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PERFORMANCE OF ELECTRONIC FUEL INJECTION SYSTEM USING COMPRESSOR AND CONTROLLER

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Abstract
This paper studied about by using air compressor instead of fuel pump in which the petrol is pressurized by the compressed air which is sent to the fuel tank and the fuel comes out from the fuel tank through the regulating valve and it is directed towards the fuel injector. The fuel injector is controlled by using micro-controller and TPS (Throttle position sensor) which is mounted on the throttle body. The fuel eventually evaporated in the inlet port by velocity spray which is created by the injector by pulsating needle, which receive the signal from the micro-controller. Here, the effort is made to make the system in which, the compressor is only running to create a necessary pressure range and then reaching to its maximum range, it is shut-off during the engine running. When the petrol level and pressure in the fuel tank decreases to the minimum value, the compressor is start again. The working of fuel pump is totally eliminated. By this system, during the time interval between shut off to start point of compressor, we can save the available power of an engine which earlier continuously used to drive the fuel pump.

1. INTRODUCTION

All new cars produced today are equipped with Fuel injection systems instead of carburetors. Fuel injectors spray carefully calibrated bursts of fuel mist into cylinders either at or near opening to the combustion chambers. Since the exact quantity of gas needed is injected into the cylinders, fuel injection is more precise, easier to adjust and more consistent than a carburetor, delivering better efficiency and air pollution control. Fuel injection systems vary widely, but most are operated or managed electronically. Difference between carburetor and fuel injection system include: Fuel injection atomizes the fuel by forcibly pumping it through a small nozzle under pressure, but a carburetor releases the vacuum created by intake air rushing through it to add the fuel to the air stream. A carburetor has no electronic parts and thus does not need an electricity supply, and easier to service, while the fuel injection system has variable electronic control system.

1.1 WHAT IS FUEL INJECTION

An internal combustion engine, the fuel injection systems is that which delivers fuel or a fuel air mixture to the cylinders by means of a pressure from a pump. Fuel injection means metering fuel into an internal combustion engine. It was originally used in diesel engines because of diesel fuel's greater viscosity and the need to overcome the high pressure of the compressed air in the cylinders. A diesel fuel injector sprays an intermittent, timed, metered quantity of fuel into a cylinder, distributing the fuel throughout the air within. Fuel injection is also now used in gasoline engines in place of a carburetor. In gasoline engines, the fuel is first mixed with air, and the resulting mixture is delivered to the cylinders. Metering of the fuel

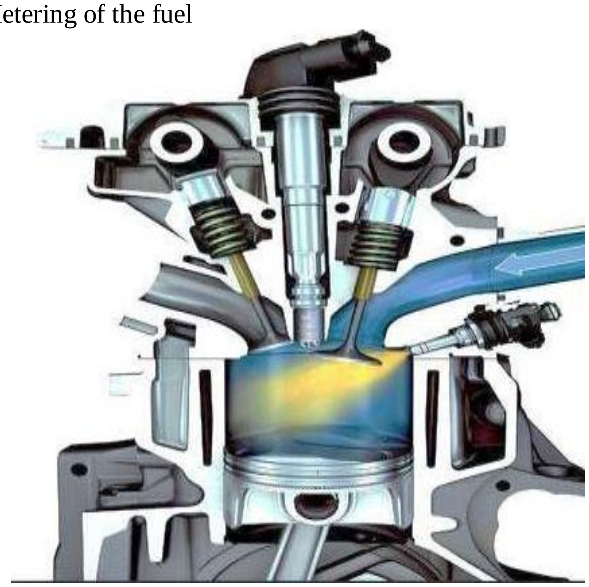

Figure 1 Direct Injection

charge may be preformed mechanically or electronically. In a diesel engine, the fuel injected directly into the combustion chamber (direct injection) or into a smaller connected auxiliary chamber (indirect injection). In the spark-ignition engine, the fuel is injected into the before it enters the combustion chamber by spraying the fuel into the air stream passing through the throttle body (Throttle Body Injection) or into the air flowing through the port to the intake valve. On automotive spark ignition engines, the carburetor has largely been replaced by a gasoline fuel injection system with either mechanical or electronic control of fuel metering.

1.2 OBJECTIVES OF FUEL INJECTION

The functional objectives for fuel injection systems can vary. All share the central task of supplying fuel to the combustion process, but it is a design decision how a particular system will be optimized. There are several competing objectives such as: Power output, Fuel efficiency, Emissions performance, Ability to accommodate alternative fuels, Durability, Reliability, Drivability and smooth operation, Initial cost, Maintenance cost and Diagnostic capability.

1.3 BENEFITS OF FUEL INJECTION

The two fundamental improvements are: 1. Reduced 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.

2.0 PORT FUEL INJECTION SYSTEM

In the port injection arrangement, the injector is placed on the side of the intake manifold. The injector sprays petrol into the air inside the intake manifold. The petrol mixes with the air completely. This mixture of petrol and air then passes through the intake valve and enters into the cylinders. Port fuel injection (PFI), systems use one injector at each cylinder. They are mounted in the intake manifold near the cylinder head where they can inject a fine, atomized fuel, mist as closed as possible to the intake valve. Since each cylinder has its own injector, fuel distribution is exactly equal. With little or no fuel to wet the manifold walls, there is no need for manifold heat or an early fuel evaporation system. Fuel doesn't collect in puddles at the base of the manifold. This means that the intake manifold passages can be turned or designed for better lowspeed-power availability. The port type systems provide a more accurate and more efficient delivery of fuel.

3.0 CENTRAL-PORT FUEL INJECTION SYSTEM (CPFI)

General Motors developed an "in-between" technique called central port fuel injection called CPFI. It uses tubes from a central injector to spray fuel at each intake port rather than the central throttle body. However fuel is continuously injected to all ports simultaneously, which is less than optimal. This system is very similar to the standard multi-port injection system. The main difference lies in the location and construction of the fuel injector(s). instead of an injector positioned at each intake manifold port, the injector(s) are centrally located in the intake manifold plenum assembly. Hence the name is given as a" central port fuel injection" (CPFI).

4.0 ECU

The core part of Ecotrons ECU is Free Scale's 16 bit or 32 bit microprocessor that is specifically designed for powertrain controls. ECU also includes some Application Specific Integrated Circuits, or ASIC chips, from world famous automotive semiconductor manufacturers, like Infineon, and International Rectifier etc. Most importantly,Ecotrons. ECU contains the state-of-art engine control software which combines both efficiency and flexibility of the modern engine control technology. Ecotrons has a few small engine ECUs; all small sizes and light weight. One is like the below picture, potted with the epoxy for weather proof. ECU judges the working state of the engine through the sensor measuring data acquisition and calculation. ECU performs Optimization and control tasks according to the existing and stored calibration data.

5.0 MICROCONTROLLER BASED ELECTRONIC ENGINE CONTROL

The HPC16164, a 16 bit microcontroller, from National Semiconductor has several features that make it ideal for automotive control applications. Based around a 16-bit core capable of instruction cycle times of 118 ns at 17 *MHz* clock input, it offers the fast exection speeds required for real time applications. On chip 16*KBytes* of ROM and 512 Bytes of RAM prove ample for the various data tables and variables that need to be manipulated. On board peripherals such as powerful timers and fast A/D converter additionally make it very attractive for engine control applications. Finally, the large I/O requirements of the application are supported by a space conserving PLCC package.

4.0 PROCEDURE OF PERFORMANCE TESTING: -

Check all the engines system like cooling system, fuel system and attachment of rope brake dynamometer. The fuel which is weighted at outside is filled up in the fuel tank. Insert the ignition key and start the engine by cranking. First, the engine should be run on No-load Condition. And note down the time of start of engine. The idling (No load mode), is adjusted by the adjustable screw provided at the throttle body in such a way that the speed of the engine during idling is maintained about 1500 rpm. Then, allow the engine to run on this condition up to one hour and after one hour shut off the engine. Then, the door of the fuel tank is opened and remaining fuel in the fuel tank is drawn outside and weighed again. Note down the fuel consumption of engine on idling condition during one hour running. Then, 10 *Kg*. weight is applied on the rope brake dynamometer, by adjusting the dead weight on the rope so that, the net load on the engine (W – S) = 10 *Kg*, where W = Dead Weight (L * 9.81) *N*. and S = spring Pull (*N*).in running condition of engine at 1500 *rpm* constant.Then, again the fuel tank is filled with the weighted fuel and allows the engine to run on same condition for one hour. After one hour, shut-off the engine and drawn out the remaining fuel from the fuel tank by opening bottom door and weightened . Note down the fuel consumption of engine on 10 *Kg*. load condition during one hour running. Repeat the same procedure for applying the load 20, 30 and 40*Kg*. successively and note down the fuel consumption for 1 hour running of engine.

5.0 WORKING OF ENGINE

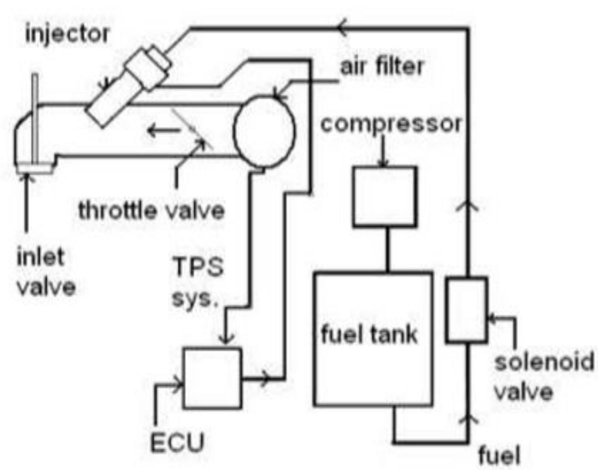

Figure 2

6.0 COMPRESSOR

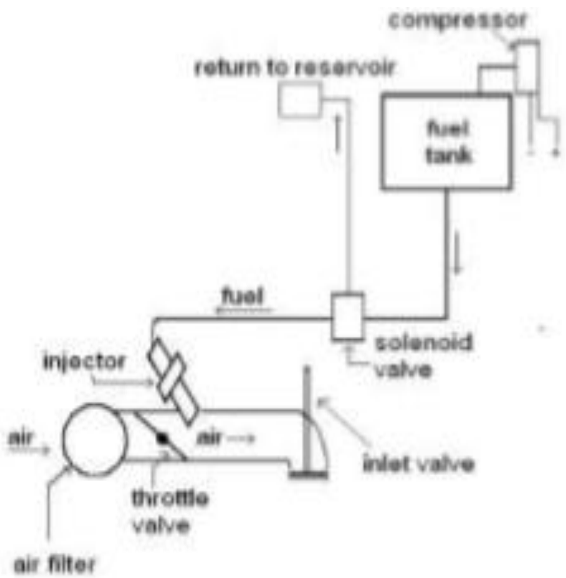

Figure 3

First, the compressor is run by giving the supply from 12 *V* battery and pressure in the fuel tank is created up to 3 *bars.* As soon as, the pressure of 3 *bar* is gained, the compressor is shut-off either by manually switch provided on the compressor or by arranging the automatic cut-off.Then, the engine is started by cranking and simultaneously the motor pump is started for cooling the water jacket. The Throttle Position Sensor (TPS) is positioned in such a way that during idling (No load mode), minimum of fuel is supplied. After some time, due to continuous running of engine, the level of petrol in the fuel tank gets lower and pressure inside the fuel tank is decreased. Then, the compressor is again started and necessary pressure range (1.25 to 3.5 *bar*) is built up again. After the sufficient pressure range in the fuel tank is gained, again the compressor is shutoff. This process is repeated till the engine is running.

7.0 WORKING OF FUEL INJECTOR, MICROCONTROLLER

When the micro-controller circuit is switched on, the voltage signal from the Throttle Position Sensor (TPS) goes into the controller depending upon the amount of flow of air through the throttle valve. The micro-controller receives the signal from the TPS and processes on the received data and produces a pulsating 12 *V* signal which goes to the fuel injector which is connected to a small plate type sensor and control mechanism of needle valve. Depending upon the flow of air through the throttle valve, the amount of fuel injected by the fuel injector is controlled by the control signal applied by the micro-controller.At the idling, the frequency of signal is set high in micro-controller and when the engine is accelerated by opening of throttle valve, depending upon the different load conditions, the frequency of a pulsating 12 *V* signal decreases and simultaneously the quantity of fuel injected increases with increase in the amount of sucked air during suction stroke by more opening of needle valve of fuel injector. Thus, the air-fuel mixture is kept constant throughout the working of engine on particular operating conditions.

8.0 PROCEDURE OF PERFORMANCE TESTING

The fuel tank is filled with the weighted fuel. Then, switch on the battery and start the compressor to increase the pressure of fuel by compressed air. When fuel comes out from the fuel tank and reaches to the fuel injector line, start the engine by cranking. Switched on the micro-processor and adjust the rope brake dynamometer on idling (No load) condition. Allow the compressor to run on the interval of time by the manual ON/OFF switch. Allow the engine to run continuously for one hour in idling conditions and then shut off. Open the fuel tank and drawn out the remaining fuel and weighed it. Note down the reading of fuel consumption for one hour running of the engine. Then, apply 10 *Kg.* weight on rope brake dynamometer by adjusting the dead weight accordingly and allow the engine to run on same condition for one hour and note down the fuel consumption. This process is repeated by applying 20, 30 and 40 *Kg.* load on the rope brake dynamometer and note down the fuel consumption.

9.0 RESULTS

Load on Engine (Kg.)	Speed Of Engine (rpm)	Fuel Consumption (Kg/hr)
No load (Idling)	1500	3.05
10	1500	3.32
20	1500	3.57
30	1500	4.12
40	1500	4.88

Load on Engine (Kg.)	Speed of Engine (rpm)	Fuel Consumption (Kg/hr)
No load (Idling)	1500	2.86
10	1500	3.11
20	1500	3.42
30	1500	4.02
40	1500	4.46

10.0 CONCLUSION

After performing test on a Engine with CPFI system using compressor, following conclusions may be drawn.By using CPFI system, the power available at the shaft can be saved by using compressor with cut-off system instead of fuel pump which continuously operates and receive the power from engine. By using CPFI system, we can maintain the air-fuel ratio same as in case of normal engine without the carburetor. By using CPFI system, we can reduce the fuel consumption of engine up to little extent but definite amount. By using CPFI system, the engine can be run economically with prolonged application over the cost of compressor and micro compressor. By using CPFI system, the brake thermal efficiency can be increased.

REFERENCES :

1. Diesel Fuel Injection published by Robert Bosch GmbH, 1994.
2. Wertheimer.H.P., 1993, "Electronic fuel injection for gas engines/ compressors, American society of mechanical engineers paper No.ETCE-98-4693.
3. Diesel injection pumps, Diesel injectors, Diesel fuel pumps, turbochargers, Diesel trucks all at First Diesel Injection LTD". Firstdiesel.com. Archived from the original on 2010-11-18. May 11, 2009.
4. Cengle, Y.A., & Boles, M.A. (2008). Thermodynamics: An Engineering Approach. 6th ed. New York, N.Y.: McGraw-Hill.
5. C. L. Ford, J. F. Carrotte and A. D. Walker, "The Impact of Compressor Exit Conditions on Fuel Injector Flows" ASME Journal of Engineering for Gas Turbines and Power , Volume 134 , Issue 11.
6. https://www.sae.org/publications/technical-papers/content/920295/
7. https://www.sae.org/publications/technical-papers/content/880180/
8. https://www.slideshare.net/sam_e_square/performance-of-electronic-fuel-injection-system-using-compressor-and-controller-53802352
9. International Journal of Mechanical Engineering and Technology (IJMET)
   Volume 6, Issue 11, Nov 2015, pp. 33-42, Article ID: IJMET_06_11_004