

A REVIEW PAPER ON DESIGN, FABRICATION & TRIAL ON MULTI CYLINDER PETROL ENGINE TEST RIG

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ABSTRACT

The basic task of the development engineer is to reduce the cost and improve power output and reliability of the engine. Trying to achieve these goals there is various design concepts to find the effects on engine performance of a particular design concept to resorts to testing. Thus, in general, developments of engine will have to conduct a wide variety of engine tests. Engine performance is an indication of the degree of success with which it is doing its assigned job. These performance characteristics can be verified by using a different Testing Methods. In this research to designed & fabricated multi cylinder petrol engine test rig for demonstration purpose as well as an experimental setup to carry out various performance characteristics trials on the same. The aim of this project is to study the performance characteristics of a four stroke four cylinder spark ignition petrol engine. Here set of demonstrated break power, break specific fuel consumption, Break thermal efficiency, mechanical efficiency and heat balance at various load conditions. Generally the Morse Test and Heat Balance can be performed on the multi-cylinder engine by running the engine at required speed and different parameters can be measured by using different measurement systems.

KEYWORDS: multi cylinder petrol engine, performance characteristics, efficiency.

1. INTRODUCTION:

The design and development of test setup and experimental data collection and analysis are equally important for any experimental research. For the success of test rig development depends on proper planning, design and selection of right kind of equipment and measuring instruments and skill in fabrication and the precession and accuracy of the observations during trial. All the above mentioned

parameters are discussed in this paper. Four stroke four cylinder water cooled, Maruti Esteem engine is selected for the present study. This engine is converted into a Test Rig by attaching Retrofits. Rope brake dynamometer is used for Measurement of brake power. A belt is wound on the brake drum and loaded by a power screw on one side. Spring balance shows tensions in rope side. Air consumption is measured trough orifice meter air tank. One end of a U tube manometer is connected to air tank while other is free to atmosphere. The difference in water levels in two sides indicates the pressure gradient across the orifice. The rate of air consumption and volumetric efficiency can be calculated from this pressure gradient. Fuel consumption is measured with a three way cock and simple burette marked on its length. Calorimeter is a heat exchange with counter flow of water. The various inlet and outlet temperatures of water, exhaust gas are measured with thermocouples and digital display. The flow rate of water passing through calorimeter is measured with Rota-meter.

2. LITERATURE SURVEY:

J.D.V. at el [1] in this paper the study of petrol engine using compressed Biogas as a fuel is carried out and the following results are obtained Fuel consumption on petrol mode is less than compressed biogas. BSFC of compressed biogas is higher. Brake thermal efficiency on petrol mode will be higher compared to compressed biogas.

Exhausts gas temperature of petrol fuel engine is more compared to compressed biogas Engine produces somewhat less Power Ranger run on compressed biogas compared to petrol.N.B.G. at el [2] this paper contains performance analysis of multi cylinder CI engine by using various alternate fuel. Experiment is conducted with fuel with mixing of

cashew nut oil, cottonseed oil and its blends in various proportions by volume and then following results are obtained on multi cylinder Hindustan 4 stroke diesel engine BSFC is less for the blend 20 over the entire range of load compared to diesel fuel. Mechanical efficiency B20 blend was considered higher over entire load range Volumetric efficiency for B40 blend was consider higher over entire load range. B20 blend is preferred to use because of low specific fuel consumption, power utilized is more, and low exhaust gas temperature.

Apart from this various performance tests have been carried out on different engines with different fuels [3-12].

3. EXPERIMENTAL DESIGN & PROCEDURE:

Experimental set up usually consists of:

- 1) Selection of Engine & design of base frame.
- 2) Design and Construction of Dynamometer.
- 3) The Layout and Actual Construction of Foundation for the Project.
- 4) Designing and Construction of Sensor Panel and Attachment of the same to the Engine.
- 5) Design, Selection and Assembly of Heat Exchanger to the engine.
- 6) Carrying out Testing on the Test Rig.

3.1 SELECTION OF ENGINE & DESIGN OF BASE FRAME:

3.1.1. SELECTION OF ENGINE:

The engine is very smooth. The car is powered by a transverse alloy blocks head E MPFI (Electronic Multi Point Fuel Injection) petrol engine which drives the front wheels. The VXI has a 1298cc unit with 4 valves per cylinder whose output is 85bhp and 10.6 Kgm (at 6000rpm). The diesel has a 1527 cc Peugeot engine putting out 57bhp and 9.7 Kgm (at 5500rpm). Performance is very good.

Engine Type	4 stroke
Displacement	1298 (cc)
Power	85@6000 (PS@rpm)
Torque	110@4500 (Nm@rpm)
Bore	74 (mm)
Stroke	75.5 (mm)
Compression Ratio	9



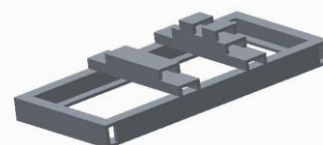
(Figure. 1 Maruti Esteem 4 cylinder petrol engine)

3.1.2. Engine Frame

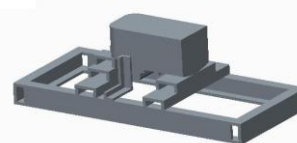
- To make engine stand still and to support it properly the design and construction of frame is done.
- The design of the frame should be such that it should absorb all the vibrations of the engine and also it should be sturdy and robust to sustain the load coming on it.
- A rectangular frame of length 4 feet * 2 feet of "C" channel.



(Figure. 2 Basic Structure)



(Figure.3. Supporting structure)



(Figure.4. Installation of Engine)

3.1.3. RADIATOR FRAME

To safeguard working engine components from seizing due to overheating, some arrangement of keeping it under safe operating temperature will have to be made and system employed for this is cooling system

Types of cooling system:

- A) Air cooling system
- B) Water cooling system

For attaching the radiator following attachment is done
M.S square bar 1 feet long
M.S plate of 2 feet
a flat M.S plate of 16 inch long



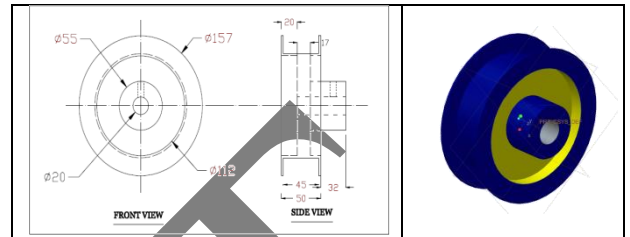
(Figure. 2 Radiator Frame)

Tensile strength for cast iron (σ_t) = 480 N/mm²

Belt width (b) = 40 mm

Diameter of Hub of Pulley D = 55 mm

Length of Hub (L) L = 32 mm



(Figure 8. Dynamometer)

3.2 DESIGN AND CONSTRUCTION OF DYNAMOMETER:

3.2.1. SHAFT DESIGN CALCULATIONS:

Medium carbon steel, case hardening with 0.4% carbon.

Speed (N) = 5600 RPM

Torque (T) = 100 N-mm

Bending Stress (σ_b) = 66 Mpa

Pulley Weight (w) = 34.52 N

Maximum tension in the belt, $T_1 + T_2 = 147.15$ N

Resultant force of pulley Resultant (R) = 112.83 N

Combined twisting & bending moment = 46.69 Mpa

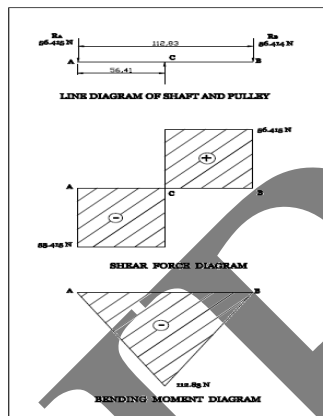
3.2.3. DESIGN OF FRAME :

FOR MAIN FRAME:

Sr. No.	Part Name	Dimensions (MM)	Quantity (Nos)
1	'C' Channel	750	2
2	'C' Channel	550	1

FOR BEARING BLOCK HUB:

SR. NO.	PART NAME	DIMENSIONS (MM)	QUANTITY (NOS)
1	Hollow square channel	120×40×40	2
2	Flat Plate (upper)	250×40×4	1
3	Flat Plate (lower)	550×50×10	1



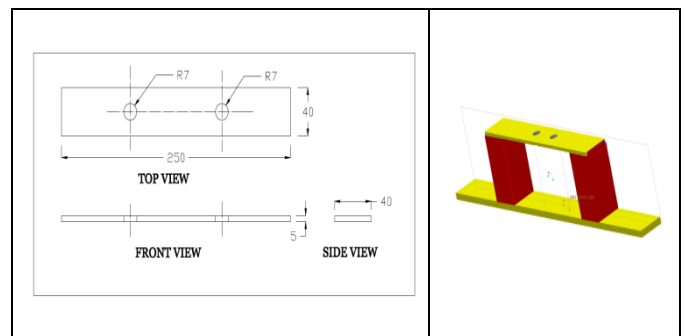
(Figure 6. SFD and BMD for shaft)

Twisting moment $T_e = 11285.144$

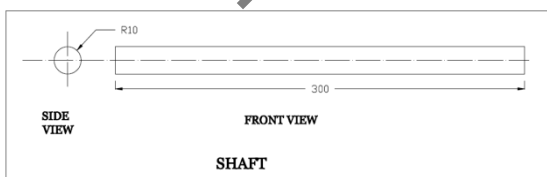
Equivalent bending moment $M_e = 11284.074$

$$T_e = \frac{\pi}{16} \times \tau_{max} \times d^3 \quad d = 10.71 \text{ mm}$$

This diameter is not suitable for our engine torque and loads which is act upon it. So we have selected a standard size of shaft 20 mm diameters according to design data book.



(Figure 9. Base plate for pulley block hub)

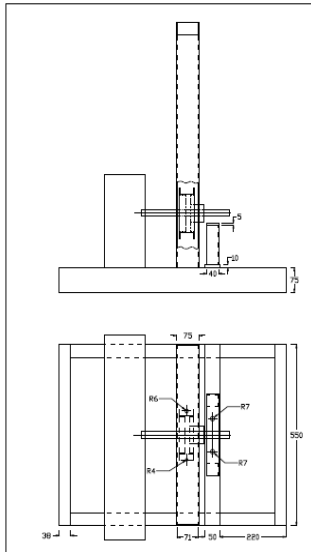


(Figure 7. Shaft)

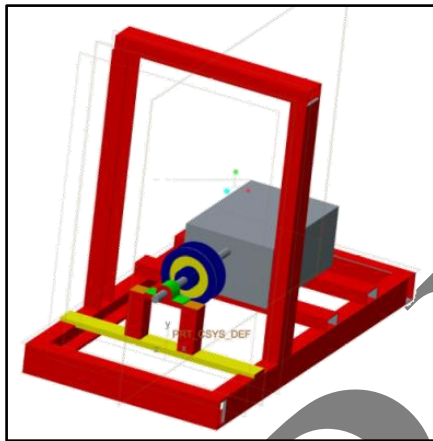
3.2.2. PULLEY DESIGN

Pulley material = Cast Iron

Speed of the pulley (N) = 5600 rpm



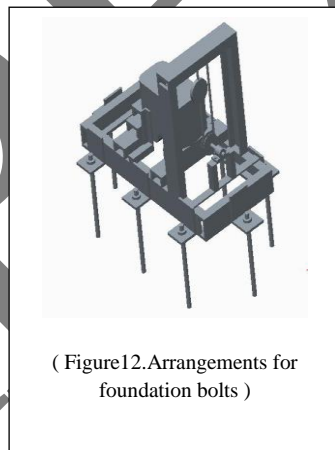
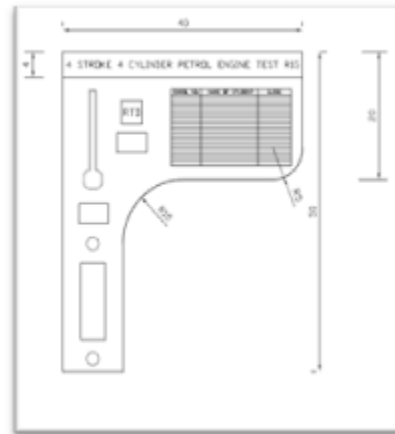
(Figure 10. Final Assembly 2D of dynamometer frame)



(Figure 11. Final Assembly 3d model of dynamometer frame)

Reinforcement

Bars (length wise) $(2.15 \times 4) \times 3 = 25.8 \text{ m}$
 Bars (width wise) $(1.85 \times 9) \times 5 = 83.5 \text{ m}$
 Bars vertical $(0.95 \times 4) \times 3 = 11.4 \text{ m}$
 $120.3\text{m} \times 0.395 = 47.5 \text{ kg}$
 Foundation bolts M16 & 250 mm long 8 nos.



(Figure 12. Arrangements for foundation bolts)



(Figure 13. Actual foundation)

3.3. THE LAYOUT AND ACTUAL CONSTRUCTION OF FOUNDATION FOR THE PROJECT:

Foundations supporting machines such as reciprocating engines, radar tower, punch presses, turbines, large electric motors and generators etc. are subjected to vibration caused by unbalanced machine forces as well as static weight of machine

Engine setup	Multi cylinder
Foundation Block size LxW mm	2000 x 900
Depth (black soil/rocky soil) mm	750 - 800

Measurement:

Excavation $2.0 \times 1.0 \times 1.25 = 2.50 \text{ cum}$
 Soling $2.0 \times 1.0 \times 0.3 = 0.5 \text{ cum}$
 P.C.C $(1:2:4) \text{ MS}2.0 \times 1.0 \times 0.152 = 0.3 \text{ cum}$
 Concrete $\text{M}20 \text{ } 1.70 \times 0.7 \times 0.95 = 1.131 \text{ cum}$

3.4. DESIGNING AND CONSTRUCTION OF SENSOR PANEL AND ATTACHMENT OF THE SAME TO THE ENGINE:

BAKELITE BOARD

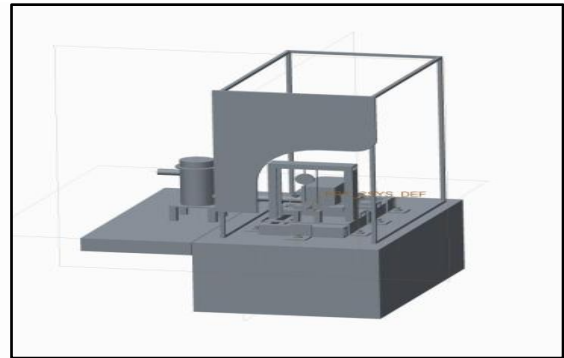


(Figure 14. Preplanned arrangement of all equipment and name plate before Mfg)



(Figure 15. Basics of KTD sensors installations)

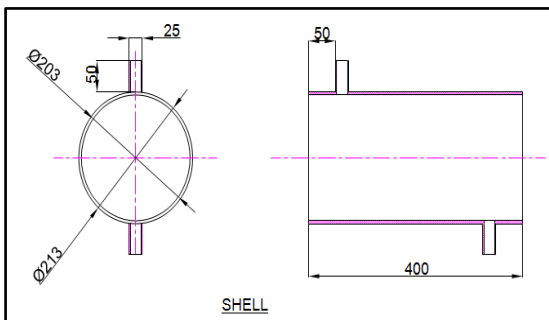
3.6. FINAL DESIGN & ASSEMBLY OF THE TEST RIG:



(Figure 17. 3D Final designed structure)

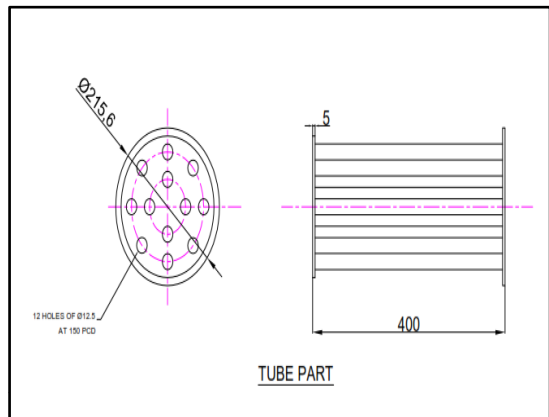
3.5. DESIGN AND ASSEMBLY OF HEAT EXCHANGER TO THE ENGINE:

3.5.1. DESIGN OF SHELL:

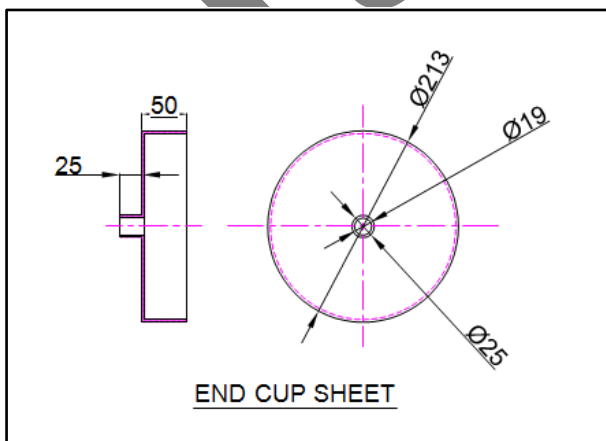


(Figure 16. 2 D Shell)

3.5.2. DESIGN OF TUBE PART:



3.5.3 DESIGN OF END CUP SHEET:



END CUP SHEET



(Figure 18. Actual fabricated & erected test rig)

4. CALCULATIONS & DISCUSSION:

TABLE NO. 1: BRAKE POWER, INDICATED POWER, FRICTION POWER, BRAKE SPECIFIC FUEL CONSUMPTION

LOAD (kg)	SPEED (rpm)	FUEL CONSUMP	B.S.F.C	B.P (KW)	I.P (KW)	F.P (KW)
1	2200	0.000307	0.228	4.84	6.41	1.57
2	1874	0.000329	0.19	6.21	8.1	1.89
4	1658	0.000383	0.202	6.81	8.8	1.99
6	1430	0.000449	0.183	8.81	10.8	1.99
7	1425	0.000534	0.187	10.27	12.2	1.93
8	1469	0.000624	0.185	12.08	13.9	1.82

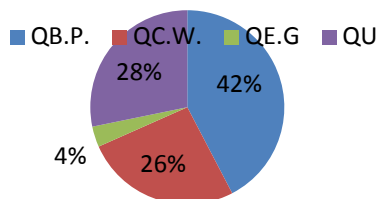
TTABLE NO. 2: VARIOUS INLET AND OUTLET TEMPERATURES FOR WATER AND EXHAUST GAS

LOAD (kg)	T1	T2	T3	T4	T5	T6
1	27	30	27	35	90	85
2	27	31	27	42	115	102
4	27	31	27	50	135	179
6	27	32	27	54	168	152
7	27	34	27	63	187	174
8	27	35	27	70	210	197

TABLE NO 3: CALCULATION OF HEAT BALANCE SHEET

LOAD (kg)	QS	QB.P.	QC.W.	QE.G	QU
1	46418.4	17454.92	7531.2	962.08	20470.2
2	49744.8	20374.69	11296.8	1486.56	16586.75
4	57909.6	24519.4	15062.4	1988.12	16339.68
6	67888.8	31745.38	18828	2798.14	14517.28
7	80740.8	36992.12	26359.2	3278.01	14111.46
8	94464.12	43498.76	33890.4	4074.31	13000.65

Heat Balance Sheet for 6kg



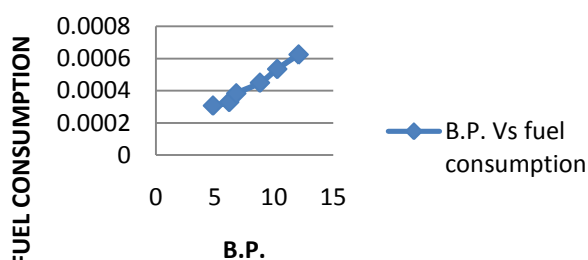
Graph No.1: Heat Balance Sheet.

TABLE NO 4: various efficiencies at different loads

LOAD (kg)	η_{bth}	η_{ith}	η_{mech}
1	37.53	49.71	75.39
2	44.94	58.62	76.66
4	42.34	54.7	77.38
6	46.71	57.27	81.57
7	45.79	54.39	84.18
8	46.09	52.22	86.9

THE DIFFERENT GRAPHS ARE BEEN PLOTTED :

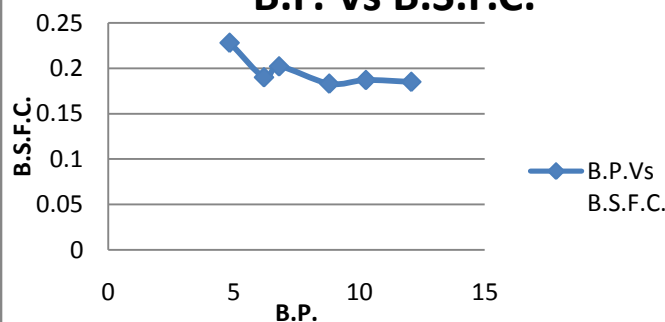
B.P. Vs fuel consumption



Graph No.2: Brake power Vs. Specific fuel consumption

DESCRIPTION: In the above graph Brake power is taken in x-axis and fuel consumption should be taken in y-axis. The fuel consumption has been compared with petrol fuel at various loads and it is shown in figure. It is observed that the Brake power was considering Higher over entire load range.

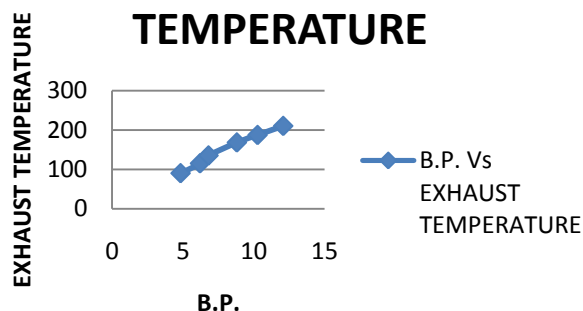
B.P. Vs B.S.F.C.



Graph No.3: Brake power Vs. Brake Specific fuel consumption

DESCRIPTION : In the above graph Brake power is taken in x-axis and BSFC should be taken in y-axis. The BSFC of the Petrol has been compared at various loads and it is shown in figure. It is observed that the Brake power for petrol was considering lower over entire load range.

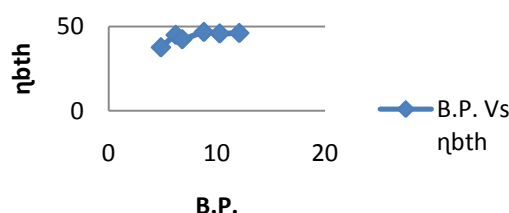
B.P. Vs EXHAUST TEMPERATURE



Graph No 4: B.P.Vs. Exhaust gas Temperature

DESCRIPTION : The variation of exhaust gas temperature with Brake power conditions is shown in Figure. It is observed that the exhaust gas temperature increases with load because more fuel is burnt to meet the power requirement.

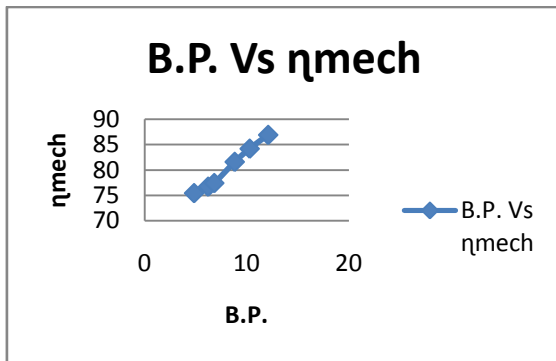
B.P. Vs η_{bth}



Graph No 5: Brake power Vs. Brake thermal efficiency

DESCRIPTION: In the above graph Brake Thermal efficiency has been compared at various loads and it is

shown in figure. It is observed that the Brake Thermal efficiency was considering higher over entire load range.



Graph No 6: Brake power Vs. Mechanical efficiency

DESCRIPTION: In the above graph Brake power is taken in x-axis and Mechanical Efficiency should be taken in y-axis. The Mechanical efficiency of the blends has been compared with diesel fuel at various loads and it is depicted in figure. It is observed that the Mechanical Efficiency was considering Higher over entire load range.

5. FUTURE SCOPE:

In the common test rig, each & every input parameter have to be changed manually and to find out the required output parameter, we have to measure by connecting the test equipment's manually and to carry out the calculations manually. In future this manual test rig can be computerized using software's which would be operator friendly

Modifications can be made such that it will result as a test bed and not as test rig which means any engine can be tested on the same setup.

Fuel consumption can be measure by volume difference or by weight difference. Radiator can be eliminated with direct connections. Flow meter is required for calculating mass and flow of exhaust gas.

CONCLUSION :

The complete design of each component has been discussed in detail and the same details are used for fabrication. The trial is carried on the engine and various performance parameters such as specific fuel consumption, Brake thermal efficiency, mechanical efficiency and heat balance at various load conditions.

1. As brake power increases fuel consumption also increases
2. Brake specific fuel consumption decreases with increase in brake power
3. Exhaust temperature increases as brake power increases
4. As brake power increases both brake thermal efficiency and mechanical efficiency increases

Our project might be have some its own limitations but an effort has been made to the fullest to make it successful.

REFERENCES

- 1) Jayesh D.Vaghmashi¹ Mr.D.R.Shah² Mr.D.C.Gosai³ - *An Experimental Study of Petrol Engine Using Compressed Biogas as aFuel* - IJSRD Vol. 2, Issue 04, 2014 ISSN (online): 2321-0613
- 2) N. BalajiGanesh¹,Dr. B Chandra Mohan Reddy² - *Performance Analysis of Multi-Cylinder C.I. Engine by using Various Alternate Fules-* Ijergs Volume 2, Issue 4, June-July, 2014 ISSN 2091-2730
- 3) SavitaPatil¹, Rupesh Kumar Malviya², Kuber Dwivedi³ -*Investigation on Performance Characteristics of Petrol EngineUsing Alternate Fuel* - IOSR e-ISSN: 2278-1684,p-ISSN: 2320-334XIssue 4 Ver. V (Jul- Aug. 2014),
- 4) AinaTFolayan,"influence of engine parameter on performance characteristics of spark ignition engine", Pelagia research (200 8) pp1915-1922.
- 5) Ganeshan.V "*Internal Combustion Engines*",7 Tata Mc.Graw Hill Publishing, New Delhi, 2002.
- 6) A Text Book on "*Internal Combustion Engines*" by Domkundwar
- 7) E.porpatham , A. Ramesh ,B. Nagalingam (2011) *Effect of compression ratio on the performance and combustion of a biogas fuelled spark igiton enigne journal homepage :www.elsevier.com/locate/fuel*
- 8) Hey wood John.B, "*Internal Combustion Engines Fundamental*", Mc. Graw Hill Book Company, New Delhi, 1988.
- 9) Carl S. Hansen, Conly Hansen, Greg Sullivan, "*Using Biogas as a Fuel for Trucks and Tractors* ",paper number: 074145,ASABE Meeting at Minnesota during 17 - 20 June 2007
- 10) C.C.M. Luijten, E. Kerkhof, "*Jatropha oil and biogas in a dual fuel CI engine for rural electrification* ",Energy Conversion and Management 52 (2011) 1426-1438
- 11) R. Chandra, V.K. Vijay , P.M.V. Subbarao , T.K. Khura, "*Performance evaluation of a constant speed IC engine on CNG, methane enriched biogas and biogas* ",Applied Energy xxx (2011)
- 12) A. S. Gautam, R .Garrick. J. H. Lee, C. M. Demico, P. E. Hannum and L. A.Villasmil, "*A Comparison of the Emission from Gasoline vs Compressed Natural Gas for an Electronic Fuel Injected Two Cylinder, Four-Stroke Engine*" SAE Technical Paper 2012-32-0016, 2012.