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A Study on Advance Electronic Fuel Injection System

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Abstract

This paper describes advanced fuel injection system for small vehicles which have recently become commercially available. system have been designed and developed by the authors' organization. This system called electronic fuel injection (EFI) use electrical and electronic device to monitor and control engine operation. An electronic control unit (ECU) or the computer receives electrical signals in the from of current or voltage from various sensors. The fuel injection pump is driven by an electric motors the pressure control valve regulates the pressure at 100 bar and the calibration fluid is injected through the nozzle into the measuring Cylinder. For the analysis fuel is injected to the virtual conical jar made at the bottom of injector. Fuel consumption and emission result from system are present, and in case it is shown that engine out exhaust emission meet current and future in Europe, India and Taiwan without the need for exhaust after treatment. It is also shown that system offer significant fuel saving relative to otherwise-equivalent, carbureted baseline vehicles. The paper also includes a short overview of the performance and cost implication of system relative to alternative emission control methods.

Keyword: - *fuel injection, electronics, fuel, engine, consumption, emission.*

I. Introduction

Electronic Fuel injection works on the some very basic principal. The following discussion broadly outlines how or Conventional Electronic Fuel Injection (EFI) system operates. The Electronic Fuel Injection system can be divided into three: basic sub-system. These are the fuel delivery system, air induction system, and the electronic control system.

- Strict emission standards require precise fuel delivery
- Computers used to calculate fuel needs
- EFI very precise, reliable & cost effective
- EFI provide correct A/F ratio for all loads, speeds, & temp range.

Fuel injection is a Fuel system for admitting fuel into an internal combustion engine. In olden days carburetors are used to fulfils this action. A Carburetor is a device that blends air and fuel for an Internal Combustion Engine. Carburetor works on the Bernoulli's Principle. The lower its static pressure, and the higher its dynamic pressure the throttle (accelerator) linkage does not directly control the flow of liquid fuel. [1]

During the last 30 years of or so, reductions in tailpipe exhaust emission of more than 90% have been demanded of, and achieved by the automobile industry. In addition to reduced exhaust emission, EFI has also introduced other benefits such as reduced brake specific fuel consumption, increased full-load output and improved drive ability. [2, 3]

II. Air Inlet System

The volume of air drawn into the system depends on air pressure and density, throttle valve position, engine speed and the cleanliness of the

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air cleaner element. The EEC IV module evaluates these factors through the Air Charge Temperature (ACT) sensor, Manifold Absolute Pressure (MAP) sensor Throttle Position Sensor (TPS) and control, the engine idle speed via the Idle Speed Control Valve (ISCV).

III. Improved Unit-To-Unit Repeatability

In the EU for example, two and three wheeled motor vehicles are currently believed to be responsible for 5-10% of overall HC and CO emission and it is anticipated that this proportion will increase to 15-20% by the year 2020 [4]. In some large Asian cities, the situation is already more serious; the high popularity of motorcycles in Taiwan for example, means that they are currently believed to be responsible for approximately 30% of overall HC and 40% of overall CO emissions [5].

IV. Fuel Injection System

In fuel injection system, induced air can be metered precisely and the fuel is injected in the manifold. The fuel injection system has a charge forming device which supplies a rich fuel and air mixture to a tuned injector tube connected adjacent to one and through a port or valve to the engine cylinder and is adjacent the other end to the engine crankcase. The charge forming device has an injector air inlet and fuel mixing passage to which under engine wide open throttle operating conditions at least a majority of the fuel is supplied by a high speed fuel circuit and preferably a minor portion of the fuel is also supplied by an idle circuit.

- Uses pressure (not Vacuum) from an electrical pump to spray fuel into the intake manifold.
- Provides the engine with proper air-fuel ratio (14.7:1)
- Apply advanced fuel injection system.

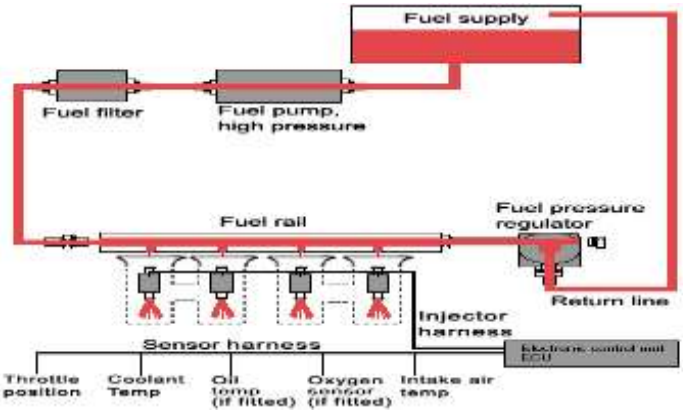

Figure.1. fuel injection system

This is the strategy advocate by Synerject for both 2-strok and 4-stroke engine, and the one which will be detailed in the remainder of this paper. Although higher in piece cost than either oxidation catalysts or SAI systems (refer Table 1 and Table 2), by offering significantly reduced fuel consumption and increased riding pleasure in addition to very low engine-out exhaust emission, we believe that such systems offer the best of all worlds to both manufacturer and end user on an overall cost/benefit basis. Of course, certain combinations of the various methods described above can also be implemented. For example, both 2-stroke and 4-stroke electronic injection system have been successfully combined with exhaust catalysts, and in the medium term it is anticipated that such systems will become 'standard' as emissions requirements become more stringent [6]. 'Combined fuel injection systems have therefore also been included in Table 1 and Table2, for System similar to this now appear in current model vehicles manufactured by Volkswagan-Porsche, Datsun, Volvo, General Motors, Chrysler, Citroen and others [7]. The flexibility of control offered by the electronic system permits features of fuel shut-off during deceleration, precise fuel metering and cylinder distribution, cold start enrichment, compensation for absolute air pressure (altitude compensation), enrichment for acceleration and full load , over speed cut-off, and protection from flooding. Automated production processes are

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now available for rapid individual system calibration [8].

The air induction system

- The air induction system consist of the air cleaner, air flow meter, throttle valve, air intake chamber intake manifold number, and intake.
- When the throttle valve is opened air flows through the air cleaner, through the air flow meter (on L type system), past the throttle valve, and through a well tuned intake manifold runner to the intake.
- Air delivered to the engine is a function of driver demand as the throttle valve is opened further, more air is allowed to enter the engine cylinders.

Table 1- Comparison of different emissions control system for small vehicle 2-stroke engine

System \ Attribute	Fuel consumption & CO_2 emissions	CO emissions	HC + NOx emissions	Emissions durability (catalyst aging / misfire)	Specific torque & power (Acceleration)	Cold start	Driveability	Maintenance (Oil / oil filter servicing)	Incremental piece cost * – relative	Incremental investment cost * – relative
2-stroke carburettor (Baseline):	(=)	(=)	(=)	(=)	(=)	(=)	(=)	(=)	0.0	0.0
Oxidation catalyst:	=	✓	✓	✗	✗	=	=	=	0.3	0.5
Replace with 4-stroke:	✓	✗	✓	✓	✗✗	=	✓	✗	1.0	2.0
2-stroke electronic injection ('eSDI'):	✓✓	✓	✓	✓	=	✓	✓✓	✓	1.0	1.0
'eSDI' + oxidation catalyst:	✓✓	✓✓	✓✓	✓	=	✓	✓✓	✓	1.3	1.5

Key	
✗✗	Much worse
✗	Worse
=	Equal
✓	Better
✓✓	Much better

Table 2 – Comparison of different emissions control systems for small vehicle 4-stroke engines

System \ Attribute	Fuel consumption & CO_2 emissions	CO emissions	HC + NOx emissions	Emissions durability (cat. aging / tampering)	Specific torque & power (Acceleration)	Cold start	Driveability	Maintenance (SAI valve inspection)	Incremental piece cost * – relative	Incremental investment cost * – relative
4-stroke carburettor (Baseline):	(=)	(=)	(=)	(=)	(=)	(=)	(=)	(=)	0.0	0.0
SAI (Secondary Air Injection):	=	✓	✓	✗	=	=	=	✗	0.5	1.0
SAI + oxidation catalyst:	=	✓✓	✓✓	✗	=	=	=	✗	0.8	1.5
4-stroke electronic injection ('SePI'):	✓	✓	✓	✓	✓	✓	✓	=	1.0	1.0
'SePI' + Three-Way Catalyst (TWC):	✓	✓✓	✓✓	✓	✓	✓	✓	=	1.3	1.5

Key	
✗✗	Much worse
✗	Worse
=	Equal
✓	Better
✓✓	Much better

Electronics control system

- The electronics control system consists of various engine sensor, electronic control unit (ECU), fuel injector assemblies, and related wiring.
- The ECU determines precisely how much fuel needs to be delivered by the injector by monitoring the engine sensor.
- The ECU turns the injectors on for a precise amount of time, referred to as injection pulse width of injection duration, delivery the proper air/fuel ratio to the engine.

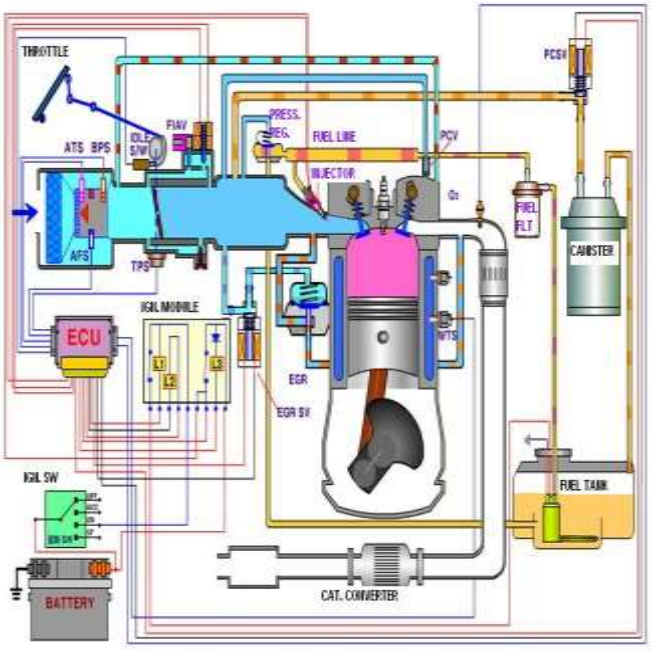

Figure.2. fuel injection system

Electronic Fuel Injection- uses various engine sensor and control module to regulate the opening and closing of injector valve.

- Fuel delivery system

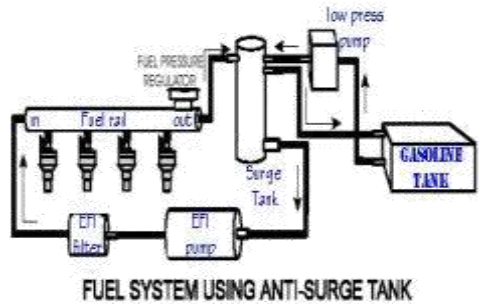

Figure.3. fuel delivery system

- Sensor system

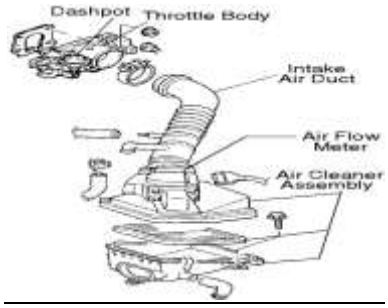

Figure.4. Sensor system

- Air induction system

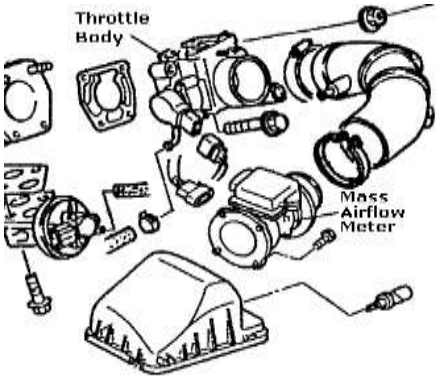

Figure.5. Air induction system

Mechanical injection system have appeared for many years in racing vehicles and in consumer applications. The earliest successful commercial offering of electronic fuel injection appeared in the 1958-59 Chrysler 300 sedan, a Bendix designed system [9]. In 1967, a system produced by Robert Bosch appeared in the Volkswagen Variant model, primarily designed to reduce in the face of 1968 U.S. pollution control regulations. The system offered "computerized" control, and successfully reduced exhaust emissions and improved fuel economy significantly compared to the non injected model [10].

V. Problem Defintion

Since in the convection fuel injectors the fuel is not mixed completely, we are making some change in the design of fuel injectors so as to increase the fuel and air mixing. So for this action to be done we are using multi hole fuel injector instead of single hole fuel injector because in single hole fuel injectors due to the high pressure change the flow of fuel from the fuel injector rushes to the combustion chamber following a hollow conic trace or shape.[1,11]

VI. Effect Of Fuel Pressure And Supply Volage

The fuel pressure is varied from 0.25 to 2.75 bar insteps of 0.25bar at different injector supply voltage varying from 6 to 12 volt DC in steps of one volt. Figure 4 show the variation of static fuel injection rate with the fuel pressure at different injector supply voltage. The static fuel injection rate with the fuel pressure non linearly as the increase in fuel pressure increase the fuel velocity, which increase the fuel injection rate. The relationship is a second order polynomial approximation. Also it is found that the same trend is observed for both injectors. From the figure 5 it is observed that the injector supply voltage does not influence the static fuel injection rate. As the injector supply voltage does not influence the static fuel injection rate. As the injection dead time is very small, which is in the order of ms, when compared to the total injection on duration of 60second, the effect of injection rate remains nearly constant for all injector supply voltages but increase with the fuel pressure for both injectors[12].

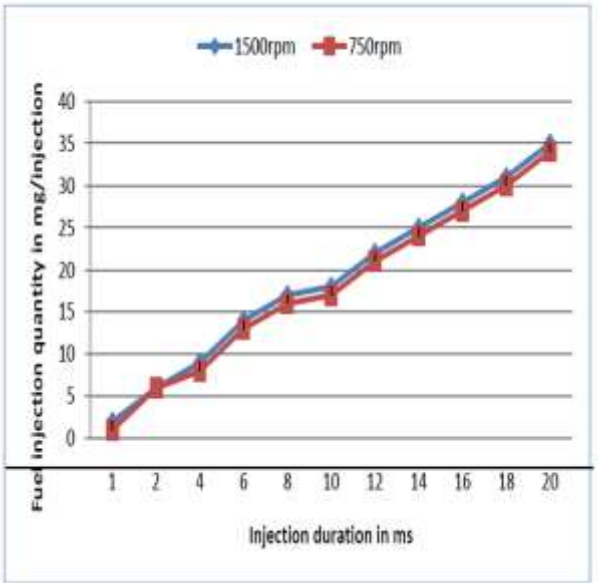

Figure.6. Variation of fuel injection rate with injection duration at two engine speeds

Basic System Operation

- The enters engine through the air induction system where it is measured by the air induction system where it is measured by the air flow meter. As the air flows into the cylinder, fuel is mixed into the air fuel injector.
- Fuel injectors are arranged in the intake manifold behind each intake valve. The injectors are electrical solenoids which are operated by the ECU.
- The ECU pulses the injector by switching the injector ground circuit on and off.
- When the injector is turned on, it opens, spraying atomized fuel at the back side of the intake valve.
- The precise amount of fuel delivered to the engine is a function of ECU control.
- The ECU determines the basic injection quantity based upon measured intake air volume and engine rpm.

VII. Advantage Of EFI

- Uniform Air/Fuel Mixture Distribution
- Excellent fuel Economy With Improved Emissions Control
- High Accurate Air/Fuel Ratio throughout all engine operating conditions
- Superior throttle response and power
- Improved cold engine
- Start ability and operation
- Simple mechanics, reduced adjustment sensitivity.
- The two fundamental improvements are:
  1. Reduce response time to rapidly changing inputs, e.g. rapid throttle movements.
  2. Deliver an accurate and equal mass of fuel to each cylinder of the engine, dramatically improving the cylinder-to-cylinder distribution of the engine. [12]

VIII. Conclusions

The main conclusions arising from the information presented in this paper are as follows:

1) Delayed fuel delivery, using a timed injection technique either at the in intake port or directly into the cylinder, is effective in circumventing the problem of back fire into the intake manifold.
2) Electronic control of fuel injection is feasible and may easily provide the control flexibility necessary for optimum overall engine performance.
3) An electronically actuated injection valve with sufficient flow rate and actuation speed can be fabricated and applied in either port or direct injection system.
4) The development in electronic fuel injection system has made it possible to overcome the level of pollution and improve the performance of engine in term of parameters like fuel consumption. It has eliminated the short circuiting losses completely.
5) The optimization of injection timing greatly reduces the specific fuel consumption and exhaust emission due to better control over the air fuel ratio.

6) The use of DI system can improve atomization which leads to proper burning of fuel and have less pollution and better efficiency.

References

[1]. Experimental and numerical analysis of fuel flow in the diesel engine injection nozzle Martin Volmajer, Breda Kegl, Ph.D.*Research assistant*

[2]. CONCAWE, "Motor Vehicle Emission Regulations and Fuel Specifications – Part 2 – Detailed Information and Historic Review (1970 –1999)", 2000.

[3]. Norbye J., "Automotive Fuel Injection Systems –A Technical Guide", ISBN 0 85429 347 7, 1985.

[4]. Commission of the European Communities, " Proposal for a Directive of the European Parliament and of the council Amending Directive 97/24/EC on Certain Components and characteristics of two of three-wheeled motor vehicles", 2000/0136(COD), 2000.

[5]. Environmental Protection Administration (EPA) of the Government of the Republic of China," Current Situation of Motorcycles Pollution Control in Republic of China", 1996.

[6]. Nuti M., "Emissions from Two-Stroke Engines", ISBN 0-7680-0215-X, 1998.

[7]. Tractor and Mechanical Publications, The Petrol Fuel Injection Book for Automobiles, P.I. 1972, Interautoco., Ltd, Middlesex, England (1972).

[8]. J. H. SCHLAG, Automatic Computer Controlled Calibration of EFI Control Units, SAE Trans., 760243, 1976.

[9]. A. WINKLER & R. SUTTON, Bendix electronic fuel-injection system, SAE Trans. 65 (1957).

[10]. G. BAUMANN, Bosch Electronically Controlled Gasoline Injection System for Spark Ignited Engines, Robert Bosch G.m.b.H., Stuttgart, W. Germany (1967).

[11]. Effect of the injection pressure on the internal flow characteristics for diethyl and dimethyl ether and diesel fuel injectors, Thulasi vijaykumar , rajagopal thundil karuppa raj, and kasianantham nanthagopal.

[12]. K.Kumaravel, "Experimental studies on the Comparison of static fuel injection characteristics of fuel injectors used in GDI engine''. International journal of advanced scientific and technical research'' ISSN 2249-9954, 2014.

[13]. Aprilia S.P.A., "DITECH, Direct Injection Technology", Press release, May 2000.

[14]. ACEM Pollution working group, "The motorcycle industry in Europe, ACEM Pollution Research Program on Motorcycles", 1998.