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Investigation on Performance Characteristics of Petrol Engine Using Alternate Fuel

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Abstract: *In the present scenario the S.I. engines being used in automotives by various manufactures are not properly suitable to out climatic condition. As our country is among tropical countries where the variation in the temperature is having very vast range i. e. from 0ºC to 48ºC in various regions of the country. Looking in to this vast varying temperature range it is very difficult to say that which temperature is most suited to operating condition of engines and gives us best performance level as for as SFC and brake power is concerned. In my work I have tried to investigate the best option to run the S.I. engine and simultaneously to maintain the emission norms. Petrol reserves are getting exhausted and it is recommended to find the alternate solution to it. In the present work the potential of methanol is being explored to serve as alternate fuel. This work is carried out with the use of petrol and methanol on a three cylinder, four stroke, petrol Maruti 800 engine connected to eddy current type dynamometer for loading was adopted to study engine power, fuel economy, engine exhaust emissions of hydrocarbon, oxides of nitrogen in the exhaust. The performance results that are reported include brake power and specific fuel consumption (SFC) as a function of engine coolant temperature; i.e. 50ºC, 60ºC, 70ºC and 80ºC with varying engine speed of 1500, 2000, 2500, rpm. Today research and development in the field of gasoline engines have to face a double challenge: on the one hand, fuel consumption has to be reduced, while on the other hand, ever more stringent emission standards have to be fulfilled. The development of engines with its complexity of in-cylinder processes requires modern development tools to exploit the full potential in order to reduce fuel consumption. There are many strategies for improving fuel economy and reducing exhaust emission. Hydrocarbon emission (HC) and carbon monoxide (CO). And finally it is concluded that no remarkable difference is recorded. With use of methanol instead of petrol the variation is marginal and can be attributed to the cycle temp and combustion efficiency. Thus methano l is recommended for use as an alternative fuel for petrol engine in coming future.*
Key words: *Petrol engine, methanol, C.I. engine, SFC And engine speed.*

I. Introduction

The internal combustion engine is the key to the modern society. Without the transportation performed by the millions of vehicles on road and at sea we would not have reached the living standard of today. We have two types of internal combustion engines, the spark ignition, S.I. and the compression ignition, C.I. Both have their merits. The SI engine is a rather simple product and hence has a lower first cost. The problem with the SI engine is the poor part load efficiency due to large losses during gas exchange and low combustion and thermodynamics efficiency. The C.I. engine is much more fuel efficient and hence the natural choice in applications where fuel cost is more important than first cost. The problem with the C.I. engine is the emissions of nitrogen oxides. As the environmental problems caused by vehicle exhaust emissions become more severe, exhaust gas emission regulations and fuel economy standards become more stringent.

The experimental study is carried out on a three cylinders, four stroke, water cooled petrol engine. Maruti 800 is engine connected to eddy current type dynamometer for loading. My objective of this project is to examine engine performance parameter i.e. specific fuel consumption (SFC), brake power (BP) and also measurement of engine exhaust emission i. e. nitrogen oxides, hydrocarbons at coolant temperature of 50^0C, 60^0C, 70^0C, 80^0C and at an engine speed of 1500, 2000, 2500 rpm with respect to engine load 6, 9, 12 kg for fuel used Petrol and Methanol. The results are shown by various graphs i.e. between engine coolant temperature and specific fuel consumption, engine coolant temperature and brake power, engine speed and specific fuel consumption, engine speed and brake power, engine load and specific fuel consumption, engine load and brake power, engine coolant temperature and nitrogen oxide, engine coolant temperature and hydrocarbon, engine speed and nitrogen oxide, engine speed and hydrocarbon.

II. Methodology

Experimental Setup :

The setup consists of three cylinder, four stroke, Petrol engine connected to eddy current type dynamometer for loading. It is provided with necessary instruments for combustion pressure and crank-angle measurements. These signals are interfaced to computer through engine indicator for Pθ−PV diagrams. Provision is also made for interfacing airflow, fuel flow, temperatures and load measurement. The set up has stand alone panel box consisting of air box, fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator, load indicator and engine indicator. Rotameters are provided for cooling water and calorimeter water flow measurement. The setup enables study of engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. Windows based Engine Performance Analysis software package "Enginesoft" is provided for on line performance evaluation.

2.1. Specifications:

Product	**:**Engine test setup 3 cylinder, 4 stroke, Petrol (Computerized)
Engine	**:**Make Maruti, Model Maruti 800, Type 3 Cylinder, 4 Stroke, Petrol , water cooled, Power 27.6Kw At 5000 rpm, Torque 59 NM at 2500rpm, stroke 72 mm,Bore 66.5mm, 796 cc, CR 9.2
Dynamometer	**:**Type eddy current, water cooled, with loading unit
Piezo sensor	**:** Range 5000 PSI, with low noise cable
Crank angle sensor	**:**Resolution 1 Deg, Speed 5500 RPM with TDC pulse.
Engine indicator	**:**Input Piezo sensor, crank angle sensor, No of channels 2, Communication RS232
Temperature sensor	**:** Type RTD, PT100 and Thermocouple, Type K
Temperature	**:** Type two wire, Input RTD PT100, Range 0– 100 Deg C,
Transmitter	**:** Output 4–20 mA and Type two wire, InputThermocouple, Range 0–1200 ^{0}C,Output4–20 mA
Load sensor	**:** Load cell, type strain gauge, range 0-50 Kg
Fuel flow transmitter	**:** DP transmitter, Range 0-500 mm WC
Air flow transmitter	**:** Pressure transmitter, Range (-) 250 mm WC
Rotameter	**:** Engine cooling 100-1000 LPH; Calorimeter 25-250 LPH
Pump	**:** Type Monoblock
Add on card	**:** Resolution12 bit, 8/16 input, Mounting PCI slot
Software	**:** Enginesoft" Engine performance analysis software
Overall dimensions	**:** W 2000 x D 2750 x H 1750 mm

III. Procedure:

Experiment was conducted on a three cylinder, four stroke, Petrol Maruti 800 engine which is connected to eddy current type dynamometer for loading. The performance results which include Brake Power (B.P.) and Specific Fuel Consumption (SFC) as a function of engine coolant temperature; i.e. 50ºC, 60ºC, 70ºC and 80ºC are reported. The emissions results reported include the concentrations of hydrocarbon, oxides of nitrogen in the exhaust. The test has been conducted to study the effect of engine temperature on SFC and B.P. with varying engine speed i.e. 1500, 2000, 2500 rpm with the load of 6,9,12 kg.

Engine coolant temperature has been controlled by controlling cooling water flow rate. The cooling water flow rate for engine is measured manually by rotameter. The values of engine performance parameter are directly obtained by "Engine Soft" software.

A test matrix is created to record the engine performance parameter but main focal point was on specific fuel consumption and brake power of the engine at different engine speed 1500, 2000, 2500 rpm with the engine load of 6,9,12 kg at engine coolant temperature 50ºC, 60ºC, 70ºC, and 80ºC. These test have been carried out for both petrol and methanol fuel.

3.1. Observation And Tabulation

Table No. 3.1 Test Matrix

S.No.	Engine Speed (rpm)	Engine Load(kg)	Engine Temp. (ºC)
1	1500	6 9 12	50,60,70,80
2	2000	6 9 12	50,60,70,80
3	2500	6 9 12	50,60,70,80

3.1. fuel used: - petrol

Table No. 3.2:- SFC, BP, HC AND NO_x emission at engine speed 1500rpm and 6 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	1500	6	50	940	2.03	285	636
			60	810	2.18	302	653
			70	850	2.03	297	703
			80	680	2.18	295	738

Table No. 3.3:- SFC, BP, HC AND NO_x emission at engine speed 2000rpm and 6 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2000	6	50	890	2.35	312	542
			60	700	2.72	317	614
			70	720	2.69	328	723
			80	700	2.82	332	767

Table No. 3.4:- SFC, BP, HC AND NO_x emission at engine speed 2500rpm and 6 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2500	6	50	580	3.56	375	502
			60	780	3.26	376	497
			70	690	3.61	374	702
			80	660	3.63	376	803

Table No. 3.5:- SFC, BP, HC AND NO_x emission at engine speed 1500rpm and 9 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	1500	9	50	721	3.29	391	898
			60	640	3.19	378	1210
			70	644	3.01	381	1267
			80	624	3.11	385	974

Table No. 3.6:- SFC, BP, HC AND NO_x emission at engine speed 2000rpm and 9 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2000	9	50	641	3.88	398	1052
			60	656	4.07	406	1350
			70	643	3.9	396	1318
			80	570	4.12	392	1460

Table No. 3.7:- SFC, BP, HC AND NO_x emission at engine speed 2500rpm and 9 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2500	9	50	643	3.35	369	803
			60	623	5.12	402	1460
			70	628	3.13	386	1310
			80	610	5.28	382	1065

Table No. 3.8:- SFC, BP, HC AND NO_x emission at engine speed 1500rpm and 12 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	1500	12	50	580	2.42	312	1165
			60	590	4.14	328	1310
			70	600	2.32	320	1366
			80	570	3.96	284	1235

Table No. 3.9:- SFC, BP, HC AND NO_x emission at engine speed 2000rpm and 12 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2000	12	50	600	5.2	403	1956
			60	580	5.27	418	2017
			70	560	5.54	422	2096
			80	530	5.19	428	2118

Table No. 3.10:- SFC, BP, HC AND NO_x emission at engine speed 2500rpm and 12 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2500	12	50	550	6.43	408	2126
			60	540	6.48	409	2138
			70	530	6.66	404	2303
			80	490	6.41	405	2425

3.2. Fuel Used: - Methanol

Table No. 3.11:- SFC, BP, HC AND NO_x emission at engine speed 1500rpm and 6 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	1500	6	50	1020	1.99	300	650
			60	940	2.00	310	670
			70	930	1.99	315	715
			80	720	2.00	310	750

Table No. 3.12:-SFC, BP, HC AND NO_x emission at engine speed 2000rpm and 6 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2000	6	50	920	2.29	341	558
			60	750	2.58	338	632
			70	770	2.40	342	731
			80	740	2.62	354	782

Table No. 3.13:- SFC, BP, HC AND NO_x emission at engine speed 2500rpm and 6 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2500	6	50	610	3.28	395	528
			60	810	3.05	385	515
			70	720	3.47	392	721
			80	690	3.41	399	820

Table No. 3.14:- SFC, BP, HC AND NO_x emission at engine speed 1500rpm and 9 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	1500	9	50	738	2.69	421	1012
			60	658	2.83	399	1225
			70	652	2.89	392	1300
			80	640	3.00	401	999

Table No. 3.15:- SFC, BP, HC AND NO_x emission at engine speed 2000rpm and 9 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2000	9	50	652	3.68	411	1072
			60	671	3.87	424	1381
			70	660	3.0	417	1329
			80	600	4.0	409	1473

Table No. 3.16:- SFC, BP, HC AND NO_x emission at engine speed 2500rpm and 9 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2500	9	50	652	3.20	382	826
			60	642	4.89	407	1485
			70	641	2.91	409	1363
			80	629	4.99	403	1090

Table No. 3.17:- SFC, BP, HC AND NO_x emission at engine speed 1500rpm and 12 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	1500	12	50	600	2.22	328	1187
			60	621	4.0	341	1327
			70	627	2.11	331	1390
			80	593	3.78	300	1258

Table No. 3.18:- SFC, BP, HC AND NO_x emission at engine speed 2000rpm and 12 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kwhr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2000	12	50	628	5.0	398	1978
			60	597	5.02	399	2052
			70	585	5.39	404	2123
			80	545	5.0	418	2143

Table No. 3.19:- SFC, BP, HC AND NO_x emission at engine speed 2500rpm and 12 kg engine load

S.N.	Engine Speed (rpm)	Engine Load (kg)	Engine Temp. (ºC)	SFC in (g/kw hr)	B.P. in KW	HC in ppm	NO_x in ppm
1.	2500	12	50	569	6.28	394	2149
			60	557	6.10	389	2154
			70	541	6.32	385	2321
			80	502	6.27	391	2453

IV. Result

An engine performance characteristic has been determined. The term „„„performance““““ usually means how well an engine is doing its required task in relation to the input energy or how effectively it provides useful energy in relation to some other comparable engines. It is represented by typical characteristic curves, which are a function of the engine‟s operating parameters.
An experiment was conducted on a three cylinder, four stroke, Petrol Maruti 800 engine which is connected to eddy current type dynamometer for loading. The performance results which include Brake Power (B.P.) and Specific Fuel Consumption (SFC) as a function of engine coolant temperature; i.e. 50^0 , 60^0 , 70^0 , and 80ºC are reported. The emissions results reported include the concentrations of hydrocarbon, oxides of nitrogen in the exhaust.

Following are the graphs which has obtained for various engine performance parameters:

- **i.** The effect of engine coolant temperature on specific fuel consumption with varying engine speed.
- **ii.** The effect of engine coolant temperature on brake power with varying engine speed.
- **iii.** The effect of engine load on specific fuel consumption with varying engine temperature.
- **iv.** The effect of engine load on brake power with varying engine temperature.
- **v.** The effect of engine coolant temperature on hydrocarbon emission with varying engine speed.
- **vi.** The effect of engine coolant temperature on nitrogen oxide emission with varying engine speed.

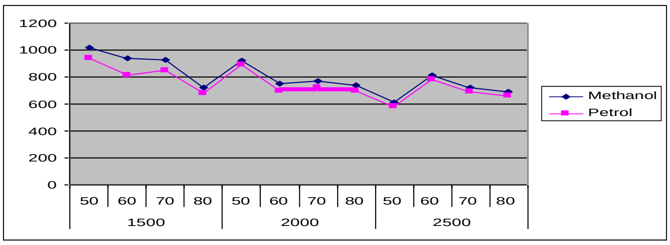

Fig.4.1 The effect of engine coolant temperature on specific fuel consumption with varying engine speed and at 6 kg engine load.

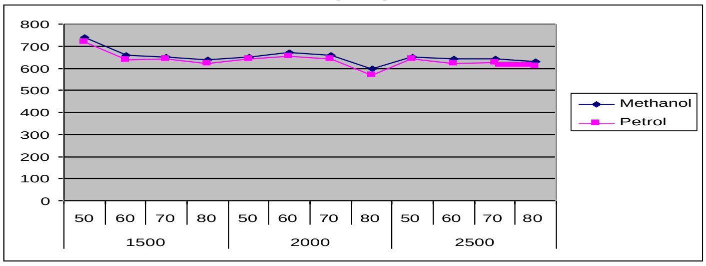

Fig.4.2 The effect of engine coolant temperature on specific fuel consumption with varying engine speed and at 9 kg engine load.

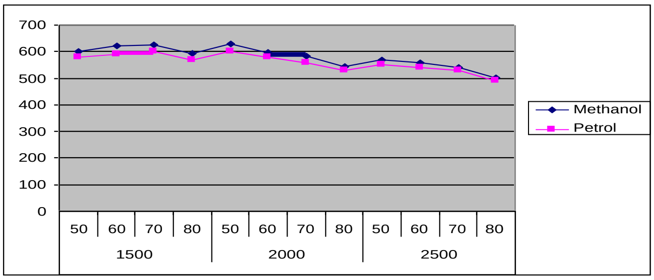

Fig.4.3 The effect of engine coolant temperature on specific fuel consumption with varying engine speed and at 12 kg engine load.

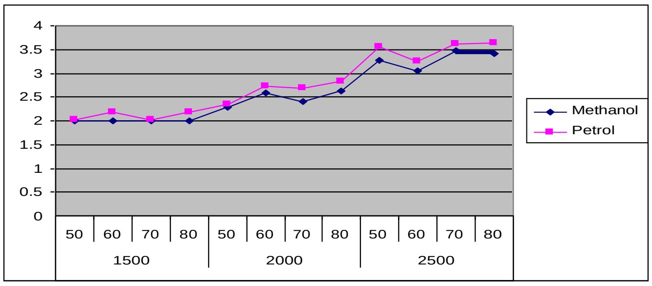

Fig.4.4 The effect of engine coolant temperature on brake power with varying engine speed and at 6 kg engine load.

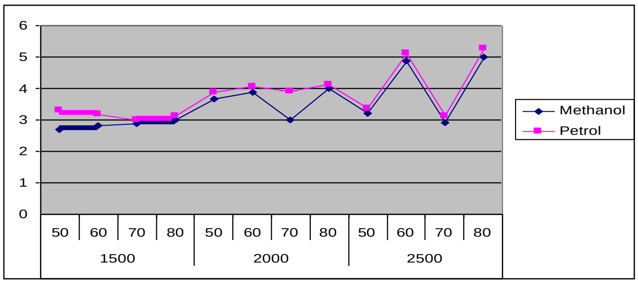

Fig.4.5 The effect of engine coolant temperature on brake power with varying engine speed and at 9 kg engine load.

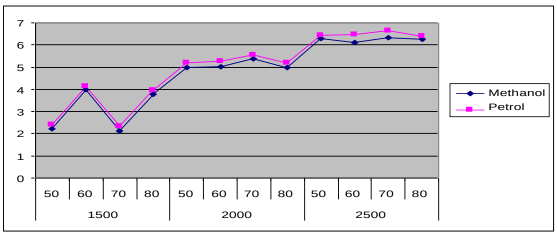

Fig.4.6 The effect of engine coolant temperature on brake power with varying engine speed and at 12 kg engine load.

4.2 Effect of engine coolant temperature on SFC and BP at constant speed

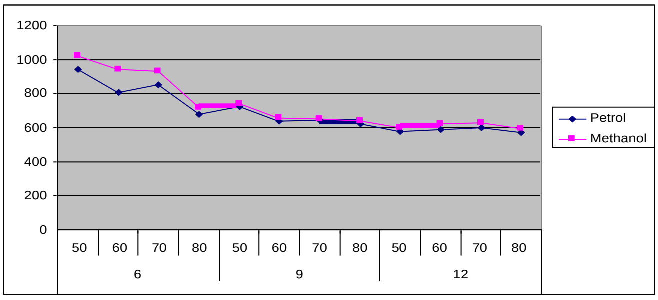

Fig.4.7 The effect of engine load on specific fuel consumption with varying engine coolant temperature and at an engine speed of 1500 rpm

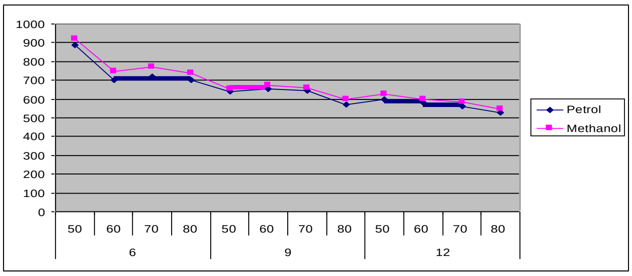

Fig.4.8 The effect of engine load on specific fuel consumption with varying engine coolant temperature and at an engine speed of 2000 rpm

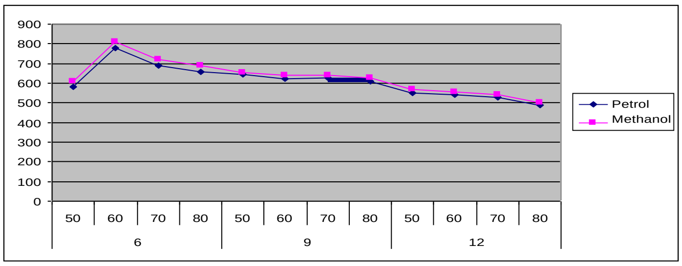

Fig.4.9 The effect of engine load on specific fuel consumption with varying engine coolant temperature and at an engine speed of 2500 rpm

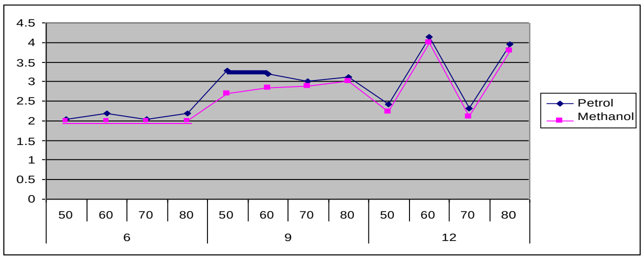

Fig.4.10 The effect of engine load on brake power with varying engine coolant temperature and at an engine speed of 1500 rpm

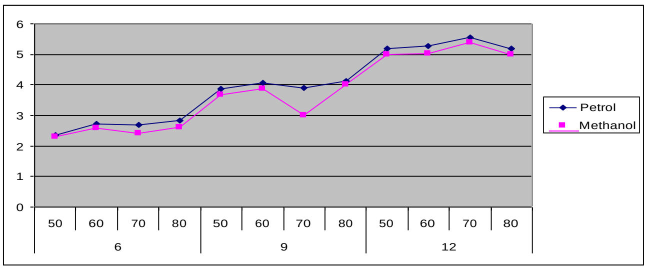

Fig.4.11 The effect of engine load on brake power with varying engine coolant temperature and at an engine speed of 2000 rpm

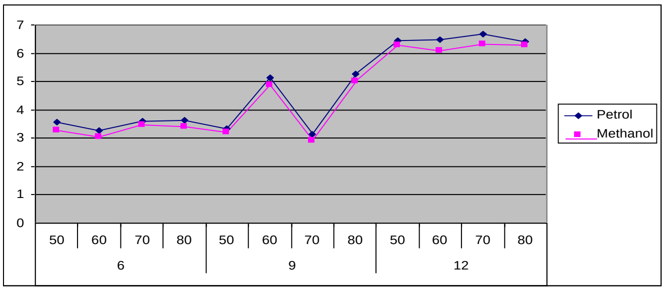

Fig.4.12 The effect of engine load on brake power with varying engine coolant temperature and at an engine speed of 2500 rpm

4.3 Effect of engine coolant temperature on HC and NO_x at constant load

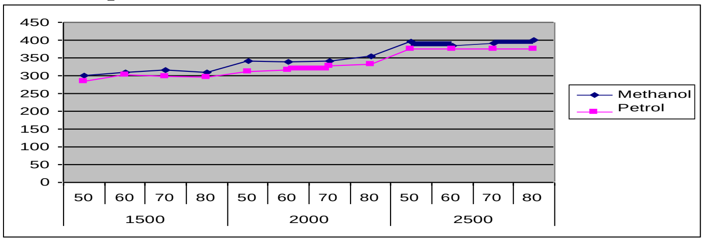

Fig.4.13 The effect of engine coolant temperature on HC emission with varying engine speed and at an engine load of 6 kg

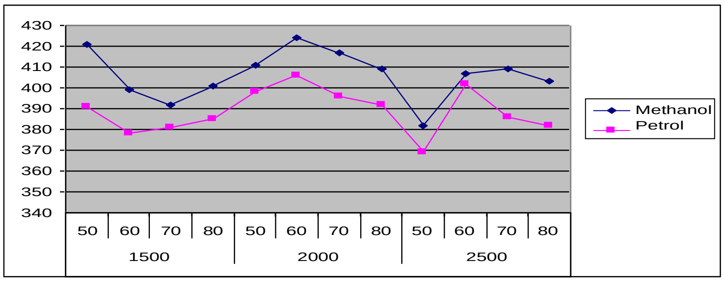

Fig.4.14 The effect of engine coolant temperature on HC emission with varying engine speed and at an engine load of 9 kg

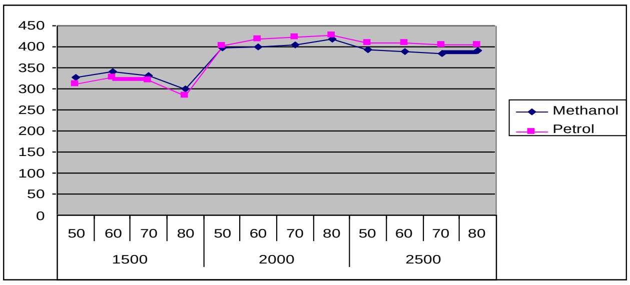

Fig.4.15 The effect of engine coolant temperature on HC emission with varying engine speed and at an engine load of 12 kg

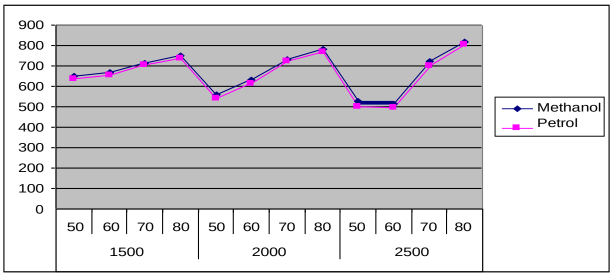

Fig.4.16 The effect of engine coolant temperature on NOx emission with varying engine speed and at an engine load of 6 kg

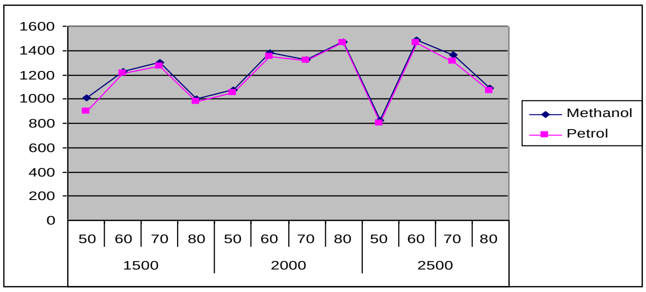

Fig.4.17 The effect of engine coolant temperature on NOx emission with varying engine speed and at an engine load of 9 kg

Fig.4.18 The effect of engine coolant temperature on NOx emission with varying engine speed and at an engine load of 12 kg

V. Conclusion

An attempt has been made to investigate the potential of methanol as alternate fuel used in petrolengine. A computerised petrol engine test rig of engine test setup with gas analyser has been identified. Experiments have been conducted on three cylinder, four stroke, petrol engine with petrol and Methanol. Readings of specific fuel consumption, brake power, exhaust gas emission has been taken in both cases, i. e. use of petrol and methanol as fuel.

The effect of engine coolant temperature on SFC with varying engine speed is analysed with both fuels (Methanol and petrol). The SFC of methanol is found greater than petrol for all engine coolant temperature range. (i.e. 50^0C, 60^0C, 70^0C,80^0C). However the SFC falls slightly with increase in coolant temperature it is also found that in all cases methanol SFC is more than petrol. For constant load test the maximum variation of SFC occurs in case of 1500 engine rpm, engine coolant temperature 60^0 C and engine load 6 kg. It is observed to be 16.04%.

The effect of engine coolant temperature on BP with varying engine speed is analysed and it is found that for similar conditions for petrol produces more power compare to methanol. It is also observed that with increase in engine speed, BP for both fuels increase for all engine coolant temperature range. For constant load test the maximum variation for BP occurs in case of 2000 engine rpm, engine coolant temperature 70^0 C and engine load 6 kg. It is observed to be 10.78%.

For constant speed test the maximum variation of SFC occurs in case of engine rpm 1500, engine coolant temperature 60^0 C and engine load 6 kg. It is observed to be 8.25%.

For constant speed test , the maximum variation of BP occurs in case of engine rpm 1500, engine coolant temperature 50^0 C and engine load 9kg. It is observed to be 18.23%.

The effect of engine coolant temperature on HC emission with varying engine speed for constant load is observed and that is found that the emission of HC is more for methanol as compared to petrol. For constant load test, the maximum variation of HC emission occurs in case of engine coolant temperature 50^0 C and engine load 9kg. It is observed to be 7.67%.

The NO_x emission for methanol is also observed more as compared to petrol for all speed range. For constant load test the maximum variation of NOx emission occurs in case of engine rpm 1500, engine coolant temperature 50^0 C and engine load 9kg. It is observed to be 12.69%.

Itis concluded that SFCincreases with methanol fuel and brake power reduces with methanol. The variation is marginal and can be attributed to the cycle temp and combustion efficiency. Thus methanol is recommended for use as an alternativefuel for petrolenginein comingfuture.

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