

## **Unit 2 : ENGINE AUXILIARY SYSTEMS**

### **Module 1: Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system**

#### **Electronic Controlled Gasoline (Petrol) Injection System (ECGIS)**

The electronic Fuel injector system consists of three different systems for the basic operation of ECGIS

1. Fuel Delivery System
2. Air Induction system
3. Electronic Control System

##### **Fuel delivery system:**

- The Fuel delivery system consists of Fuel tank, fuel pump, fuel filter, Fuel delivery pipe, fuel injector, fuel pressure regulator and fuel return pipe
- Fuel is delivered from the tank to the injector by means of an electric fuel pump. The pump is typically located in or near to the tank. Contaminants are filtered out by a high capacity in line fuel filter.
- Fuel is maintained at a constant pressure by means of a fuel pressure regulator. Any fuel which is not delivered to the intake manifold by the injector is returned to the tank through a fuel return pipe.

##### **Air induction system:**

- The air induction system consists of the air cleaner, air flow metre, throttle valve, air intake chamber, intake manifold runner and intake valve.
- 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 valve.
- 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.

##### **Electronic control System (ECS):**

- The ECS consists of various engine sensors, Electronic control unit,

Fuel injector assemblies and related wiring.

- The ECS determines precisely how much fuel needs to be delivered by the injector by monitoring the engine sensors.
- The ECS turns the injector for a precise amount of time, referred to as injection pulse width or injection duration, to deliver fuel so that proper air/fuel ratio is delivered to the engine.

### Basic Operation of ECGIS

- Air enters the engine through 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 by the fuel injector.
- Fuel injector is arranged in the intake manifold behind each intake valve. The injector is 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.
- As the Fuel is sprayed into the intake air stream, it mixes with the incoming air and vaporizes due to the low pressures in the intake manifold. The ECU signals the injector to deliver just enough fuel to achieve an ideal air/fuel ratio of 14.7:1, often referred to as stoichiometric ratio.
- 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.
- Depending on engine operating conditions, injection quantity will vary. The ECU monitors variables such as coolant temperature, engine speed, throttle angle and exhaust oxygen content and makes injection corrections which determine final injection quantity.

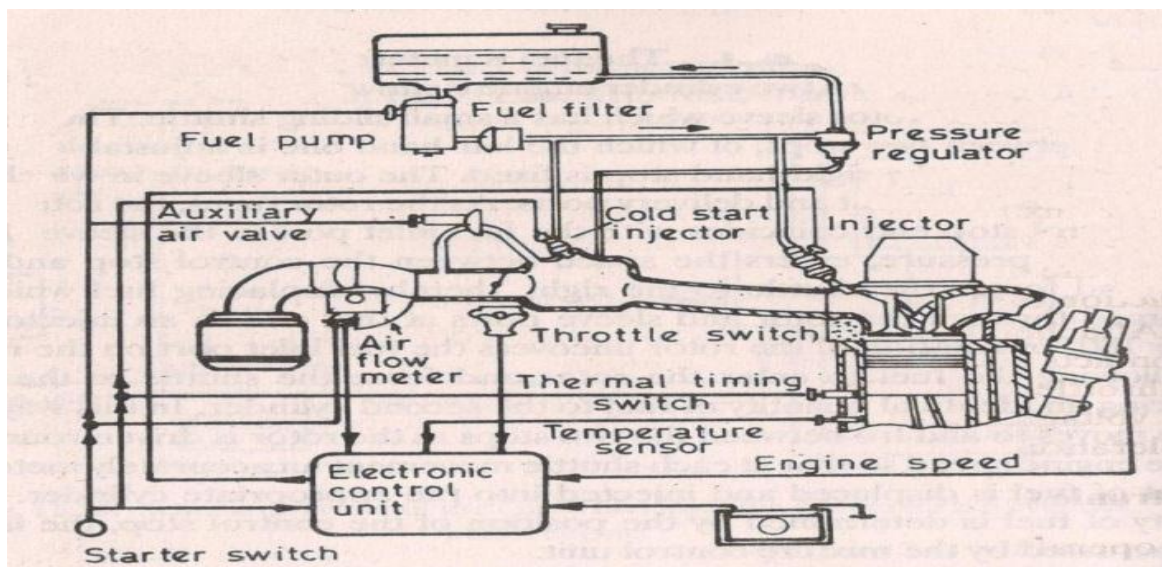


Fig.1 Electronic control gasoline injection system- L-Jetronic with air flow meter

### Advantages of Electronic Controlled Gasoline (Petrol) Injection System

- Uniform Fuel/Air mixture distribution
- High Accurate Fuel/Air Ration Control
- Superior Throttle Response and Control
- Excellent Fuel Economy
- Improved Cold engine Start ability
- Simple Mechanics and Reduced Adjustment Sensitivity.

### Single Point Injector System

- It has only one injector that injects the fuel before entering into the intake manifold.
- In this system, the fuel is mixed with fuel before the throttle valve. The single-point fuel injection system is also known as throttle body injection.
- The amount of fuel to be injected is decided by the engine control unit. The engine control unit takes the input from different sensors and decides the amount of fuel to be supplied for the injection.
- The fuel injector sprays the fuel for mixing with the flow of air and this air-fuel mixture enters the intake manifold.

The intake manifold further distributes the mixture to all cylinders.

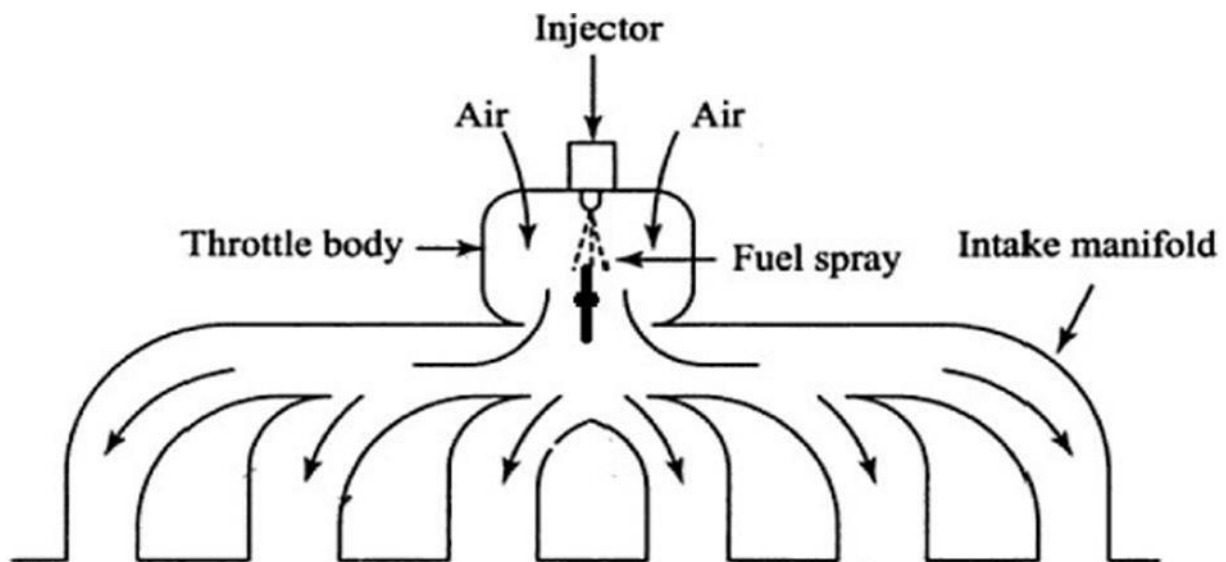


Fig. Throttle body injection (Single point)

### Advantages

- Simple construction.
- Accurate fuel supply (in comparison with carburetor).
- Easy maintenance.
- It uses only a single injector.

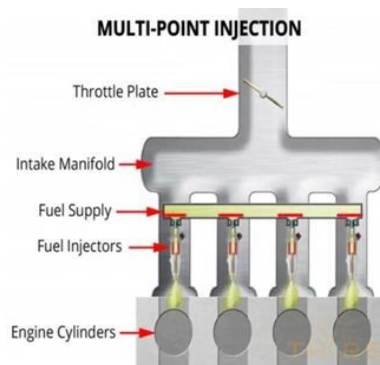
- Reliable operation

### **Dis Advantages**

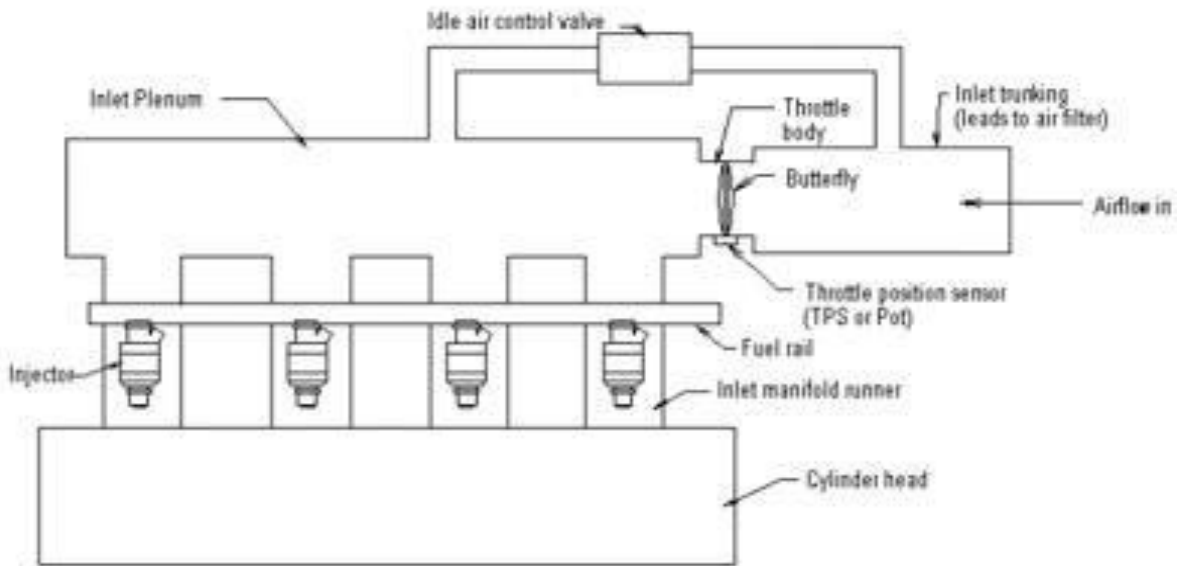
- Ununiform fuel supply to all cylinders.
- Less efficient.
- It wets the intake manifold by forming a layer of fuel on the intake manifold.
- Lower fuel economy.

## **Multi Point Fuel Injection System**

- In multi-point fuel injection (MPFI) technology, every cylinder in the combustion chamber of the engine is given an injector at the front of their inlet valves (outside the intake port), which is why it's also called 'Port Injection'.
- Every injector sprays fuel at the same time and each cylinder gets a more precise volume of fuel, with less possibility of fuel condensation outside the intake manifold. While MPFI has the advantage of lower fuel wastage as compared to TBI, since the fuel is sprayed at the same time in all the cylinders, it doesn't get properly synced with the rotation of all the pistons. This results in the fuel idling in the engine and port for as long as 150 milliseconds. All the same, from the performance point of view, the MPFIs function much better as compared to TBIs.



Multiple point injection with plenum



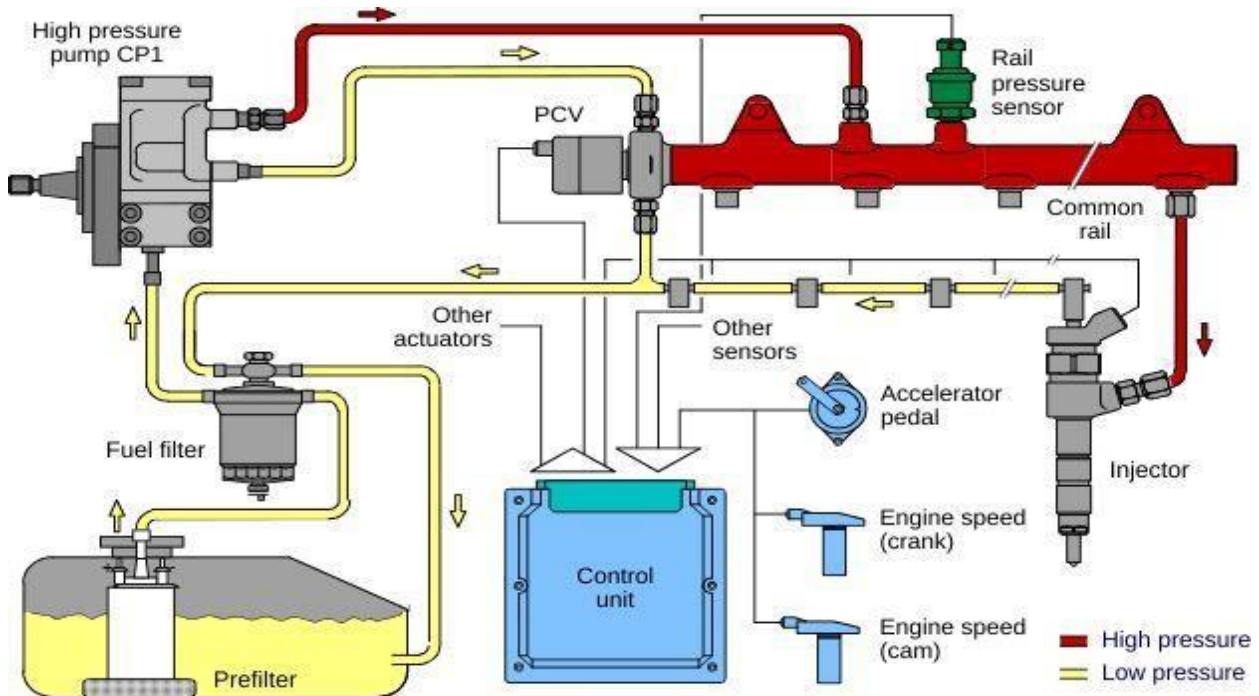
### Advantages

- The system is reliable
- It reduces the difference in power that each cylinder creates.
- It increases the fuel efficiency of an engine
- Better atomization of fuel
- MPFI system have fewer emissions
- Better utilization and distribution of fuel within an engine.
- Better acceleration and deceleration of engine
- It improves the cold start properties of the engine
- Vibrations in reduce in the engine
- Improves durability and functionality of an engine

### Dis Advantages

- Misfiring might occur sometimes
- It requires regular inspection of fuel injectors
- The system is expensive compared to conventional systems.
- Repairing fuel injector can be tedious compared to carburetors
- The system usually has a shorter life.
- ECU failure could occur suddenly.
- A hot engine might be difficult to start due to possible vapor lock in the steel fuel lines above the engine.

## Electronically Controlled Diesel Injection System



The function of the diesel fuel system is to inject a precise amount of atomized and pressurized fuel into each engine cylinder at the proper time. Combustion in a diesel engine occurs when this rush of fuel is mixed with hot compressed air.

### Parts of Diesel Injection System

- **Fuel Tank:** There are many different types and shapes of fuel tanks. Each size and shape is designed for a specific purpose. The fuel tank must be capable of storing enough fuel to operate the engine for a reasonable length of time. The tank must be closed to prevent contamination by foreign objects. It must also be vented to allow air to enter, replacing any fuel demanded by the engine. Three other tank openings are required--one to fill, one to discharge, and one to drain.
- **Fuel Lines:** There are three types of diesel fuel lines. These include heavyweight lines for the high pressures found between the injection pump and the injectors, medium weight lines for the light or medium fuel pressures found between the fuel tank and injection pump, and lightweight lines where there is little or no pressure.
- **Fuel Filters:** Diesel fuel must be filtered not once, but several times in most systems. A typical system might have three stages of progressive filters--a filter screen at the tank or transfer pump, a primary fuel filter, and a secondary fuel filter. In series filters,

all the fuel goes through one filter and then through the other. In parallel filters, part of the fuel goes through each filter.

- **Fuel Transfer Pump:** Simple fuel systems use gravity or air pressure to get fuel from the tank to the injection pump. On modern high-speed diesel engines, a fuel transfer pump is normally used. This pump, driven by the engine, supplies fuel automatically to the diesel injection system. The pump often has a hand primer lever for bleeding air from the system. Modern injection pumps are almost all jerk pumps that use the plunger and cam method of fuel injection.