Review on Fuel Injection System For Petrol

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Abstract

Fuel injection is the process of injecting fuel in the air to provide an air-fuel mixture to the engine. Air enters through the air induction system, as air flows into cylinder, fuel is mixed into the air by the fuel injector. Fuel injectors are arranged in the intake manifold behind each intake valve & these are operated by the ECU. The Electric Control Unit (ECU) decides the instant of opening of the valve and the timing of operation. Decision making depends on various sensors placed at various parts of engine.

***Keywords**: Fuel, ECU, Intake Manifold*

1. INTRODUCTION

Fuel injection is the process of injecting fuel in the air to provide an air-fuel mixture to the engine. This supply has to be precisely controlled and accurately timed to ensure an optimum performance of engine with maximum possible efficiency.

2.Types of Petrol Fuel Injection

1. Single-point, central fuel injection or throttle bodyinjection (TBI)
2. Multi-point fuel injection (MPFI)
3. Continuous injection
4. Sequential fuel injection (SFI)
5. Simultaneous injection
6. Direct injection

2.1 Single-Point, Central Fuel Injection or Throttle Body Injection (TBI)

The system injects fuel into the throttle-body (a wet system), so fuel can condense and cling to the walls of the intake system. This system also resulted in harming emissions. Computer-controlled TBI was inexpensiveand simple, however, and lasted well into the 1990s

2.2 Multi-Point Fuel Injection (MPFI)

Multi-point fuel injection devotes a separate injector nozzle to each cylinder, right outside its intake port, which is why the system is sometimes called Port injection. Shooting the fuel vapors this close to the Intake pod almost ensures that it will be drawn completely into the cylinder. The main advantage is that MPFI meters fuel more precisely than do TBI designs, better achieving the desired air/fuel ratio and improving all related aspects. Also, it virtually eliminates the possibility that fuel will condense or collect in the intake manifold. With TBI and carburetors, the intake manifold must be designed to conduct the engine's heat, a measure to vaporize liquid fuel. This is unnecessary on engines equipped with MPFI, so the intake manifold can be formed from lighter-weight material, even plastic.

2.3 Continuous Fuel Injection System (This is a mode of injection)

Continuous fuel injection systems provide a continuous spray of fuel from each injector at a point in the intake port located just before the intake valve. Because the entrance of the fuel into the cylinder is controlled by the intake valve. (Intermittent injection)

2.4 Sequential Fuel Injection (SFI) (This is amode of injection)

Sequential fuel injection, also called sequential port fuel injection (SPFI) or timed .Injection, is a type of multi-port injection. Though basic MPFI employs multiple injectors; they all spray their fuel at the same time or in groups. As a result, the fuel may" hang- around" a port for as long as 150 milliseconds when the engine is idling. This may not seem like much, but it's enough of a short coming that engineers addressed it: Sequential fuel injection triggers each injector nozzle independently. Timed like Spark Plugs, they spray the fuel immediately before or as their intake valve opens. It seems a minor step, but efficiency and emissions improvements come in very small doses.

2.5 Simultaneous Injection (This is a mode of injection)

In multi-point injection, the injectors can all be triggered simultaneously, twice per cycle. In a throttle- body system, the central injector is normally triggered on each ignition pulse. With 2injectors, alternate triggering may be used.

2.6 Direct Injection

Direct injection takes the fuel injection concept about as far as a can go, injecting fuel directly into the combustion chambers, past the valves .More common in diesel engines, direct Injection is starting to pop up in petrol engine designs, sometimes called DIG for direct injection gasoline or GDI for Gasoline Direct Injection. Again, fuel metering is even more precise than in the other injection schemes, and the direct injection gives engineers yet another variable to influence precisely how combustion occurs in the cylinders. The science of engine design scrutinizes how the fuel –air mixture swirls around in the cylinders and how the explosion travels from the ignition point. Things such as the shape of cylinders and pistons; port and spark plug locations; timing, duration and Intensity of the spark; and number of spark plugs per cylinder (more than one is possible)all affect how evenly and completely fuel combusts in a gasoline engine.

3. Working of the System

Air enters through the air induction system, as air flows into cylinder, fuel is mixed into the air by the fuel injector. Fuel injectors are arranged in the intake manifold behind each intake valve & these are operated by the ECU. The Electric Control Unit (ECU) decides the instant of opening of the valve and the timing of operation. Decision making depends on various sensors placed at various parts of engine.

3.1 COMPONENTS :

- Fuel Tank
- Fuel Feed Pump
- Injection Pump
- Injectors
- Fuel Filter

4.Types of Sensors used in the System

4.1Mass Airflow Sensor

For by increasing the passageway of an idle speed control device. This lets more air by-pass the throttle this air has been measured by the airflow meter, so extra fuel is metered to maintain the same air fuel.

Primary Sensor and ComponentInformation

The mass type airflow sensor detects the mass of air flowing in to the intake manifold. By measuring the mass of the air, it prevents changes in air density affecting the air-fuel mixture.

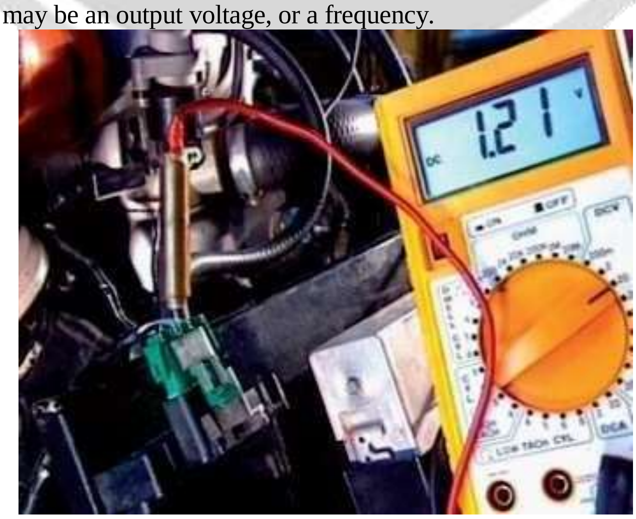
4.1Mass Airflow Sensor

The airflow meter has an electrically-heated wire, mounted in the air stream. A control circuit is linked to the wire, and current is supplied to the wire to keep its temperature constant. The higher the airflow, the more the temperature of the wire falls - and the higher the current needed in the wire to keep its temperature constant.

So how this current varies is a measure of what is happening to the air flow. Current flow variation is then read as an output voltage, and converted by the ECU to an intake air signal. This determines the basic fuel quantity needed for injector pulse duration. The air flow meter can have a self-cleaning function that burns dust and other contaminants from the hot wire. This is done by the control unit heating the wire to 1000°Celsius for approximately 1 second. This happens 5 to10 seconds after the ignition is switched off. This function operates only when certain conditions have been met. For this vehicle, the engine must have reached operating temperature, and the vehicle must have been travelling above 10 kilometers an hour or above 6.2 miles per hour. In some types of sensors, the hot wire is mounted in a sub passage connected to the main passage. This allows maximum airflow through the main passage. The hot wire may be sealed in a glass envelope. This protects the wire, and eliminates the need for burn-off. In others, the heating element is a ceramic plate.

4.2 Manifold Absolute PressureSensor

Changes in engine speed, and load, cause changes in intake manifold pressure. This sensor measures these pressure changes and converts them into an electrical signal. It's called a manifold absolute pressure, or MAP, sensor. The signal may be an output voltage, or a frequency.



By monitoring output voltages, the control unit senses manifold pressure and uses this information to provide the basic fuel requirement. It can use a piezoelectric crystal. If there is a change in the pressure exerted on this crystal, it changes its resistance. This alters its output sensor is connected to the intake manifold by a small diameter, flexible tube. The control unit sends a 5 volt reference signal to the sensor. As manifold pressure changes, so does the electrical resistance of the sensor, and this in turn produces change in the output voltage. During idling, manifold pressure is low, which produces a comparatively low MAP output. With wide open throttle, manifold pressure is closer to atmospheric, so output is higher.

4.3 Tachometric Relay

A tachometer is used to indicate engine RPM. It is normally connected to the negative terminal of the ignition coil. The pulses from the ignition primary circuit are then used as an input to operate the tachometer. At idle speed, the frequency of the pulse is steady. As the engine speed rises, the frequency of the pulse increases, as the tachometer indicates. As a safety measure, the tachometric relay uses an input (from the negative side of the ignition coil) to ensure the relay operates only when engine speed is above a specified minimum, say, 350 RPM. In this way it can operate as a safety device, ensuring for instance that the fuel pump operates only when the engine speed exceeds this figure

4.4Temperature Sensor

To maintain the air-fuel ratio within an optimum range, the control unit must take account of coolant temperature and air temperature. Extra fuel is needed when the engine is cold, and when the air is colder, and therefore denser The coolant temperature sensor is immersed in coolant in the cylinder head. It consists of a hollow threaded pin which has a resistor sealed inside it. This resistor is made of a semiconductor material whose electrical resistance falls as temperature rises. The signal from the coolant temperature sensor is used to control the mixture enrichment when the engine is cold and is processed in the control unit. Enrichment occurs during engine cranking, and then slowly reduces he engine warms up. This ensures a steady engine response immediately after releasing the starter. The control unit continually monitors coolant temperature during engine operation. If the air temperature sensor is installed in the airflow sensor, it’s positioned in the air stream, and it’s called an intake air temperature sensor, or IAT.

4.5Cold Start Systems

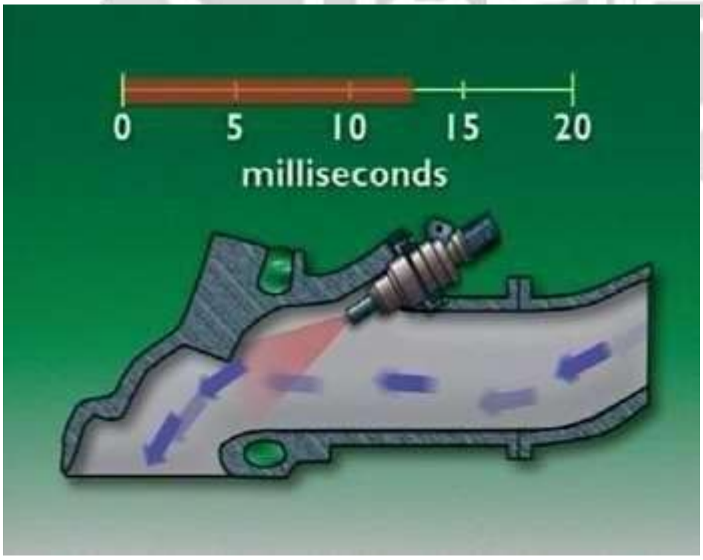
When a cold engine starts, some of the fuel injected by the main injectors condenses on the cold intake port or the cylinder walls .Less fuel stays mixed with the air, which weakens the mixture. To overcome this and ensure a rapidstart, an extra supply of fuel must be provided.

In some cases, during engine cranking, extra injection pulses in each revolution can provide the extra fuel. It depends on engine temperature, and there is a time limit to prevent flooding. The cranking period is followed by after- start enrichment. Over about 30 seconds, this slowly reduces to normal warm-up. The engine then responds steadily, immediately after releasing the starter. More air comes from an auxiliary air valve or by pass air control valve. This bypasses the throttle valve, to raise the engine's idle speed when it is cold, and during warm- up .Extra fuel can also come from a separate cold-start injector, normally mounted centrally on the plenum chamber. It's supplied with fuel under pressure from the fuel rail, and only operates when the engine is cranking.

A switch called a thermo time switch, immersed in engine coolant, completes the electrical circuit. It controls the operation, according to engine temperature. This ensures the injector operates under cranking conditions only when the engine is actually cold. The control unit can help cold- starting and provide cranking enrichment by increasing the pulse width of the injectors. This is in addition to the cold- start injector operation, and is again, temperature- controlled. Some sequential systems use a pre-injection of fuel. This means all injectors open simultaneously, to provide an initial injection of fuel. This happens only during cold cranking, and there is a time delay, to preventpre-injection occurring again within a certain time if the engine does not start. The system reverts to sequential injection when the engine starts.

4.6Fuel System Sensor

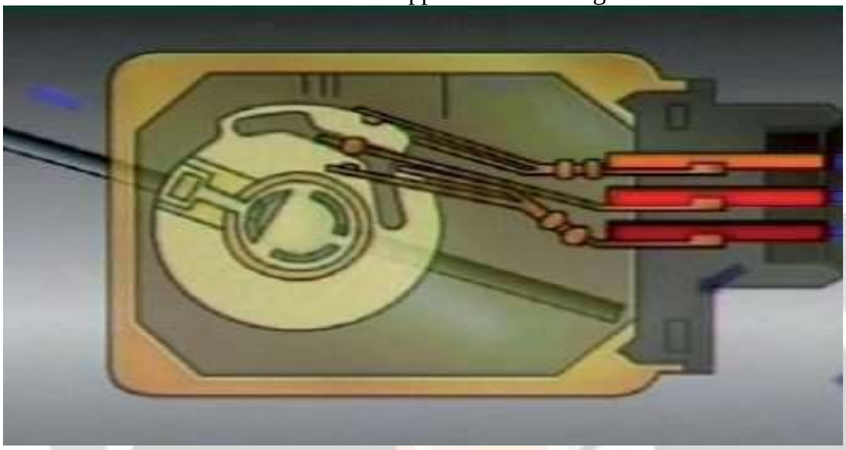
An air flow meter varies its signal by the deflection of a vane as air enters the engine. Deflecting the vane moves contacts across a potentiometer, to signal its position, and thus, the amount of air entering the system



The temperature sensor uses material with a negative temperature coefficient of resistance. Its resistance is high when it' scold, but it falls as its temperature rises. It is called a thermistor. This is the opposite of a normal resistor, which increases its resistance as temperature rises. The coolant temperature sensor is immersed in coolant, in the cylinder head. The air temperature sensor is in the air intake - at the airflow meter, or in the manifold. Throttle position can be signaled by a potentiometer attached to the throttle shaft. It provides a continuous, varying signal, through the entire range of throttle position. Throttle position can also besignalled by a contact-type switch, but it signals the idle and fully open positions only. Engine speed can be detected by a connection from the ignition system primary circuit, or by a pulse generator-type sensor, on the crankshaft. The pulses are computed by the control unit, into an engine RPM figure. They can also be used to trigger the injectors.

4.7Throttle Position Sensor

This sensor gathers information on throttle positions, to allow the control unit to make adjustments according to operating conditions. It is located on the throttle body, and operated by rotation of the throttle spindle or shaft. Throttle position is sensed by a contact type switch, or a potentiometer. The switch type has 2contacts - idle and full load. It can be supplied with a voltage to the center terminal of its connector.



4.8Injectors

The injector used for throttle-body injection is similar to that used for multi-point. It has a nozzle and spring-loaded plunger, operated by a solenoid. When the injector opens fuel issprayed into the intake air passing through the throttle body .In some cases; a cold-start injector is fitted. It is a solenoid operated valve, on the intake manifold or plenum chamber. It is in the main air stream, on the engine side of the throttle butterfly, and it's supplied with fuel under pressure from the fuel rail. The operation is controlled by the action of a thermo time switch.

The exact injector open time depends on the data the sensors give the ECU. The injector is supplied with constant live via the fuel pump relay. The engine control operates the injector by the means of turning off and on the earth circuit in quick succession. Itprovides pulses of a set duration, so that the injector valve open sand closes, or pulses, very quickly. Electrical pulses pass through the injector winding, and set up a magnetic field that draws the plunger and valve away from the nozzle seat. This function is known as pulse with modulation (PWM). The PWM is responsible for the amount of fuel injected. This can be measured with an oscilloscope and comparing the reading to the auto data value.

4.9Crank Angle Sensor

Crank Angle Sensing uses information on the speed and position of the crankshaft to control ignition timing, and injection sequencing. The control unit can then trigger the ignition, and injection, to suit operating conditions

The position sensor may be mounted externally on the crankcase wall, or it may be inside the housing of the ignition distributor 3.0 European On BoardDiagnostics3.1 On-Board Diagnostics and European On-Board Diagnostics On-Board Diagnostics, or OBD, in an automotive context, is a generic term referring to a vehicle's self-diagnostic capability. If the vehicle's onboard diagnostic system detects a malfunction, a DTC (diagnostic trouble code) corresponding to the malfunction is stored in the vehicle's computer, and in certain cases will illuminate the MIL (malfunction indicator light, or check engine light). A service technician can retrieve the DTC, using a "scan tool", and take appropriate action to resolve the malfunction. A diagnostic system that is able to detect and store emission related failures. A fault in EOBD will trigger a "freeze frame" and a "TROUBLE CODE" (TC), after the correct drive cycle .In Europe the EOBD (European On-Board Diagnostics) system was mandated by European Directive 98/69/EC for all petrol vehicles made from 1 January 2001.Modern EOBD implementations use a standardized fast digital communications port to provide real-time data in addition to a standardized series of diagnostic trouble codes, or DTCs, which allow you to rapidly identify and repair malfunctions within the vehicle. Fault code is defined by the Society of Automotive Engineers (SAE) and binding for all EOBD systems. System's monitored by EOBD Catalytic converter efficiency Misfire detection. (Ignition and crank angle)Fuel systemO2 sensors (EVAP system) including tank ventilation feedback).

5.Conclusion

In this paper studied about process of injecting fuel and their types and types of sensors used in the process and their application.

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