Optimization of kirloskar petrol engine performance by using open engine control unit

S. J. Adsul
Department of Mechanical Engineering,
Walchand college of engineering, Sangli, Maharashtra, India

P. A. Mane
Department of Mechanical Engineering,
Walchand college of engineering, Sangli, Maharashtra, India

S. S. Mulay
Apex Innovation pvt. Ltd, Kupwad m.i.d.c area, Sangli

Abstract - This paper deals with developing test bench which will give us idea about how to tune engine parameters and also give the flexibility to change the parameters electronically. To achieve this old carbutretor system is relpaced by gasoline port injection system. To carry out experimentation modified kirloskar single cylinder water cooled engine is selected. In optimization process of kirloskar engine air-fuel ratio is try to maintain constant through out the operating range of engine. Initially in Experimentation work tuning of engine is done as per the same load and rpm condition as that of carburetor. The rpm range varies in between 1000 to 1800 rpm. And Throttle opening varies in range of 20 to 100%. The graphs of brake power and brake thermal efficiency vs rpm is plotted for each throttle opening and part throttle efficiency of ecu based system is compared with crburetor system. For tuning of engine we have taken generic ecu of performnce electronics company from US.

Keywords – ecu , engine tuning, part load performance, gasoline port injection system.

I. INTRODUCTION

Today there is no escape from the computer in the modern car. While it is true that carburetors in the old days were doing the job of supplying an air/fuel mixture to the engine, there were a collection of compromises such as fuel economy, high emissions etc. When tuning the carburetor you had to decide which you were willing to give up: power or fuel efficiency. You couldn't get all three. To get all three, computer-controlled fuel injection is required which is one of the part of engine control unit. Today's automobile manufacturers strive to design automobiles that provide the best performance balanced against good efficiency. Efficiency has become a central issue in the design of new engines because of the need to meet tighter environmental regulations and the demand for fuel frugal automobiles by consumers.

Tuning the engine to achieve maximum efficiency is a huge part of getting the best performance out of the race cars. Making adjustments to the fuel injection system to change the amount and release time of fuel, changing the size or flow of fuel injectors, and utilizing the many available engine sensors to make other modifications can all have a great impact on engine horsepower and efficiency [11]. Modern engines use software loaded in the engine's Engine Control Module (ECM) to optimize performance and efficiency of the engine. The ECM collects all sensor data, interprets and processes this data, and then sends out control signals necessary for the smooth and efficient operation of the engine for example: In order to have complete combustion, the air-fuel mixture must be correct. The Stoichiometric ratio for air-fuel in a petrol engine is 14.7:1. This means that, volumetrically, 14.7 times more air than fuel is needed for complete combustion. The complete combustion of air yields carbon dioxide (CO_2) and water (H_2O). If there is not enough air then the combustion process will be incomplete and produce carbon monoxide, nitrous oxides and unburnt hydrocarbons as unwanted byproducts. The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper. In modern automobiles the ECM will have to calculate the amount of air entering the intake manifold before it can calculate the amount of fuel to deliver to each cylinder. To do this, the air flow, air temperature and air pressure is measured. For example, if the temperature is low, the air density will be high; therefore, more air will enter the intake manifold. However, if the pressure is high, the air density will also be high, thus more air will enter the intake manifold. Therefore various sensors are used to measure parameters such as mass air flow, air temp, air pressure then these sensors collect data and feed the information to the ECM. The ECM computes in real-time the correct amount of fuel to be injected into the cylinders and the firing times of the spark plugs. As cars became more complex and government regulations related to exhaust emissions became stricter, however, carburetors have been replaced with electronic fuel injection systems, which can more precisely control the flow of fuel to the engine. This results in optimum engine performance, better fuel economy, and lower exhaust emissions.

Now ECU is available in market but how to tune ECU, how mapping of engine is done and idea about how engine management system works such information is only limited to manufacturer of vehicles. Therefore test bench is developed in order to give above information through open ecu.

II. EXPERIMENTAL PROCEDURE

Table1- Specification of engine

Engine type	Kirloskar
Bore	0.088m
Stroke length	0.11m
No of cylinder	1
No of stroke	4
Type of cooling	Water cooled
Rated power	4.5kW @ 1800 rpm
Engine capacity	661cc
Variable compression range	6-10
Fuel used	Petrol

The Schematic diagram of experimental setup is as shown in Fig. 1. The engine used is a conventional single cylinder, water cooled, vertical four stroke SI engine. The specification of engine is shown in Table 1. The engine is basically diesel engine with a maximum speed of 1800 rpm. The above engine is modified to petrol mode through VCR technology by apex organization. The fuel injection system consisting of throttle body, solenoid operated fuel injector, fuel rail, pressure relief valve, electric operated fuel pump, fuel filter. In the experimental setup, we have used air temperature sensor, coolant temperature sensor, trigger sensor, throttle position sensor. The air temperature sensor is mounted at the air intake, coolant temperature sensor is mounted at water outlet of engine and trigger sensor is mounted at camshaft. The ignition timing, injection timing, air fuel ratio we can adjust it electronically. In the working of an engine control unit throttle position sensor gives information about how much air is going inside the combustion chamber and trigger sensor sends pulses to ECU to measure rpm. According to the signal from throttle position sensor and crank shaft position sensor ECU actuates injector to inject fuel quantity in terms of injector pulse width and also actuates spark plug to fire.

The engine is coupled to an eddy current dynamometer to measure speed and torque of the engine. The suitable instruments are connected to engine to measure air flow, fuel flow. Other than above experimental setup we have used combustion analysis software which will gives us direct measure of engine parameters such as brake thermal efficiency, brake power, indicated power, brake specific fuel consumption, air fuel ratio etc.

III. RESULT AND DISCUSSION

The aim of present study is to optimize the engine performance of electronically controlled engine over conventional carburetor engine. In the flow of conducting the experiments and optimizing engine performance, initially we have compared performance of conventional carburetor engine and electronically controlled engine. In this, the experiments are conducted at each throttle opening and rpm with same load condition as that of carburetor.

3.1. 40% Throttle opening

At 40% throttle position by keeping same load and rpm as that of carburetor the various parameters of engine are measured. The graph of brake power and brake thermal Efficiency are plotted against rpm. As reading for ECU based engine are taken at same load and rpm condition therefore brake power for both carburetor and ECU are approximately same. The brake power curve for both system is shown in Fig 2. It is observed that bsfc in case ecu based system is less than that of carburetor system. Therefore I got slightly better brake thermal efficiency in ecu based engine. The brake thermal efficiency curve is shown in Fig 3. At speed about 1113 rpm brake thermal efficiency has maximum value of 20.99%. And after that efficiency goes on decreasing as speed increases and is minimum at 1744 rpm. Because of error involved in measurement of air and fuel I have got such nature of curve.

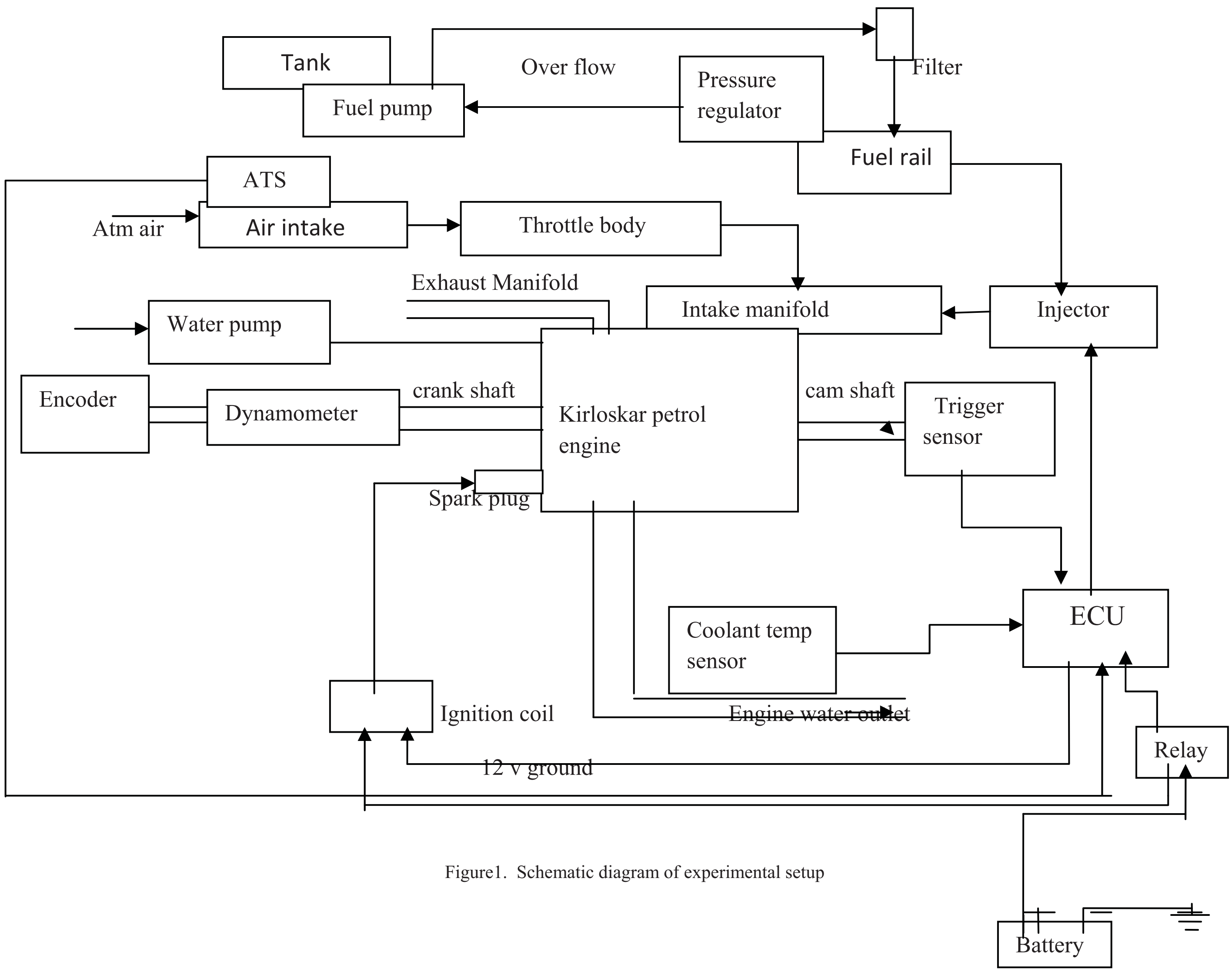

Figure1. Schematic diagram of experimental setup

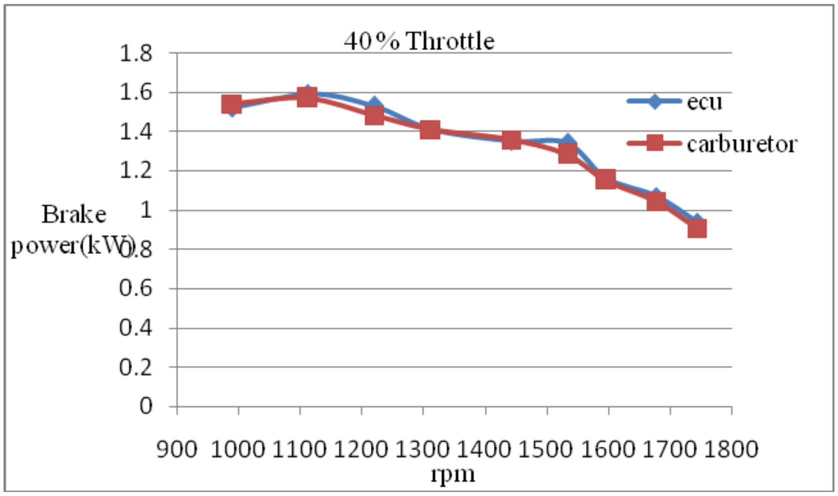

Fig. 2 variation of brake power vs rpm at 40% throttle opening

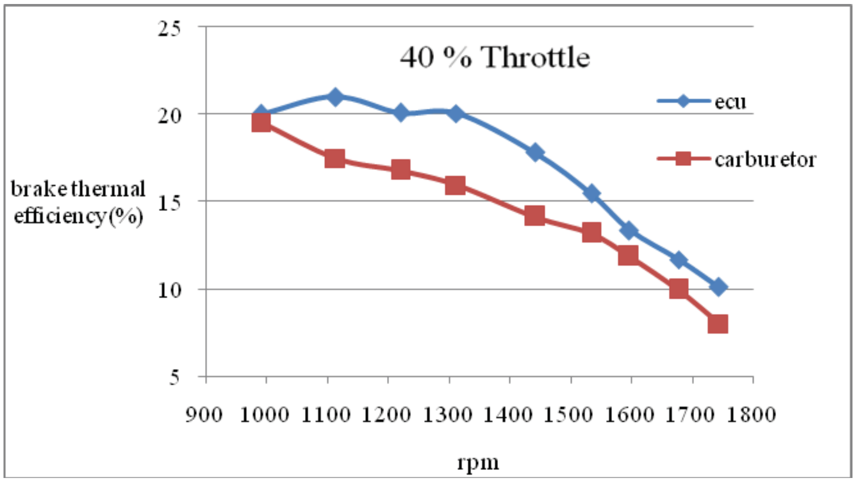

Fig. 3 variation of brake thermal efficiency vs rpm at 40% throttle opening

3.2. 60% throttle opening

As similar to that of 40% throttle, brake power for both ecu and carburetor is same. The brake power vs rpm and brake thermal efficiency vs rpm curve for 60% throttle is shown in Fig.4 and Fig.5. Brake thermal efficiency of ecu based system is more as compared to brake thermal efficiency of carburetor because bsfc in case of ecu based system is less as compared to carburetor system. And as compared to carburetor system ecu based system runs to a very lean mixture. The maximum value of brake thermal efiiciency in carburetor system is 20.56% and is increased upto 23.58% in ecu based system.

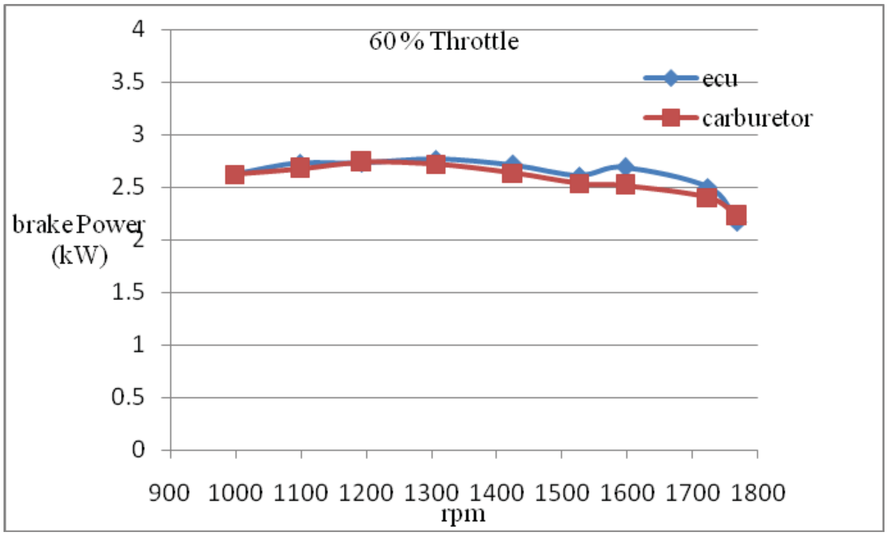

Fig. 4 rpm vs Brake power at 60% throttle

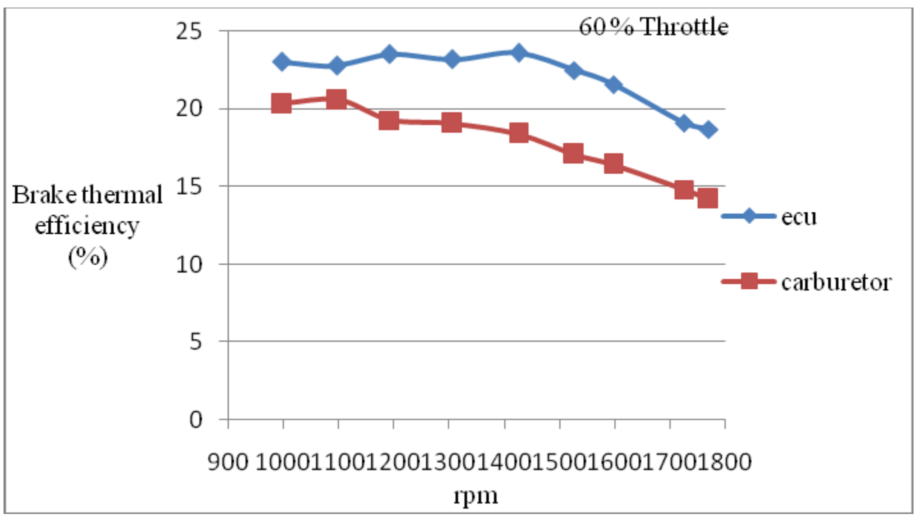

Fig. 5 rpm vs Brake thermal efficiency at 60% throttle

3.3. 100% throttle opening

The graph of brake power vs rpm and brake thermal efficiency vs rpm at 100% throttle opening is shown in Fig. 6 and Fig.7. In this graph as rpm increases brake power goes on increasing. The brake thermal efficiency of ecu based engine is 25.39%. and carburetor based engine is 25.13%.

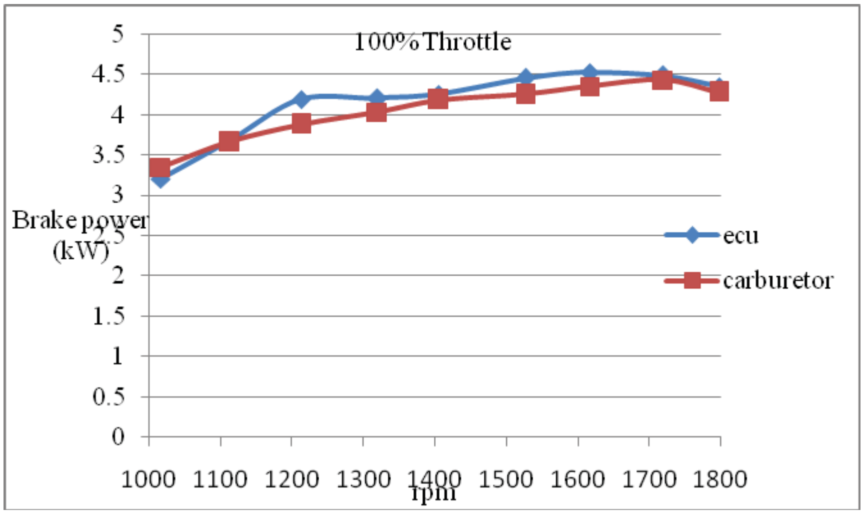

Figure 6. rpm vs brake power at 100% throttle

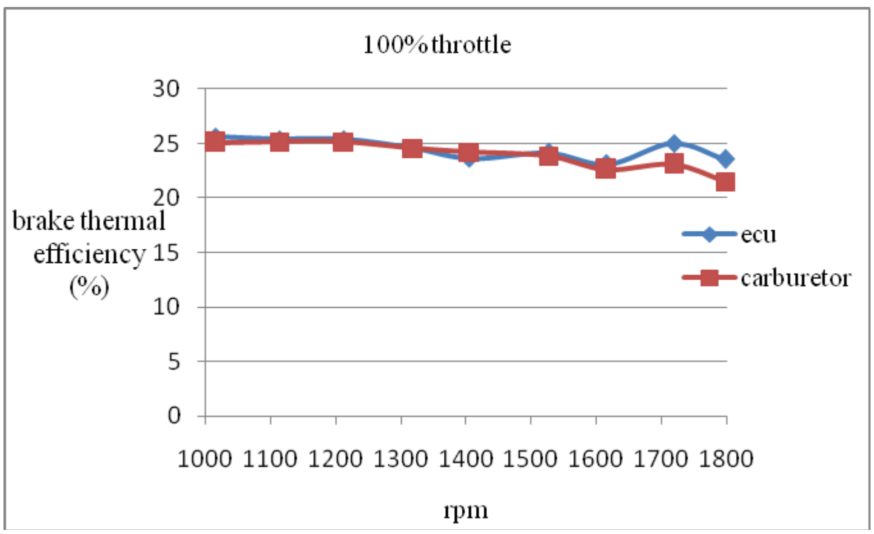

Figure 7. rpm vs brake thermal efficiency at 100% throttle

IV. CONCLUSION

From the above experimentation we can conclude that ECU based system works on a very chemically correct mixture as compared to carburetor system and due to this brake specific fuel consumption is minimum in case of ECU based system. Therefore brake thermal efficiency is increased in ECU based system.

As compared to that of carburetor system, accurate metering of fuel and air is possible in gasoline port injection system works.

REFERENCES

[1] D.A. Sen and A.A. Zainul Abidin, "An overview of the Engine Control Unit (ECU) and its sensors for the Mitsubishi G93 Engine", *Dept. of Electrical Engineering, University Tenaga Nasional, Malaysia.*

[2] Huizong Feng, Fenglin Liu, Yang Xu, "Functional Testing System Based on LabVIEW for Gas-fueled Automobile Engine ECU", *Automation College, ChongQing University of Posts and Telecommunications, ChongQing, China (ICACC) 2011, 357-361.*

[3] William B. Ribbens, "Understanding Automotive Electronics" *(November 1997), 147-182.*

[4] Jochen Schaffnit, Stefan Sinsel and Rolf lsermann, "Hardware-in-the-loop simulation for the investigation of truck diesel injection systems", *Institute of automotive control technical university of Darmstadt, American Control Conference Philadelphia, Pennsylvania (June 1998).*

[5] Luigi Glielmo , Francesco Vasca, Carlo Rossi, "Architecture for Electronic Control Unit Tasks in Automotive Engine Control" *Dipartimento di Infmatica e Sistemistica, Universitit di Napoli Federico 11,via Claudio 21,80125 Napoli, Italy, September 25-27,2000.*

[6] M. L. Mathur and R. P. Sharma, "Internal combustion engine", *Dhanpat Rao publications.*

[7] M. S. Shehate and S.M. Abdel Razek , "Engine performance parameters and emissions reduction methods for spark ignition engine" *engineering research journal 120, (december 2008) m32 – m57.*

[8] S. S Mohtasebi, A. keyhani and M. rahami, "Simulation, testing and sensitivity analysis of fuel pressure regulator for MPFI paykan 1600 cc engine", *journals of applied sciences 5 (4): 2005, 781-786.*

[9] Jacob fraden,**"**Hand book of modern sensor*", Advanced Monitors Corporation San Diego,California November 2003.*

[10] A.B. Greene, and G.G. Lucas, "The testing of internal combustion engines", *Department of transport technology, loughborough university of technology.*

[11] George Alexandrov, Kaitlin Bergin, and Rolih Ferdinand, "Automotive Engineering: Engine Fuel Map Design".

[12] V Ganesan, "Internal combustion engine", *professor Emeritus Deptt. Of sMechanical Engineering IIT Madras, Chennai.*

[13] www.indrabhagyadighanchi.org/10.html

[14] position/ speed sensor, Toyata motor sales, USA.

[15] Robert Bosch, "k- jetronics fuel injection manual",*Robert Bosch GmbH, 2000 Postfach 3002 20, D70442 Stuttgart. Automotive Equipment Business Sector, Department for Automotive Services, Technical Publications (KH/PDI2).*

[16] fuel injection system – Tbi electronic fuel injection jeep Cherokee 1988.