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Modification to Fuel Supply System of Honda CD125 Motorcycle Engine

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Abstract:- Fossil fuel which is a non-renewable energy source is ubiquitous in automobiles. The present study aims to introduce a closed-loop electronic fuel injection (EFI) system for a 125 cm^3 4-stroke gasoline engine, which tends to efficiently utilize fuel. A compatible prototype was developed and installed to the existing motorcycle engine with the aforementioned specifications in order to carry out experiments. Firstly, same volume of fuel is supplied to the selected engine with three different carburetors which are mechanical, EFI and the modified EFI and the engine was run at the speed of 6000 RPM. Then, the time taken to burn the given fuel volume was measured. Secondly, by using the three carburetors, an emission test was carried out and analyzed the gases emitted by each case. The results of the first test showed that the modified EFI system runs longer time compared to the mechanical system and shows that the system has better fuel economy. Also, the emission tests showed a significant reduction in CO and HC emitted by the modified EFI system compared to mechanical carburetor.

Keywords:- *About—Electronic Fuel Injection (EFI), Carburetor, Fuel Consumption, Engine.*

I. INTRODUCTION

Small gasoline motorcycle engines which have typical capacities in the range of 50cc to 250cc are widely used in many countries because of their convenience and good fuel economy due to the high power-to-weight ratio [2]. A survey of the worldwide motorcycles has been performed in 2001. According to the study, Asia stands 78% of the total number of motorcycle usage, Europe uses (14%) and Latin America uses (5%) of motorcycle for transportation [1] [9]. The reason of choosing motorcycles as a mode of transport has been due to the continuous increase in fuel prices. As motorcycle engines come with small engine capacity and lower fuel consumption, the fuel efficiency has been utmost interest to many manufacturing industries and research organizations. In small motorcycle, fuel system comes with carburetor which mechanically controls the air fuel mixture. However, this mechanical injection system has many disadvantages such as poor control of air fuel ratio during sudden acceleration and deceleration, cold start problems, no altitude compensations, and high emissions [2] [5]. Considering high usage of motorcycles on the road, this system has been the major contributor to air pollution especially in urban areas of developing countries [10]. Nowadays, due to the increase in fuel prices and emission limits, more attention has been paid to the fuel consumption and emission status of internal combustion engines. Therefore, an electronic fuel injection (EFI) system was developed which is an efficient system for controlling and supplying the optimal amount of fuel to the combustion chamber [6] [8]. Here, delivering an accurate and equal mass of fuel to cylinder of the engine [4]. Although this EFI system has been used for automobile cars since bigining, it has recently been used for motorcycles, then the number of motorcycle using the EFI fuel systemis very few [10]. As mentioned above, the benefits that are maintaining better fuel efficiency, better cold start and emission of minimum exhaust gas have become achieved as a result of including EFI for motor cars.

The present study was carried out in order to achieve the foregoing benefits of motor cars for motorcycles. A closed-loop electronic fuel injection system (modified EFI) was developed as a combination of electronic fuel injection system and the existing traditional motorcycle carburetor. In addition, this paper discusses different factors such as fuel injection timing and inlet air flow controlling that are required to control the quantity of fuel in the airstream for maximum fuel efficiency. The following sections will discuss methodology, test results and discussion and conclusion.

II. MATERIALS AND METHODS

Studies of previous literature helps nail down their significant failures, analysis of obtained data and data analysis regarding fuel saving methods that can be done for same motorcycles currently in use. Based on the recommendation from the literature survey, EFI method was selected as the most fuel-efficient method and the most suitable method for this study. In this EFI method there are two types of fuel injection systems being used. Considering the existing configuration of Honda CD125 engine, manifold fuel injection system was used such that it was able to fit easily. Then fuel supply system was designed as shown in Fig. 1 and Fig. 5 which presents the fuel diagram of the system. In an EFI system, fuel is needed to make high pressured (300 kPa) [10]. Then pressurized fuel is supplied to the fuel injector and the fuel injector delivers fuel to the combustion chamber as atomized fuel particles. This fuel pressure management is important in this study. Fuel pressure and butterfly valve are interconnected parts to maintain the air-fuel ratio. Then the air inlet system performance based on the volume of air drawn into the system depends on air pressure and density, throttle valve position, engine speed and the cleanliness of the air cleaner element [2].

A motorcycle that consumes more fuel was used for testing in this study. Its engine specifications are shown in TABLE 1. When introduced EFI to mechanical fuel system, fuel supply to the modified system was designed to provide required fluel pressure since the exsiting mechanical system doesn't buid up pressure. In the fuel system of EFI method, fuel is pumped by electronically driven turbine-style fuel pump and fuel system consists of a filter, fuel injector and presure regulator unit. The pressure in the fuel system is 300 KPa (43.5 Psi). Fuel is separated by a single-line fuel injector which works from a solenoid actuator needle valve. There, pressurized fuel is sprayed by fuel injector. The charateristics of the fuel injector are shown in TABLE 2.

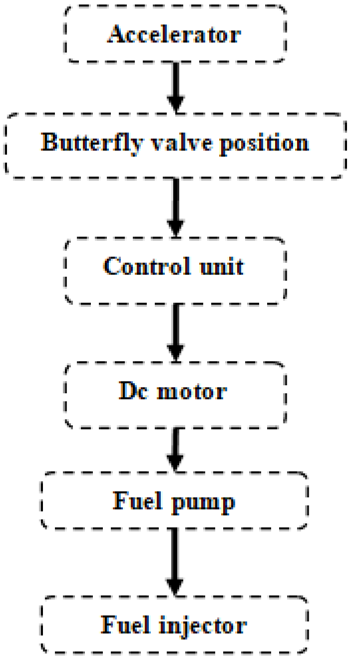

Fig 1:- 3D Design

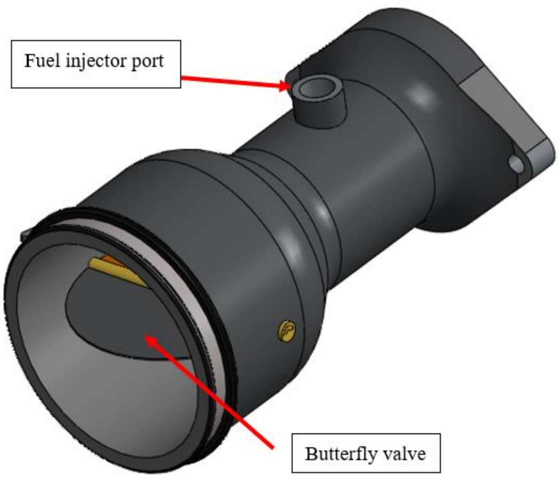

Fig. 2 Throttle body design

TABLE 1 Motorcycle engine specification

Motorcycle	Honda CD 125cc
Engine type	4 stroke Twin cylinder SOHC, Two valves per cylinder, air cooled engine.
Bore × Stroke	43.2 mm × 43.2 mm
Compression ratio	9.4:1
Max power	12.4 KW
Max Torque	9.8Nm at 6500rpm
Number of valves	4 valve overhead cam
Transition	4-speed constant mesh gear box

TABLE 2 Fuel injector specification

Sector	**Specifications**
Working voltage	12v - 14v
Temperature range	30ºc to 120ºc
Working pressure	100Kpa – 450 Kpa
Drive current	1Amp at 12v
Flow rate	38 g/min
Closed time	0.65 ms
Max open time	1ms at 300Kpa

Fig. 3. Testing arrangement

Fig. 2 shows 3D design of the throttle body and the final throttle body was manufactured according to this design. Then, the fuel supply system was changed in order to gain the required pressure for the modified system and operation of the fuel injector was based on crank position sensor signal. The pulse from the sensor was amplified to the fuel injector's sensible voltage. The exact time when the fuel injector opens is when the piston completes the first 90^0 degrees travelling from TDC to BDC. At this point, the inlet valve is fully opened. According to the electronic signals received by the fuel injector, it releases the compressed fuel into the combustion chamber as particles. The amount of fuel given to the combustion chamber is determined by the signal given by the throttle. Simultaneously, the pressure of fuel is increased by the pump. Then more fuel is supplied as per requirement. Here the RPM value of the engine depends on

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the amount of fuel supplied. According to the above description, it is clear that the engine RPM is indirectly influenced by the internal pressure of the fuel system. Fig. 3 shows an experiment carried out for this study where the new throttle body system was installed with the manifold and the engine was started. Fig. 5 shows a flow diagram of all the components from the fuel tank to injector.

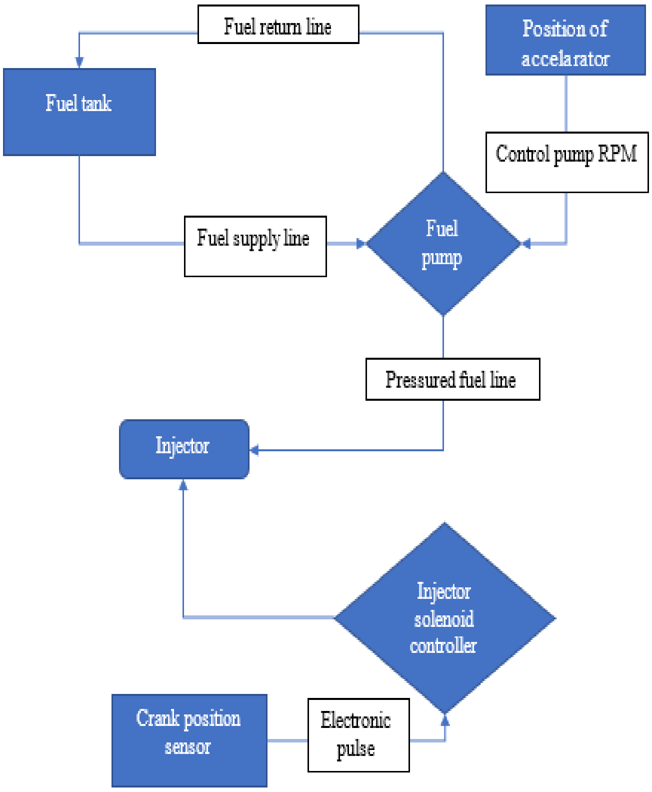

Fig. 4 Fuel system flow diagram

III. RESULTS AND DISCUSSION

TABLE 3 shows the results of an experiment using the given fuel amount of 0.25 liters. All the engines used here were maintained under the same conditions. This study has proven that the new system provides a more effective solution by maintaining a long run time. Further, it was observed that the engine run time has an increase by 25 minutes compared to mechanical carburetor. Fig. 4 shows fuel consumption in those three systems graphically. Furthermore, the fuel efficiency of the fully EFI manufactured motorcycles was higher than that of the modified EFI system, thus indicating that this study has the potential for further optimization. TABLE 4 shows the emission test (or called eco test) results with mechanical carburetor system, TABLE 5 shows the emission test results with modified EFI system and TABLE 6 shows the emission test results with fully EFI system. λ represents the ratio between the amounts of oxygen actually present in a combustion chamber vs. the amount that should have been present to obtain perfect combustion.

TABLE 3 Time based test

Type	Amount of fuel (Liter)	Engine RPM	Time (min)
Mechanical carburetor	0.25	6000	43
EFI	0.25	6000	105
Modified EFI	0.25	6000	68

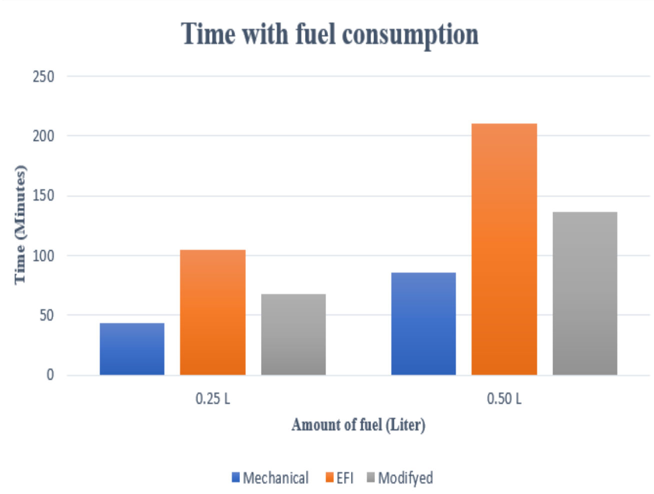

Fig. 5 Time with fuel consumption

According to the data, the motorcycle which uses the EFI system showed more environmentally friendly results. Secondly, the modified system showed a significant improvement in terms emissions. The observations show a pronounced reduction of harmful gases emitted by modified EFI system since CO amount in the exhaust is considerably lower than that of mechanical carburetor.

TABLE 4 Mechanical system emission results

	RPM	HC (ppm)	CO (ppm)	CO_2 (ppm)	O_2 (ppm)	λ
Idle	480	276	2.58	7.45	8.61	1.44
2500 RPM	2480	300	2.60	6.80	9.33	1.49

TABLE 5 Modified system emission results

	RPM	HC (ppm)	CO (ppm)	CO_2 (ppm)	O_2 (ppm)	λ
Idle	820	50	0.20	12.01	0.80	2.08
2500 RPM	2480	100	0.09	13.05	0.50	2.00

TABLE 6 EFI system emission results

	RPM	HC (ppm)	CO (ppm)	CO_2 (ppm)	O_2 (ppm)	λ
Idle	820	3	0.09	15.18	0.50	1.02
2500 RPM	2480	5	0.01	14.54	0.20	1.01

IV. CONCLUSION

In the present study, a standard mechanical carburetor in Honda CD125 four-stroke motorcycle engine was replaced with the modified EFI system to investigate fuel consumption. This includes new installation of an air induction system, fuel supply system, and input signal system. The modified EFI method shows better results in different speed ranges.

In the first test, the same amount of fuel was provided to the all three fuel injection systems and running time of each system was measured. It was showed that modified EFI was running long time period in comparison to mechanical carburetor. The second test measured the composition of gases emitted due to the three fuel systems. It was observed that the modified system has shown a significant reduction in CO and HC emitted by the engine compared to mechanical carburetor despite the fact that EFI system always shows the best results. It is interesting that the modified system has gained a positive impact on fuel economy and eco-friendliness and it seems as a potential technology to further improvements.

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