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Experimental Evaluation of Electronic Port Fuel Injection System in Four Stroke 125cc SI Engine

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Abstract—In Today's life, the two wheelers is best friend to us because wherever we gowe take it with us. And therefore we are all looking for higher performance and lower emission engines. And now a day, engines are using only carburetor for mixing of fuel and air. So these engines suffer lower operating efficiency, higher fuel consumption and produce higher level of harmful emission. So to overcome this problem,Electronic port fuel injection system is introduced. In this system the fuel injector injects fuel in accordance to need of engine which is measured by the various sensors like speed sensor, crank angle sensor, Lambda sensorand throttle body sensor, etc. And here Electronic Port Fuel Injection System for Four Stroke 125cc SI engine was designed and the Experimental Evaluation had made to investigate the performance parameters and emission parameters of the engine.

Index Terms— Small engine motorcycle, carburetor, Fuelinjection, higher performance, lower emission,

1. INTRODUCTION

Now a day, Motorcycles using carburettor systems have become the main option for transportation in many countries around the world. Here the motorcycle fleet around the world is shown in the Figure 1.1

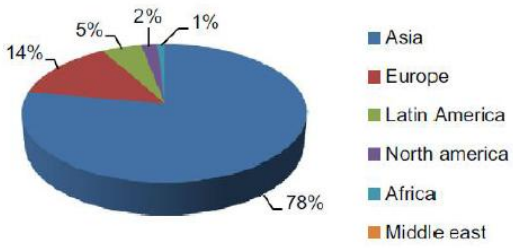

FIGURE 1.1 MOTORCYCLE FLEET

Due to increase in number of motorcycles in the roadside, the emission also gets increases and Even the performance of the mechanical injection system is also low .So to overcome this draw back the Electronic port fuel injection system is introduced.

1.1. MECHANICAL INJECTION SYSTEM

The carburettor vehicles are comes under the mechanical injection system. The word *carburetor* comes from the French word carbure which means "carbide" and *Carburer*means to combine with carbon .In this system the fuel and air are mixed to the ratio. And these ratio is attained by adjusting the two screw namely fuel screw and air screw. But we cannot adjust these two screws to correct ratio and these leads to lower performance and higher emission .Here the carburetor is shown in the Figure 1.2

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FIGURE 1.2 CARBURETTOR

1.2. FUEL INJECTION SYSTEM

It is a system in which fuel is finely atomized and injected into the cylinder through the inlet port in accordance to need of engine which is measured by the various sensors like speed sensor, crank angle sensor, Lambda sensor and throttle body sensor, etc. And there are different types of fuel injection system and they are

- Throttle body fuel injection system,
- Port fuel injection system,

- Direct injection system.

From these systems we have took Port fuel injection system which is comfort for small carburettor engines. And the Port fuel injection system block diagram is shown in the Figure 1.3.

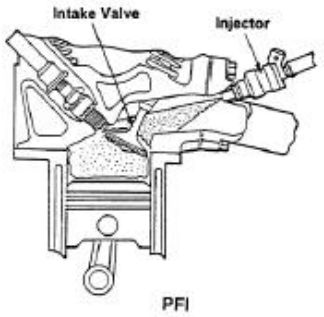

FIGURE 1.3 PORT FUEL INJECTION SYSTEM

2. DESIGN OF ELECTRONIC PORT FUEL INJECTION SYSTEM [EPFIS]

Thus the Electronic port fuel injection system had made on BAJAJ DISCOVER 125 CC BIKE by replacing carburettor in order to increase the performance and also to reduce the emission. The specification of the BAJAJ DISCOVER Bike is shown in the table.

Type	DTS-i, 4-stroke, Natural air cooled
Displacement	125 cc
Max Net Power	11 ps @ 8000 rpm
Max Net Torque	10.8 nm @ 5500 rpm
Max Speed	100 Kmph
Gears	5 Gears
Fuel Injection	Electronic Port Fuel Injection

TABLE 2.1 SPECIFICATIONS

2.1. ARCHITECTURE OF EPFIS

The general block diagram of Electronic Port fuel injection system is shown in the figure 2.1. In this system all the parts are controlled by Electronic control unit. The basic principle of fuel injection is that, at a constant differential pressure, the amount of fuel injected should be directly proportional to the electronically controlled injector opentime.

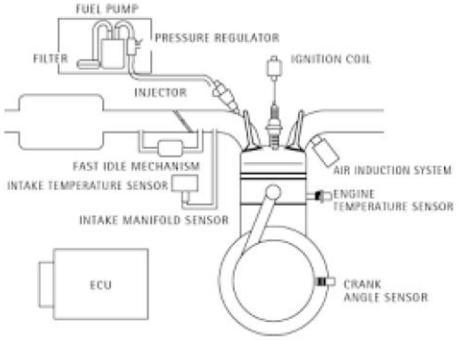

FIGURE 2.1 BLOCK DIAGRAM OF EPFIS

An Electronic control is being used for effectively controlling the air-fuel mixture in order to reduce emission.

2.2. MAJOR PARTS OF EPFIS

Some of the major parts of the EPFIS in order to fit in the BAJAJ DISCOVER 125cc Engine are.

- Crank angle sensor,
- Temperature sensor,
- Throttle position sensor,
- Mass air flow sensor,
- lambda sensor ,
- Electronic control unit,
- Fuel injector,
- Fuel pump and filter,
- Fuel Pressure regulator.

2.2.1. CRANK ANGLE SENSOR

A crank angle sensor is an electronic device used in an IC engine to monitor the position or rotational speed of the crankshaft of the engine. This information is used by engine management systems to control ignition timing and other engine parameters. Before electronic crank angle sensors were available, the distributor would have to be manually adjusted to a timing mark on the engine. The crank angle sensor is shown in the figure 2.2

FIGURE 2.2 CRANK ANGLE SENSOR

2.2.2. TEMPERATURE SENSOR

The temperature sensor is used to measure the temperature of the engine and its related parameter like air temperature and coolant temperature. Here the Thermistor is used to inform the ECU about the temperature on the engine.

2.2.3. THROTTLE POSITION SENSOR

The throttle body sensor is used to find the position of the throttle. This is a potentiometer type of sensor. At idle, the output should be 325mV and atfull load 4.8 V.

2.2.4. MASS AIR FLOW SENSOR

It is used to measure the mass of the air intake by the engine and the amount of air intake is directly proportional to the engine load. And there are two different types of mass air flow sensor and they are

- Flat type air flow sensor
- Hot wire air flow sensor

2.2.5. LAMBDA SENSOR

The Lambda sensor is used to measure the amount of unburned hydrocarbon present in the exhaust gas.These sensors operate above 300 C. There is a zirconium dioxide in between two plates one exposed to atmosphere with more oxygen, more electrons, thus negative and other plate to exhaust gas with less oxygen, less electrons, thus positive. The zirconium dioxide conducts oxygen ions proportional to AFR. Here the Lambda sensor is shown in the figure 2.3

FIGURE 2.3LAMBDA SENSOR

2.2.6. ELECTRONIC CONTROL UNIT

An engine control unit (ECU) is a type of electronic control unit that controls a many actuators on an internal combustion engine to ensure maximum engine performance.It does this by reading values from a many sensors within the engine bay, interpreting the data using multidimensional performance maps, and adjusting the engine actuators accordingly from sensors output.

2.2.7. FUEL INJECTOR

A fuel injector is nothing but an electronically controlled valve. It is supplied with pressurized fuel by the fuel pump in your car, and it is capable of opening and closing many times per second. When the injector is energized, an electromagnet moves a plunger that opens the valve, allowing the pressurized fuel to squirt out through a tiny nozzle. The nozzle is designed to atomize the fuel -- to make as fine a mist as possible so that it can burn easily. The amount of fuel supplied to the engine is determined by the amount of time the fuel injector stays open. This is called the pulse width, and it is controlled by the ECU.

FIGURE2.4 FUEL INJECTOR

2.2.8. FUEL PUMP AND FILTER

Fuel is collected from the tank via a paper filter. And fuel pump typically has resistance 0.8 ohms, voltage of 12 V, current

of 10.5 A.The fuel pump is controlled by the ECU via a fuel pump relay. When the ignition is first switched on, the pump runs for a short time toensure the system, is at correct pressure. The pump will then only run when the engine iscranked or is running. An inertia switch is usually located, which cuts the supply to the Fuel in case of a collision, to prevent fuel spillage.

FIGURE 2.5 FUEL PUMP AND FILTER

2.2.9. FUEL PRESSURE REGULATOR

The differential pressure across the injectors should be constant for correct pulse width control. When the manifold pressure exceeds the present value (of the spring) a valve is opened and the excess fuel is returned to the tank.

2.3. ELECTRONIC CIRCUIT OF EPFIS

The Electronic Fuel Injection System can be sub-divided into three main categories:

- Fuel Supply System,
- Sensing System,
- Data Processing.

The Purpose of Electronic Fuel Injection is to supply small amount of fuel into an engine's cylinders in order to operate the engine at a correct manner. Since condition of the engine is constantly changing, so the amount of fuel injected into cylinder must change along with the engine's need. To determine the correct amount of fuel to be injected into the cylinder at correct time, a computer called an Electronic Control Unit is used to calculate how much fuel that the engine requires at that time. Various engine sensors are used to determine the engine need. so that the fuel requirement is satisfied at all times. And the electronic circuit of EPFIS is shown in the figure 2.5

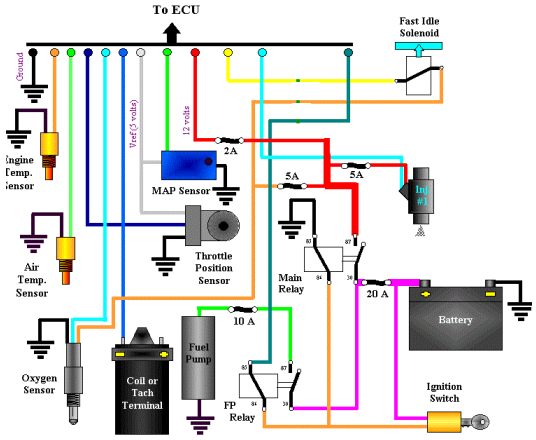

FIGURE 2.6 ELECTRONIC CIRCUIT OF EPFIS

2.4. FABRICATION OF EPFIS

It is so difficult to change the carburetted vehicle in to EPFI vehicle becauseuse the engine has previously designed for fitting carburettor and therefore lot of changes had to be made to fit sensors inside the engine. So aluminum casting and welding are made according to fit the parts inside the engine

3. PERFORMANCE TEST ON ENGINE

The performance test of the Carburettor SI engine at varying electrical load is carried out and the result are shown in the figures.

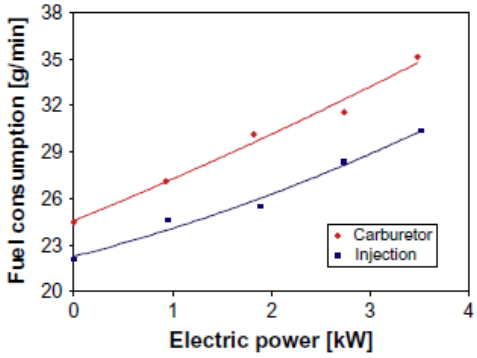

FIGURE 3.1 FUEL CONSUMPTION Vs ELECTRIC POWER

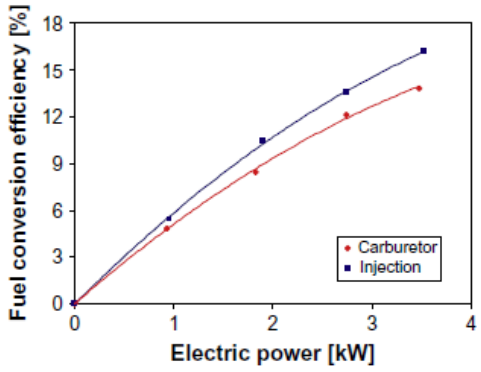

FIGURE 3.2 FUEL CONSUMPTION EFFICIENCY Vs ELECTRIC POWER

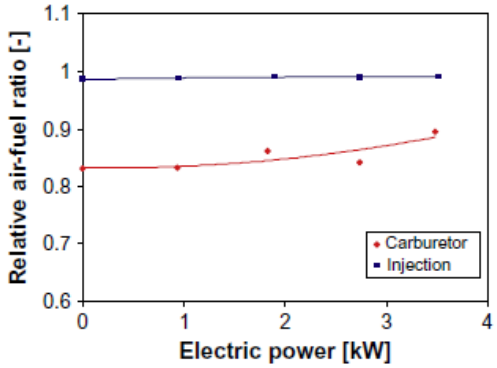

FIGURE 3.3 RELATIVE AIR-FUELS RATIO Vs ELECTRIC POWER

Here we can see that the relative air fuel ratio of the injection system and carburettor system. And this shows the injection system has relative air fuel ratio of about one.

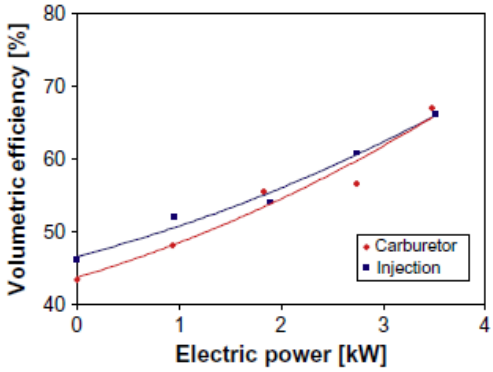

FIGURE 3.4 VOLUMETRIC EFFICIENCY Vs ELECTRIC POWER

4. EMISSION TEST ON ENGINE

The Emission test on the EPFIS Engine and Carburettor Engine was carried out at various engine load level (Electrical loading) using five gas analyzer. The results are shown in the figures

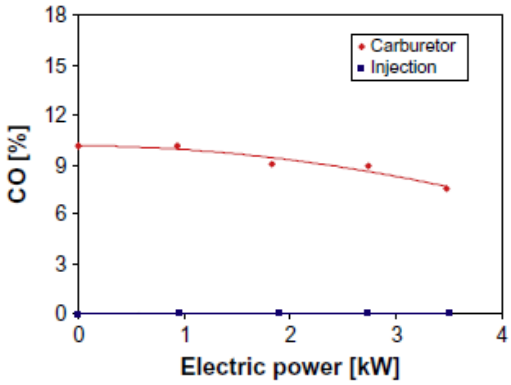

FIGURE 4.1 C0 Vs ELECTRIC POWER

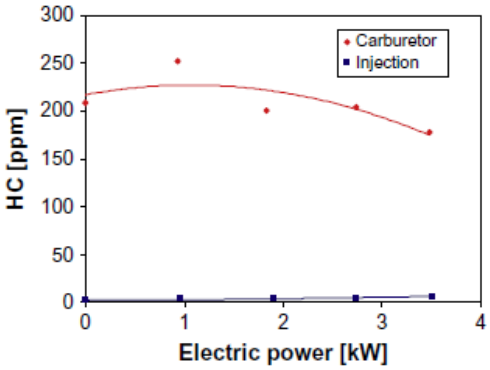

FIGURE 4.2 HC Vs ELECTRIC POWER

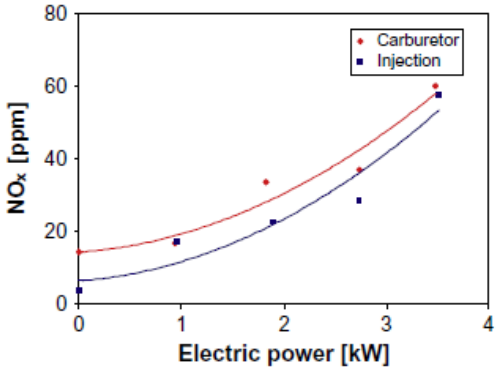

FIGURE 4.3 NO_X Vs ELECTRIC POWER

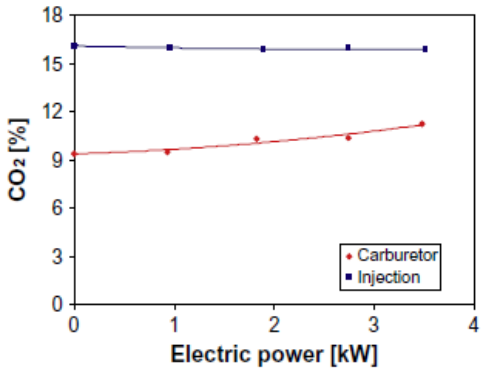

FIGURE 4.4 $C0_2$ Vs ELECTRIC POWER

Here we can see that the emission from the EPFIS Engine is lower than the normal carbureted engine. And the lambda is very much lower in this engine.

5. RESULTS AND DISCUSSION

The experiments have been carried out for both Carburetted and EPFIS engine at electrical loading conditions to determine the various parameters pertaining to performance and emission. After performing the analysis of power quality, conversion efficiency and pollutant emissions, it was evident that the fuel injection system ensured greatly improved performance and reduced environmental impact. And the result shows EPFIS Engine has very high performance and lower emission than Carburettor engine. And by using EPFIS we have also one more major advantage as mileage. Normally this kind of bikes gives 5-10 KM extra mileage per liter.

6. CONCLUSION

Thus the Electronic port fuel injection system had made on four stroke 125cc BAJAJ DISCOVER Engine by replacing carburetor. And here, Experimental investigations had carried out to evaluate the performance parameters and Emissions characteristics of the engine.

And then it was compared with carburetted engine to know about characteristic of both engines. And the result shows the Electronic Port Fuel Injection System has higher performance and lower emission than carburetted engine.

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