25.99	25.99	25.99	25.99
11	BMEP	kN/m^2	0.00	124.40	203.34	269.85	318.89	318.17
12	IMEP	kN/m^2	248.98	373.38	452.32	518.83	567.87	567.15
13	Exhaust gas temp	^0C	105.00	174.00	235.00	298.00	350.00	380.00

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Table 5: Exhaust Emissions with normal manifold

S.No	Item	Units	Load (%)					
			0	20	40	60	80	100
1	Hydro carbons	ppm	25	26	29	30	32	33
2	Carbon monoxide	% vol.	0.03	0.03	0.03	0.02	0.01	0.01
3	Carbon dioxide	% vol.	0.8	0.9	1	1.3	1.4	1.5
4	Oxygen	% vol.	19.45	19.28	19.02	18.55	18	17.4

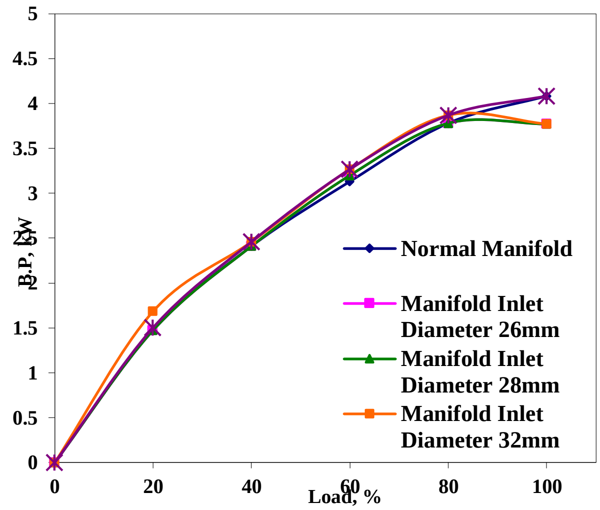
Table 6: Exhaust Emissions with manifold diameter Of 26 mm

S. No	Item	Units	Load (%)					
			0	20	40	60	80	100
1	Hydro carbons	ppm	3	9	11	17	21	123
2	Carbon monoxide	% vol.	0.02	0.03	0.07	0.23	0.38	0.91
3	Carbon dioxide	% vol.	0.8	1.2	1.2	1.4	1.5	0.9
4	Oxygen	% vol.	19.67	18.89	18.78	18.19	17.95	18.4

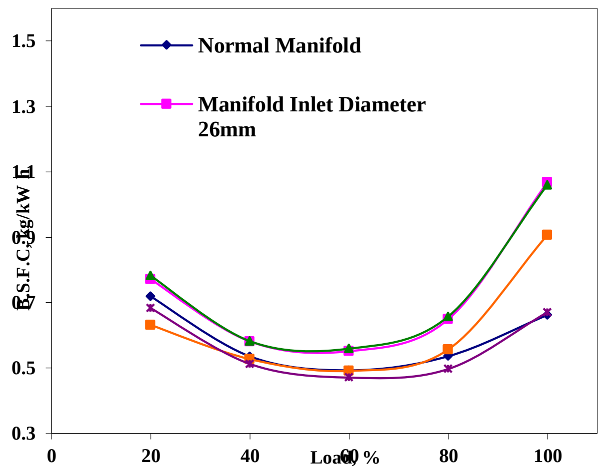
RESULTS

The results obtained from the experimental investigations on the performance and emission parameters using normal manifold, manifold with varying inlet diameters and constant outlet diameter are presented and discussed in this section. The outlet diameter is kept constant at 30mm and the inlet diameters are 26mm, 28mm, 32mm, and 34mm. The results are compared with normal manifold operation with help of graphs.

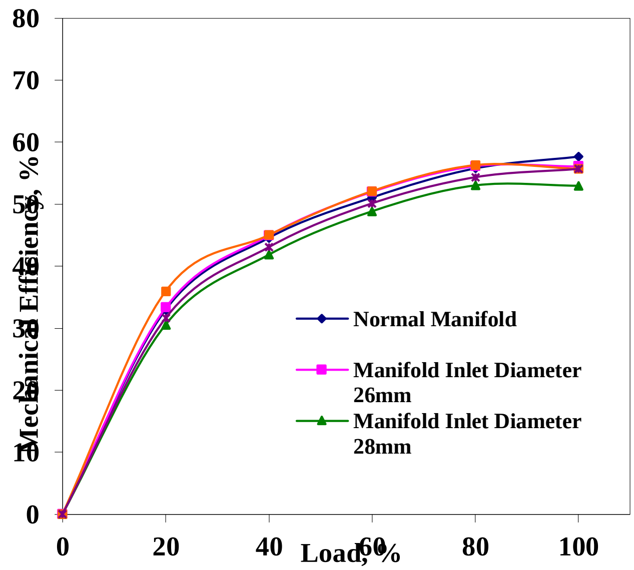
GRAPHS



Graph 1: Load vs Brake power



Graph 2: Load vs B.S.F.C



Graph 3: Load vs Mechanical Efficiency

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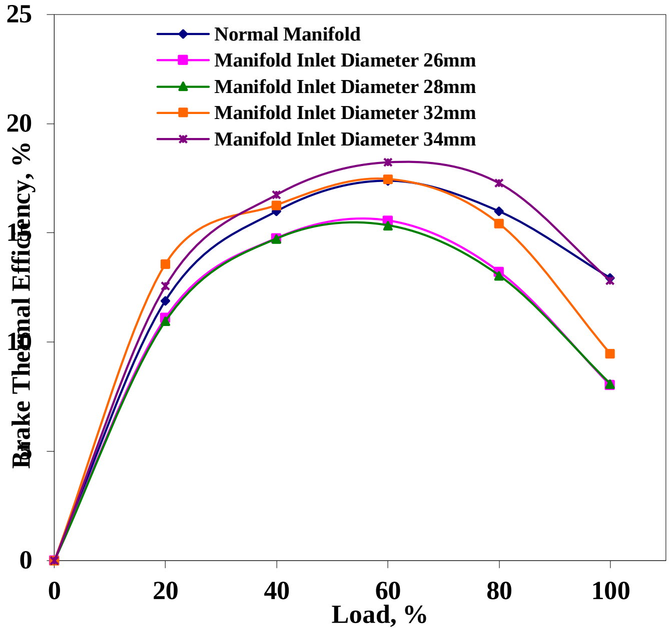
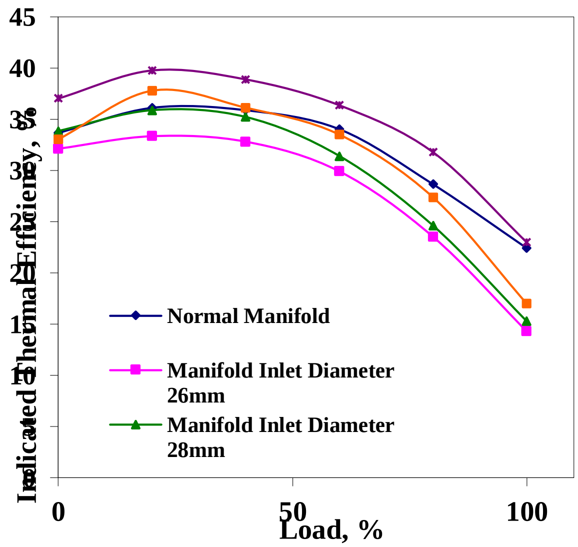
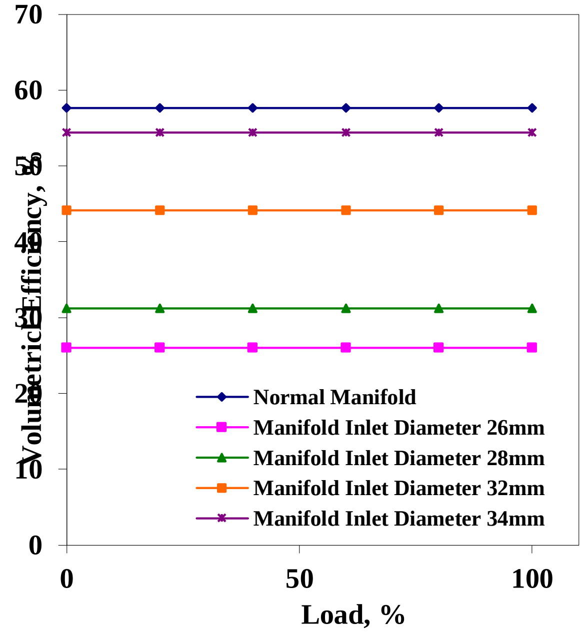


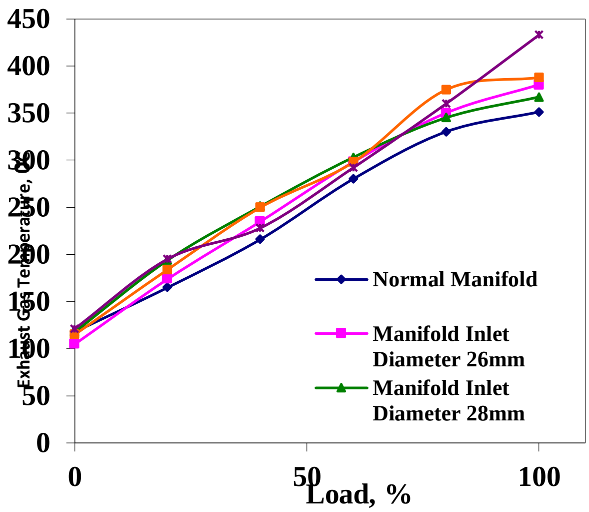
Graph 4: Load vs Brake thermal efficiency



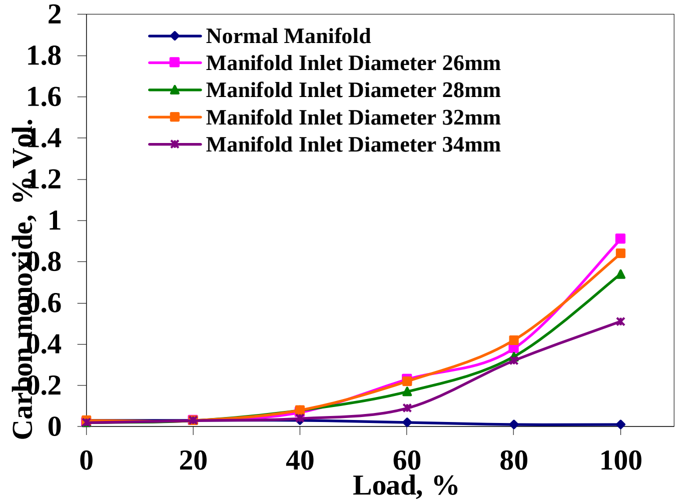
Graph 5: Load vs Indiacted thermal efficiency



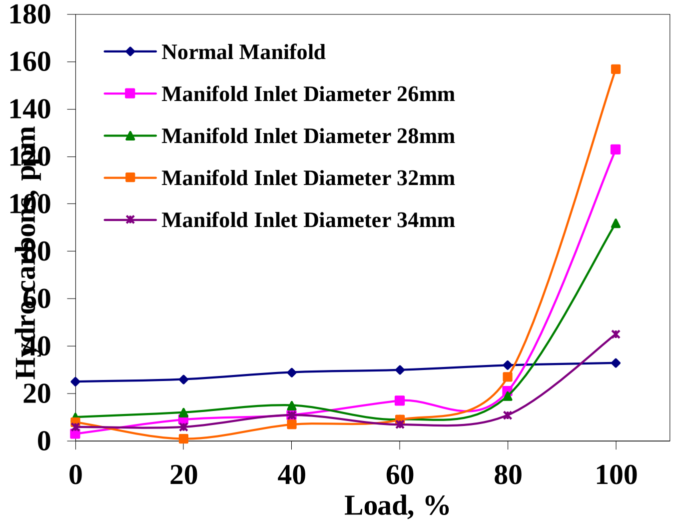
Graph 6: Load vs Volumetric efficiency



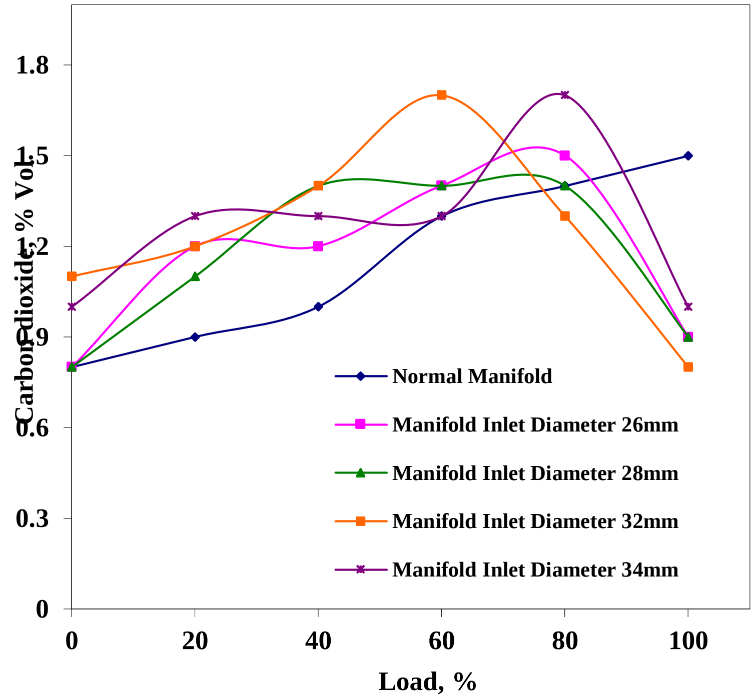
Graph 7: Load vs Exhaust gas Temperatures



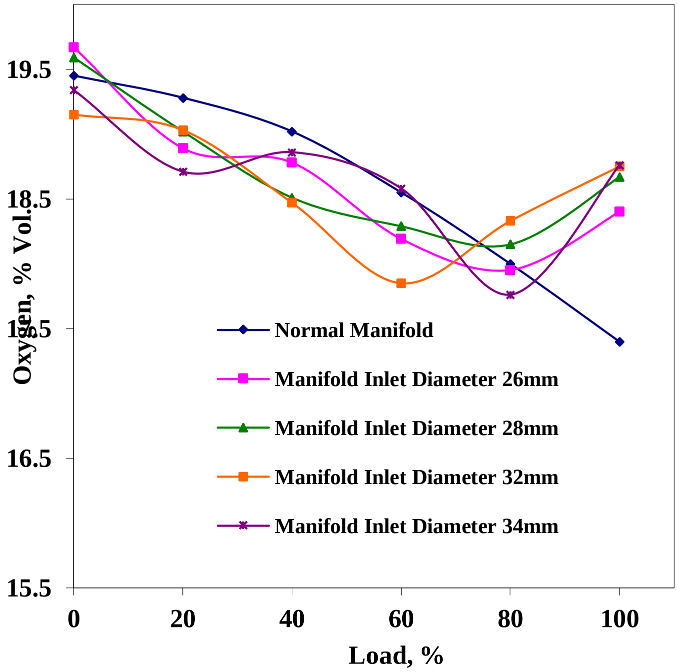
Graph 8: Load vs Carbon monoxide



Graph 9: load vs hydrocarbons



Graph 10: Load vs Carbon dioxide



Graph 11: Load vs Oxygen

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CONCLUSIONS

By using normal manifold the Specific Fuel Consumption was high at no load condition and later increased by limiting amount on loading (till full load), but with the inlet diameter 34mm of the manifold the Specific Fuel Consumption was lower at no load and at full load it coincides to that of normal manifold. And the hydro carbons emitted with the use of 34mm inlet diameter manifold is almost lower than normal manifold except at full load.

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