EXPERIMENTAL INVESTIGATION & ANALYSIS OF AN SINGLE CYLINDER FOUR STROKE TWIN-CHARGE C.I. ENGINE

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Abstract

All have always wondered how the vehicles of future generation will look like. How will new developing technologies make their impact on the design & Development, operation, handling and aesthetics of our future cars? In the present work, the experimental investigation on single-cylinder, four stroke diesel engine has been carried out further modified by supercharged, turbocharged, and combination of super-turbocharged engine. It has been found that using super-turbocharging there is increase in brake power by 48.9 %, volumetric efficiency increases by 39.17 %, but thermal efficiency can increases upto3.15 % only because of 50 % loading condition, & ultimately it will increase loading capacity of the vehicle. These results will definitely be useful for future research work which may result in revolution in automobile sector.

Keywords- *Performance Evaluation, Conventional Engine, Supercharged, Turbocharge, Super-Turbocharge.*

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1. INTRODUCTION

India is one of the fastest developing countries with a stable economic growth, which multiplies the demand for transportation in many folds. Fuel consumption, better torque & capacity is directly proportionate to this demand India trims 2012-13 fuel demand forecast on slow growth India cut its forecast for fuel demand in the current fiscal year by nearly 1 percent to 155.6 million tonnes. The economy, which grew at 6.5 percent in the year ended

In the Present scenario, the depleting fossil petroleum fuel, with ever increase in fuel price and increase in pollution level hazards to the environment that results due to engine exhaust, forces the usage of alternate fuels, beside using alternative fuel can utilize the exhaust gas for better result of engine.

Turbocharger is one of the device are extensively used throughout the automotive industry as they can enhance the output of an internal combustion (IC) engine without the need to increase its cylinder capacity.

BMW was the first to use turbo-charging in a production passenger car when they launched in 1973. The car was brilliantly packaged too and paved the way for a simply magnificent 'Turbo Era' in the automotive world.

A turbocharger unit is comprised of two main components: a turbine and a compressor, and its purpose is to increase the volumetric efficiency of the combustion chamber. The compressor of the turbocharger uses air from the ambient atmosphere and increases its density through the rotating impeller blade passages. The resultant high density airflow then enters the engine combustion chamber to mix with the fuel. Due to the increased air density (hence higher mass flow rate), the brake mean effective pressure acting upon the piston crown is enhanced. This will increase the force acting upon the piston which means the engine can produce more torque and therefore power.

Ever more power obtained by turbocharging ,The turbine of the turbocharger produces a high back pressure on the exhaust manifold which results in the exhaust gas pressure being higher than the atmospheric pressure, also it has turbo-lag problem.

Supercharging is also another device to increase the air – charge per cycle and permit the burning of a larger amount of fuel and thus increase the power output of the engine. Supercharging increases the power output limits of four-stroke engine, but the supercharger is always running. Continuous compression of the intake air requires some mechanical energy to accomplish, so the supercharger has a cost of reduced fuel efficiency when the engine is operating at low power levels or when the engine is simply unloaded and idling.

Superchargers have no lag time because they are driven directly by the crankshaft, whereas Turbochargers suffers lag because it takes a few moments before the exhaust gases reach a velocity that is sufficient to drive the impeller/turbine.

Since the superchargers are directly empowered from the engine, so as the engine starts, the superchargers can be activated. But in the case of turbochargers they take some time for the accumulation of exhaust gases.

Thus In this project combination of both supercharging and turbocharging is used to overcome on limitations of turbocharger and supercharger.

The combine system is run and achive the great amount of increase in BP, Volumetric efficiency, Thermal efficiency and loading capacity of engine

1.1 Nomenclature

IC – Internal combustion
4S – Four stroke.
BP – Brake power, kW
BHP – Brake horse power. Kw
Hw – Manometer difference, cm
$\eta_{th.}$ - Thermal Efficiency, %
$\eta_{vol.}$ - Volumetric Efficiency, %
Mf – Mass Fuel consumption (Kg/s)
ρ – Density, kg/m3
N – Engine running speed, rpm
Cd – Coefficient of discharge
CV – Calorific Value of the fuel, kJ
K – No. of cylinders

2. EXPERIMENTAL SETUP

Fig 1: Super-Turbocharged Test Rig

2.1 Engine Specification

Parameter	***Specifications***
Engine	4 S C I Engine
Make	Kirloskar
BHP	5 KW
rpm	1500
Fuel	Diesel
Cooling	Water Cooling
Bore	0.08 m
Stroke	0.11 m
Starting	Crank
Method of ignition	C I
Injection	Direct injection
Orifice diameter	0.02 m
Cd for orifice	0.62

2.2 Experimental Setup and Procedure

The performance, combustion and emission tests were carried out on a four stroke, single cylinder, naturally Aspirated, water cooled Kirloskar diesel engine having a power capacity of 5 kW. It is connected to an Eddy current dynamometer for loading. Temperature and pressure sensors are installed at the necessary locations in the test setup. The temperature sensors measure temperatures at inlet & outlet of water jacket; calorimeter water and calorimeter exhaust gas. It is also provided with pressure sensors to measure combustion pressure inside cylinder and also to measure the fuel line pressure during injection.

The provision is also made for the measurement of volumetric fuel flow. The built in program in the system calculates indicated power, brake power, thermal efficiency, volumetric efficiency and heat balance.

3. EXPERIMENTAL EVALUATION

3.1 Conventional Engine (on 50% Loading)

Sr .No	Speed (rpm)	Load (KW)	Hw. cm	$\eta_{th.}$ (%)	$\eta_{vol.}$ (%)	Mf.(kg/s)x 10^{-4}	Bsfc (kg/kwhr)
1	1200	250	3.2	4.18	50.13	1.4124	0.5
2	1198	750	2.9	11.37	51.23	1.5487	0.8
3	1195	1250	3.1	16.65	54.35	1.7628	0.9
4	1196	1750	2.8	20.91	51.85	1.9656	0.404
5	1192	2000	2.7	21.48	52.47	2.1869	0.393

6	1179	2250	2.7	32.70	46.65	2.3282	0.372
7	1177	2500	2.6	20.49	47.76	2.8653	0.4126

3.2 Turbochaged Engine (on 50 % Loading)

Sr.No	Speed (rpm)	Load (KW)	Hw. cm	$\eta_{th.}$ (%)	$\eta_{vol.}$ (%)	Mf. (kg/s) x10^{-4}	Bsfc (kg/kwhr)
1	1220	250	7.56	4.892	67.89	1.516	2.14
2	1213	750	7.03	12.04	64.96	1.596	0.760
3	1208	1250	6.56	17.12	67.10	1.822	0.524
4	1207	1750	5.24	21.79	63.10	1.978	0.406
5	1206	2000	6.12	22.73	62.78	2.149	0.386
6	1204	2250	4.85	22.88	63.47	2.162	0.345
7	1202	2500	4.2	24.38	62.24	2.514	0.362

3.3 Superchargd Engine (on 50% loading)

S.N	Speed (rpm)	Load (KW)	Hw. cm	$\eta_{th.}$ (%)	$\eta_{vol.}$ (%)	Mf. (kg/s) x10^{-4}	Bsfc (kg/kwhr)
1	1261	250	8.12	3.92	70.41	1.497	2.155
2	1256	750	7.71	10.40	68.80	1.693	0.812
3	1232	1250	7.2	15.51	75.77	1.893	0.5451
4	1224	1750	6.4	19.60	66.57	2.096	0.4315
5	1235	2000	5.5	19.45	74.67	2.415	0.4347
6	1229	2500	4.6	25.15	75.95	2.233	0.3362
1	1261	250	8.12	3.92	70.41	1.497	2.155

3.4 Super-Turbocharged Engine (on 50 % loading)

Sr .No	Speed (rpm)	Load (KW)	Hw. cm	$\eta_{th.}$ (%)	$\eta_{vol.}$ (%)	Mf. (kg/s) x10^{-4}	Bsfc (kg/kwhr)
1	1246	250	6	3.85	87.23	1.5438	2.22
2	1237	750	5.6	10.38	87.11	1.697	0.81
3	1234	1250	6	15.46	90.41	1.899	0.444
5	1233	1750	6.1	19.62	94.15	2.095	0.4309

6	1222	2500	6.3	22.76	93.54	2.5806	0.0845
1	1246	250	6	3.85	87.23	1.5438	2.22
2	1237	750	5.6	10.38	87.11	1.697	0.81

4. ANALYSIS

4.1 BP Vs Mf

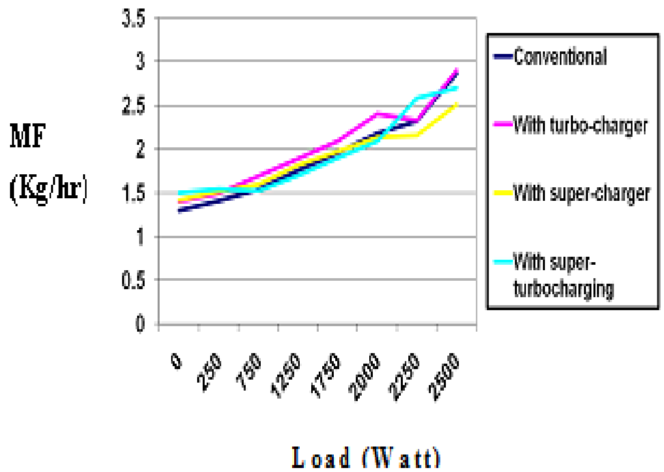

Fig 2:- Brake Specific Fuel Consumption

The variations of fuel consumption with brake power for different configurations are shown in fig 2. The fuel consumption for normal engine 1.031 kg/hr. of rated load 2500 w, which is decreases by 0.905 kg/hr with turbo charging, 0.538 kg/hr. by supercharging and slightly increased with 0.610 by combination of both

4.2 Load VS BMEP

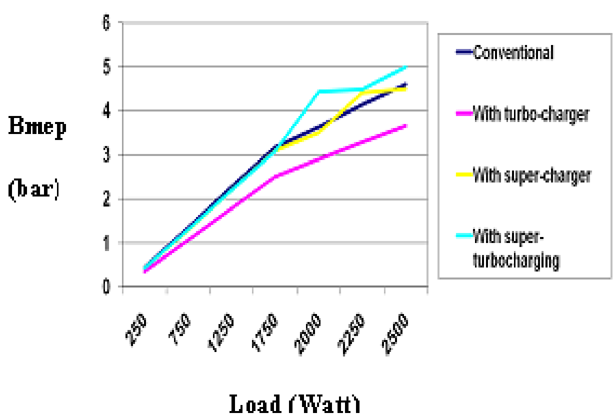

Fig 3:- Brake Mean Effective Pressure

From the above figure 3 it is evident that the brake mean specific pressure with turbocharging is less than conventional engine due to at 50 %loading condition. If the engine will runs at full load hence may get desired mean effective pressure, as supercharged engine obtained desired pressure and comparative higher value of pressure by combination.

4.3 Load VS Thermal Efficiency

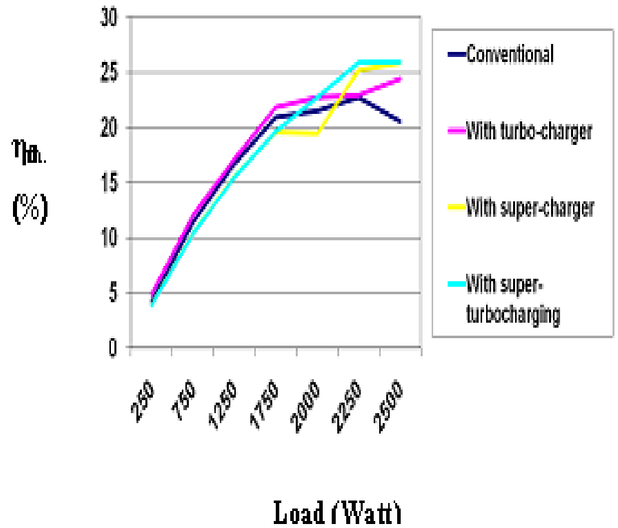

Fig: 4 - Thermal Efficiency

The variations of thermal efficiency with brake power for different configurations are shown in fig 2.3. It is found that the thermal efficiency by supercharging is increased by 16.46% which is lesser than turbocharging of 36.82 % but drastically decreases due to combining both by 3.51% only because of 50 % loading. If it will runs at full load may reach the considerable value of thermal efficiency.

5. HEAT BALANCE SHEET

5.1 HBS for Conventional Engine Hr. Basis

S.N.	DEBIT	kJ/hr.	%
1	Heat Equivalent to BP	9000	20.78
2	Heat in Cooling Water	5074.18	11.72
3	Heat in Exhaust gasses	12403.74	28.65

4	Heat Unaccounted	16824.08	38.85
	Total	43302	100

5.2 HBS for Supercharged Engine Hr. Basis

S.N.	DEBIT	kJ/hr.	%
1	Heat Equivalent to BP	9000	26.72
2	Heat in Cooling Water	6014.64	17.86
3	Heat in Exhaust gasses	14933.89	44.34
4	Heat Unaccounted	3729.22	11.67
	Total	33677.7	100

5.3 HBS for Turbocharged Engine Hr. Basis

S.N.	DEBIT	kJ/hr.	%
1	Heat Equivalent to BP	9000	24.55
2	Heat in Cooling Water	10515.20	28.68
3	Heat in Exhaust gasses	17146.6	31.01
4	Heat Unaccounted	5780.95	15.76
	Total	36661.8	100

6. RESULTS

The performance test has carried out on single cylinder four strokes C.I Engine with various attachments and following results were to be obtained.

1. Percentage increase in brake power due to turbocharging = **18**
2. Percentage increase in brake power due to supercharging = **35**
3. Percentage increase in brake power due to super& turbo-charging = **48.9**
4. Percentage increase in thermal efficiency due to turbocharging = **36.82**
5. Percentage increase in thermal efficiency due to supercharging = **16.46**
6. Percentage decrease in thermal efficiency due to super& turbo-charging because of 50% loading condition = **3.51**
7. Percentage increase in volumetric efficiency due to turbocharging = **27.34**
8. Percentage increase in volumetric efficiency due to supercharging = **11.55**
9. Percentage increase in volumetric efficiency due to super& turbo-charging = **39.17**

7. CONCLUSIONS

This paper presented a powerful effect of combination of both supercharging and turbocharging method on conventional engine. Through the analysis it is found that there is great increase in brake power, volumetric efficiency, loading capacity of engine, decreasing fuel consumption, eliminating turbo-Lag problem, but due to only 50 % loading on engine the thermal efficiency decreases by 3.51 % only is the major drawback.If the engine runs at full load then can get considerable increase in thermal efficiency.

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BIOGRAPHIES

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