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"Fuel Injector Tester"

A thesis submitted to the department of Mechanical and chemical Engineering (MCE), Islamic University of Technology (IUT), in the partial fulfillment of the requirement for degree of Bachelor of Science in Technical Education in Mechanical Engineering.

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Abstract:

The exponential development in technology and industry boosted the productivity

of industries to such unprecedented level that caused an increase in the number of automobile produced for both industrial and personal use.

As the amount of fuel is limited more studies are directed to reduce the fuel consumption of the automobile.

One way of reducing the fuel consumption is the use of efficient and accurate fuel injector and to ensure that the fuel injector is efficient and accurate the fuel injector tester is quite handy tool to provide that platform.

Another aspect is the environment concern that the emission of unburn fuel, CO and Co2 can be reduced by using accurate and efficient fuel injector.

The purpose of our project is to construct a fuel injector tester to verify if a fuel injector is accurate to the manufacturer standards or not.

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CHAPTER 1

1.1 Objective:

The objective of this experiment which is classified into two parts

- To investigate whether an injector is adequate or not through measurement and find out in which part of injector lies problem the measurement can be done by several ways.
  One of the ways is to measure the amount of fuel injector nozzle can inject into the cylinder and comparing the result with the predetermined value of the injector manufacturing company the other test is to compare between the nozzle projection of the fuel injection and the standard nozzle projection of the manufacturer.
- To investigate the presence of any leak within the injector galleries or injector nozzle that may cause the loss of fuel or cause a change in the spray pattern of the fuel injector.

CHAPTER 2

2.1 Background:

Fuel injector lasts for a long time compared with the rest of the fuel supply system integral parts but like everything eventually subject to failure due to wear and dislocation.
Some of the problems associated with the fuel injector can be fixed some cannot be fixed.
Parameters that affect the performance of fuel injector.

2.2 Flow:

The flow rate is important for complete combustion of the fuel because every engine cylinder has a certain amount of the fuel that can be burnt with maximum efficiency for equivalent of 15 second continuous operation, the rate of flow is critical to the combustion as its usually the standard time of operation for most manufacturers.

2.3 Leaks:

Leak can be through the Tapir internally or usually due to valve unable to fully close which in both cases cause the leak of fuel from the injector if there is no leak with the fuel injector then the problem may be in the fuel pump or distributor unable to set the timing.

2.4 Spray pattern:

If the flow rate is optimized and there is no leak the spray pattern will affect the combustion of the fuel usually spray pattern is result of change in the fuel injector nozzle projection that change the shape of the pattern of the spray which result in decrease in the fuel combustion efficiency.

CHAPTER 3

3.1 Component of the fuel injection tester:

- Battery
- Fuel Gallery
- Injector
- Fuel Pump
- Conventional Distributor

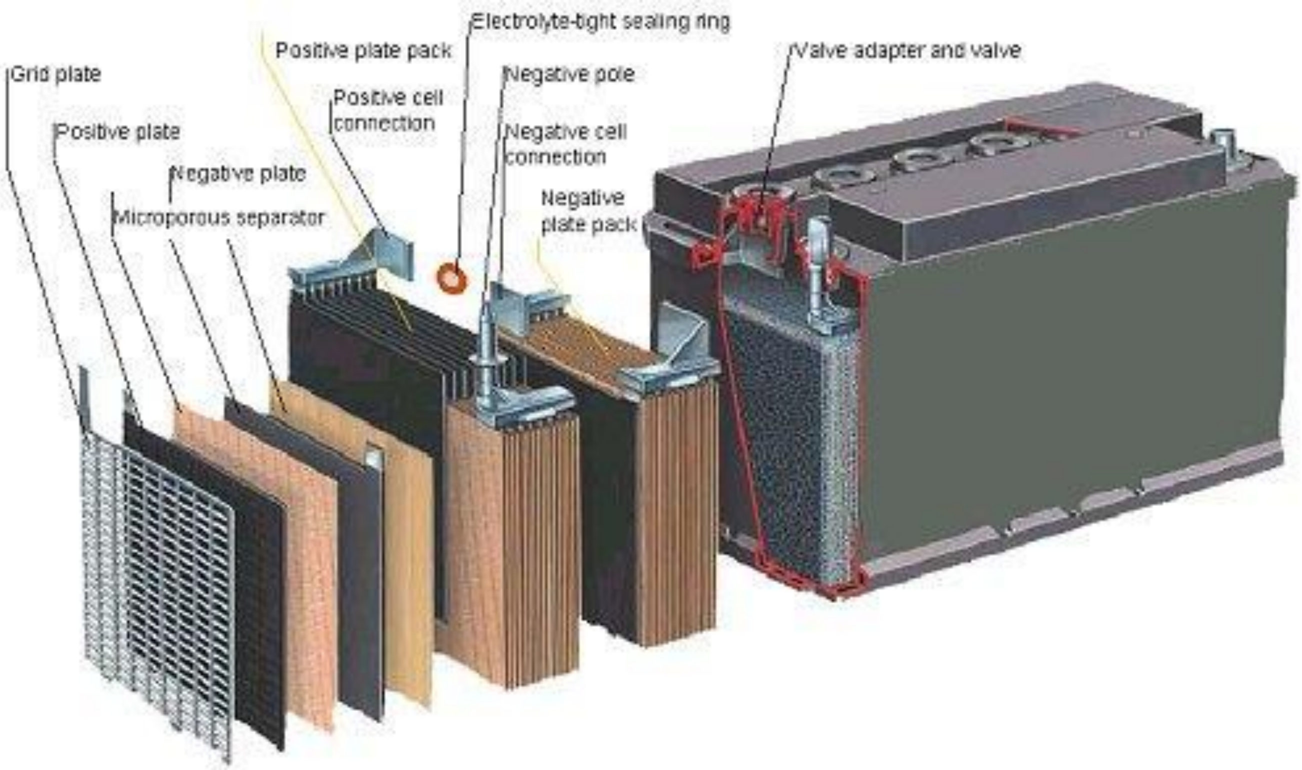
3.2 Battery:

An automotive battery is a type rechargeable battery that supplies electric energy to an automobile. Usually this refer to an SLI battery (starting, lighting and ignition) to power the starter motor, the lights and the ignition system of a vehicle’s engine.

Automotive SLI batteries are usually lead acid type and are made of six galvanic cells in series to provide a 12-volt system. Each cell provides 2.1 volts for a total of 12.6 volts at full charge. Heavy vehicles, such as highways trucks or tractors, often equipped with diesel engines, may have two batteries in series for 24-volt system or may have parallel string of batteries.

Lead-acid batteries are made up of plates of lead and separate plates of lead dioxide which are submerged into an electrolyte solution of about 38% sulfuric acid and 62% water. This causes a chemical reaction that releases electrons, allowing them to flow through conductors to produce electricity. As the battery discharges the acid of the electrolyte reacts with the materials of the plates changing their surface to lead sulfate. When the battery is recharged, the chemical reaction is reversed, the lead sulfate reforms into lead dioxide and lead. With the plates restored to their original condition, the process may now be repeated.

Battery recycling of automotive batteries reduces the need for resources required for manufacture of new batteries, diverts toxic lead from landfills and prevents risk of improper disposal and battery we use as energy source to supply power to the motor and to the injector, also we can run the experiment.


Electrolyte-tight sealing ring
Positive plate pack
Valve adapter and valve
Grid plate
Negative pole
Positive cell
connection
Positive plate
Negative cell
connection
Negative plate
Negative
plate pack
Microporous separator

3.3 DISTRIBUTOR

A distributor is an enclosed rotating shaft used in spark-ignition internal combustion engines that have mechanically-timed ignition. The distributor's main function is to route secondary, or high voltage, current from the ignition coil to the spark plugs in the correct firing order, and for the correct amount of time. Except in magneto systems, the distributor also houses a mechanical or inductive breaker switch to open and close the ignition coil's primary circuit.

The first reliable battery operated ignition was developed by Dayton Engineering Laboratories Co. (Delco) and introduced in the 1910 Cadillac. This ignition was developed by Charles Kettering and was considered a wonder in its day. Atwater Kent invented his Unisparker ignition system about this time in competition with the Delco system.

By the end of the 20th century mechanical ignitions were disappearing from automotive applications in favor of inductive or capacitive electronic ignitions fully controlled engine control units (ECU), rather than directly timed to the engine's crankshaft speed.

Description:

A distributor consists of a rotating arm or rotor inside the distributor cap, on top of the distributor shaft, but insulated from it and the body of the vehicle (ground). The distributor shaft is driven by a gear on the camshaft on most overhead valve engines, and attached directly to a camshaft on most overhead cam engines. (The distributor shaft may also drive the oil pump.) The metal part of the rotor contacts the high voltage cable from the ignition coil via a spring-loaded carbon brush on the underside of the distributor cap. The metal part of the rotor arm passes close to (but does not touch) the output contacts which connect via high tension leads to the spark plug of each cylinder. As the rotor spins within the distributor, electric current is able to jump the small gaps created between the rotor arm and the contacts due to the high voltage created by the ignition coil.

A distributor consists of a housing, a drive shaft with breaker cam, a breaker plate with contact points and condenser, an advance mechanism, a rotor and a cap. See Figure 1 for an illustration of these components.

The distributor shaft has a cam that operates the contact breaker (also called points). Opening the points causes a high induction voltage in the system's ignition coil.

The distributor also houses the centrifugal advance unit: a set of hinged weights attached to the distributor shaft, that cause the breaker points mounting plate to slightly rotate and advance the spark timing with higher engine revolutions per minute (rpm). In addition, the distributor has a vacuum advance unit that advances the timing even further as a function of the vacuum in the inlet manifold. Usually there is also a capacitor attached to the distributor. The capacitor is connected parallel to the breaker points, to suppress sparking to prevent excessive wear of the points.

Distributor cap:

The distributor cap is the cover that protects the distributor's internal parts and holds the contacts between internal rotor and the spark plug wires.

The distributor cap has one post for each cylinder, and in points ignition systems there is a central post for the current from the ignition coil coming into the distributor. There are some exceptions however, as some engines (many Alfa Romeo cars, some 1980s Nissans) have two spark plugs per cylinder, so there are two leads coming out of the distributor per cylinder. Another implementation is the wasted spark system, where a single contact serves two leads, but in that case each lead connects one cylinder. In General Motors high energy ignition (HEI) systems there is no central post and the ignition coil sits on top of the distributor. Some Toyota and Honda engines also have their coil within the distributor cap. On the inside of the cap there is a terminal that corresponds to each post, and the plug terminals are arranged around the circumference of the cap according to the firing order in order to send the secondary voltage to the proper spark plug at the right time.

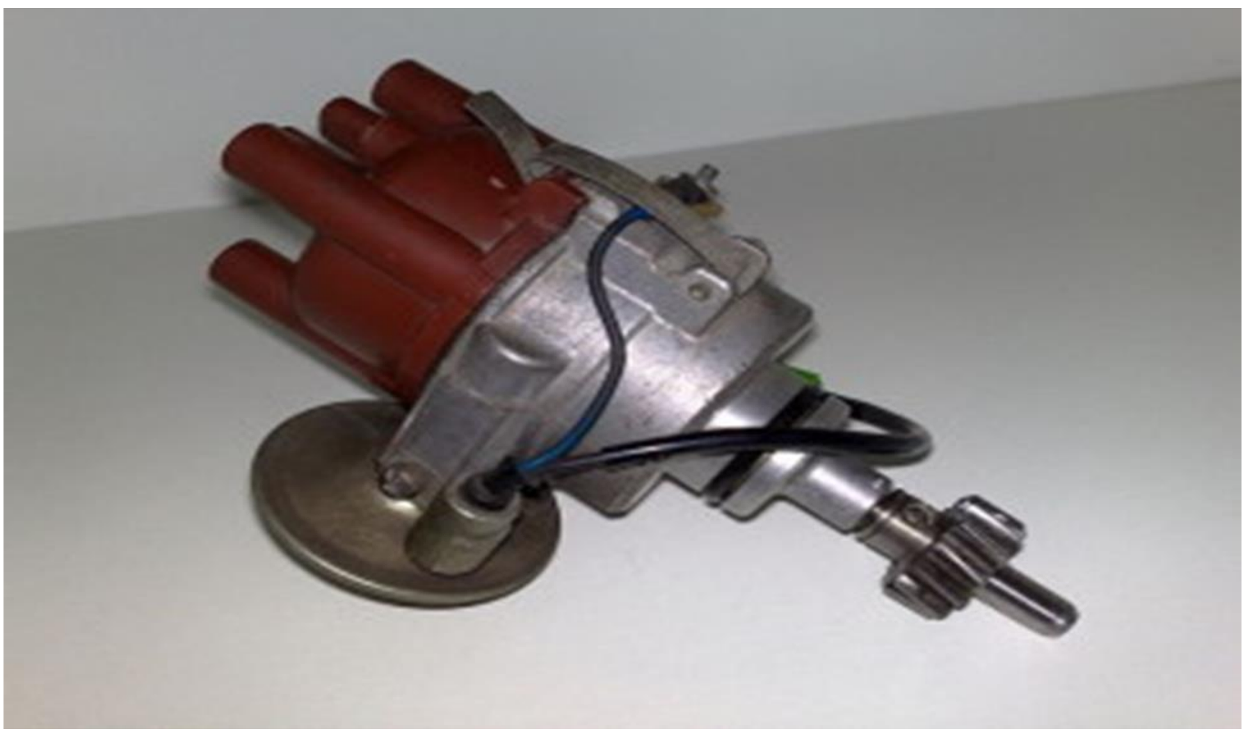
The rotor is attached to the top of the distributor shaft which is driven by the engine's camshaft and thus synchronized to it. Synchronization to the camshaft is required as the rotor must turn at exactly half the speed of the main crankshaft in the 4-stroke cycle. Often, the rotor and distributor are attached directly to the end of the one of (or the only) camshaft, at the opposite end to the timing drive belt. This rotor is pressed against a carbon brush on the center terminal of the distributor cap which connects to the ignition coil. The rotor is constructed such that the center tab is electrically connected to its outer edge so the current coming in to the center post travels through the carbon point to the outer edge of the rotor. As the camshaft rotates, the rotor spins and its outer edge passes each of the internal plug terminals to fire each spark plug in sequence.

Engines that use a mechanical distributor may fail if they run into deep puddles because any water that gets onto the distributor can short out the electric current that should go through the spark plugs, rerouting it directly to the body of the vehicle. This in turn causes the engine to stop as the fuel is not ignited in the cylinders. This problem can be fixed by removing the distributor's cap and drying the cap, cam, rotor and the contacts by wiping with tissue paper or a clean rag, by blowing hot air on them, or using a moisture displacement spray e.g. WD-40 or similar. Oil, dirt or other contaminants can cause similar problems, so the distributor should be kept clean inside and outside to ensure reliable operation.

Some engines include a rubber O-ring or gasket between the distributor base and cap to help prevent this problem. The gasket is made of a material like Viton or butyl for a tight seal in extreme temperatures and chemical environments. This gasket should not be discarded when replacing the cap. Most distributor caps have the position of the number 1 cylinder's terminal molded into the plastic. By referencing a firing order diagram and knowing the direction the rotor turns, (which can be seen by cranking the engine with the cap off) the spark plug wires can be correctly routed. Most distributor caps are designed so that they cannot be installed in the wrong position. Some older engine designs allow the cap to be installed in the wrong position by 180 degrees, however. The number 1 cylinder position on the cap should be noted before a cap is replaced.

The distributor cap is a prime example of a component that eventually succumbs to heat and vibration. It is a relatively easy and inexpensive part to replace if its Bakelite housing does not break or crack first. Carbon deposit accumulation or erosion of its metal terminals may also cause distributor-cap failure.

As it is generally easy to remove and carry off, the distributor cap can be taken off as a means of theft prevention. Although not practical for everyday use, because it is essential for the starting and running of the engine, its removal thwarts any attempt at hot-wiring the vehicle.



Components of a Distributor Cap

A distributor cap contains internal contacts and corresponding external posts.

Although distributor cap designs can vary from one application to another, they all share a few basic components:

A main housing (typically plastic)

AT least one contact/lead per cylinder

A main contact point (to connect the rotor and coil)

The main body of a distributor cap is typically made from molded plastic that has a number of metal components built into it. A typical cap has one metal contact and post per cylinder and one central contact and post for the coil. The central contact is typically a spring-loaded carbon brush that mates with a central contact point on the rotor, which allows it to remain electrically connected while the rotor is spinning. The other contacts are spaced evenly around the perimeter of the cap, which allows the rotor to touch them as it spins.

Rather than having a central contact and post for the coil, some caps have two internal contacts. This is due to the fact that some vehicles have ignition coils that are located inside or on top of the distributor. Instead of using an external post and a coil wire, these coils are connected to a rotor by an internal connection inside the cap.

Other caps have slight variations in design due to the way that the engines of some vehicles are set up. Although most engines that use distributors are designed to only fire each spark plug on the combustion stroke of its corresponding cylinder, some engines use a waste spark ignition system. These ignition systems always fire two plugs at once: one on its combustion stroke and the other on its exhaust stroke. In order to account for this, distributor caps in waste spark ignition systems have half as many internal contacts as there are cylinders in the engine, and each contact is tied into two posts.

Another variation is found in vehicles that have two spark plugs per cylinder. Distributor caps in these ignition systems have one internal contact per cylinder, but each one connects to two posts. These posts are then connected to two spark plugs per cylinder via spark plug wires.

FUEL PUMP:

A fuel pump is a frequently (but not always) essential component on a car or other internal combustion engine device. Many engines (older motorcycle engines in particular) do not require any fuel pump at all, requiring only gravity to feed fuel from the fuel tank or under high pressure to the fuel injection system. Often, carbureted engines use low pressure mechanical pumps that are mounted outside the fuel tank, whereas fuel injected engines often use electric fuel pumps that are mounted inside the fuel tank (and some fuel injected engines have two fuel pumps: one low pressure/high volume supply pump in the tank and one high pressure/low volume pump on or near the engine).

Electric pump

In many modern cars the fuel pump is usually electric and located inside the fuel tank. The pump creates positive pressure in the fuel lines, pushing the gasoline to the engine. The higher gasoline pressure raises the boiling point. Placing the pump in the tank puts the component least likely to handle gasoline vapor well (the pump itself) farthest from the engine, submersed in cool liquid. Another benefit to placing the pump inside the tank is that it is less likely to start a fire. Though electrical components (such as a fuel pump) can spark and ignite fuel vapors, liquid fuel will not explode (see flammability limit) and therefore submerging the pump in the tank is one of the safest places to put it. In most cars, the fuel pump delivers a constant flow of gasoline to the engine; fuel not used is returned to the tank. This further reduces the chance of the fuel boiling, since it is never kept close to the hot engine for too long.

The ignition switch does not carry the power to the fuel pump; instead, it activates a relay which will handle the higher current load. It is common for the fuel pump relay to become oxidized and cease functioning; this is much more common than the actual fuel pump failing. Modern engines utilize solid-state control which allows the fuel pressure to be controlled via pulse-width modulation of the pump voltage. This increases the life of the pump, allows a smaller and lighter device to be used, and reduces electrical load.

Cars with electronic fuel injection have an electronic control unit (ECU) and this may be programmed with safety logic that will shut the electric fuel pump off, even if the engine is running. In the event of a collision this will prevent fuel leaking from any ruptured fuel line. Additionally, cars may have an inertia switch (usually located underneath the front passenger seat) that is "tripped" in the event of an impact, or a roll-over valve that will shut off the fuel pump in case the car rolls over.

Some ECUs may also be programmed to shut off the fuel pump if they detect low or zero oil pressure, for instance if the engine has suffered a terminal failure (with the subsequent risk of fire in the engine compartment).

The fuel sending unit assembly may be a combination of the electric fuel pump, the filter, the strainer, and the electronic device used to measure the amount of fuel in the tank via a float attached to a sensor which sends data to the dash-mounted fuel gauge. The fuel pump by itself is a relatively inexpensive part. But a mechanic at a garage might have a preference to install the entire unit assembly.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3.5 Fuel Gallery

It is a place where the fuel is store before it injected to the engine and the fuel gallery is attached to the injector because the fuel is stored there with his pressure so that when the injector valve open then the fuel will flow to the engine.

Fuel injection:

Fuel injection is the introduction of fuel in an internal combustion engine, most commonly automotive engines, by the means of an injector.

All diesel engines use fuel injection by design. Petrol engines can use gasoline direct injection, where the fuel is directly delivered into the combustion chamber, or indirect injection where the fuel is mixed with air before the intake stroke.

On petrol engines, fuel injection replaced carburetors from the 1980s onward. The primary difference between carburetors and fuel injection is that fuel injection atomizes the fuel through a small nozzle under high pressure, while a carburetor relies on suction created by intake air accelerated through a Venturi tube to draw the fuel into the airstream.

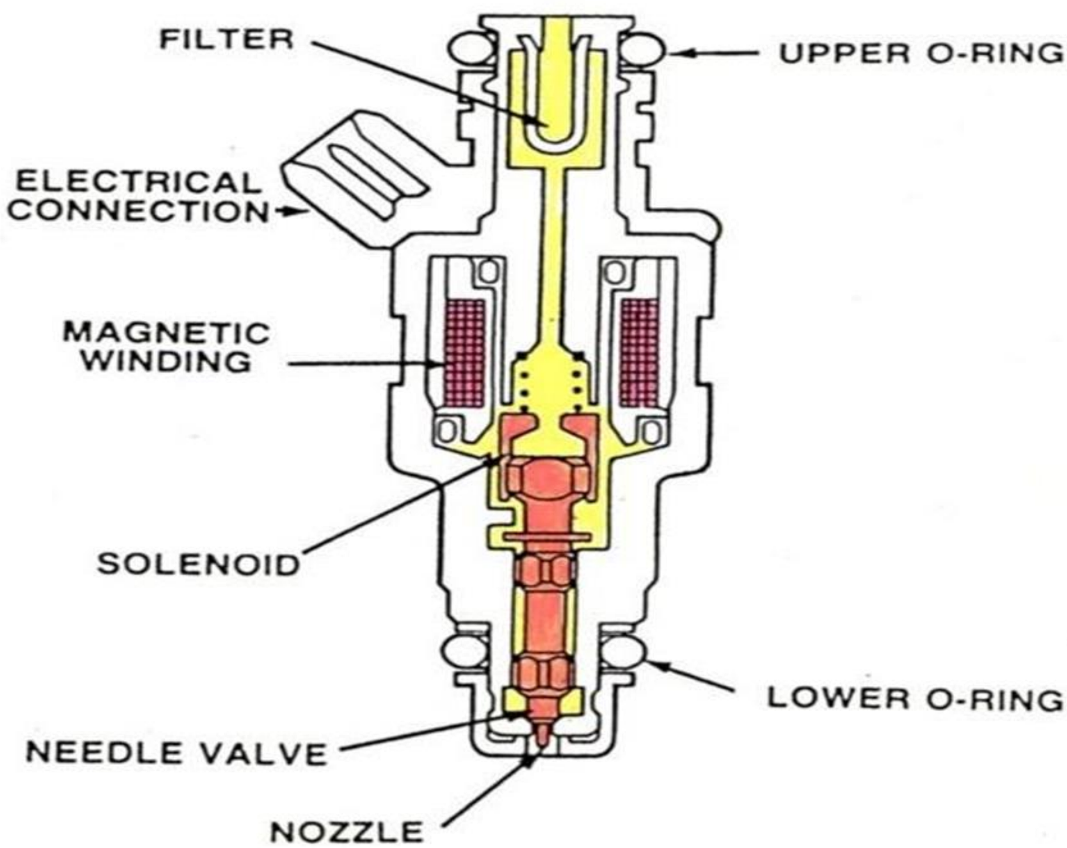
Fuel injector:

When signaled by the engine control unit the fuel injector opens and sprays the pressurised fuel into the engine. The duration that the injector is open (called the pulse width) is proportional to the amount of fuel delivered. Depending on the system design, the timing of when injector opens is either relative each individual cylinder (for a sequential fuel injection (SFI) system), or injectors for multiple cylinders may be signalled to open at the same time (in a batch fire system).

3.7 BASIC DESCRIPTION

Injectors deliver fuel from the fuel rail into the cylinder by use of a solenoid powered valves. The coils in the solenoid will have electricity applied in short burst called the pulse width (typically from 2-20mm depending on engine speed and throttle position) which will pull on the valve to open it up spraying the atomized fuel. A spring will rest the valve to the closed position when the solenoid is no activated

There are two types of injector tips: pintle and hole/disk type, seen in the image below. Pintle types were the first design and have the valve at the very tip of the injector. It provides good atomization of fuel, but could easily have deposit buildup on the valve restricting the flow. Hole/disk type fuel injectors fixed the deposit buildup problem by recessing the tip further up the injector and having the fuel spray through a cap with holes drilled in it atomizing the fuel.



3.8 Major component

O ring the upper o ring seals the injector to the fuel rail the lower o ring seals the injector to the intake manifold

Fuel filter basked to prevent the debris from clogging the pintle and seat it's just second line of defense the inline fuel filter does the real filtering

Injector body the case holds the internal parts in place this is seal unit and parts inside cannot be replace only the o ring pintle cap and filter can be replace

Pintle a finely machine part that normally sits down from passing through the injector when lifted away from the seat the fuel is allow to pass the pintle usually only move a few thousands of an inch this is why I's important to keep fuel system cleaned maintained

Pintle cap hold the lower o ring on place and insulation the seat from the engine heat it's also protect the pintle from damage while the injector removed

Coil winding this coil when energized pulls the pintle up away from seat

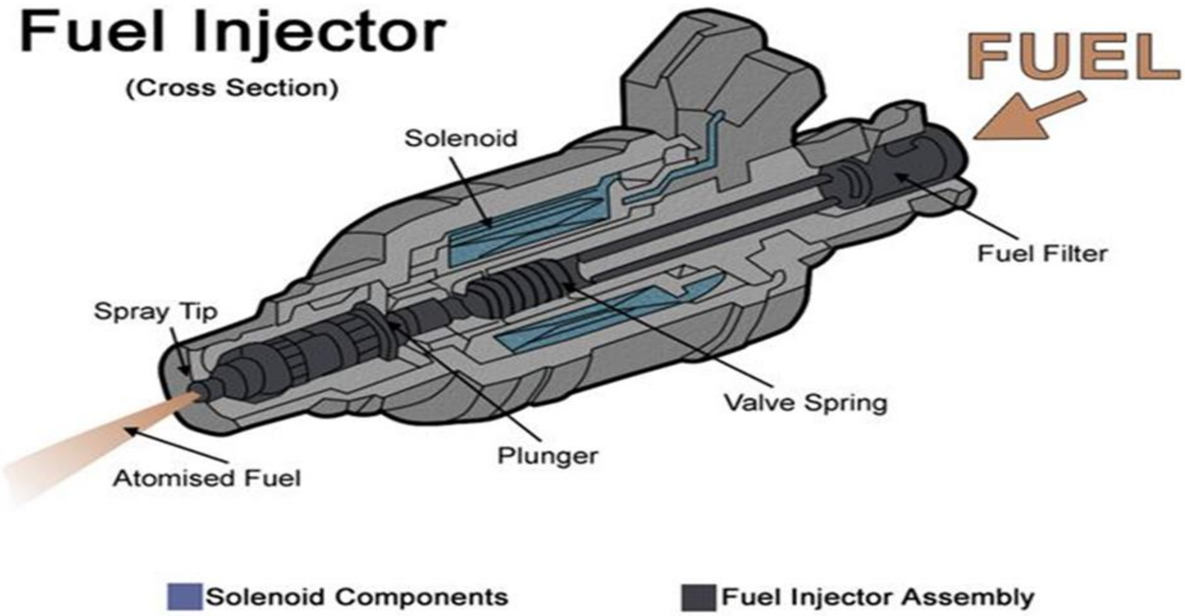
Pintle seat this is the precision machined surfaced that matched to the pintle the design and size of the seat and the pintle determines the flow rate.

Working principle of fuel injector

The main purpose of fuel injector to deliver measure amount of fuel to the engine and the internal construction consist of return pintle and body casing and coil winding so the coil when it energized it’s create magnetic fields so it’s push the spring back and this cause of movement allow to the fuel to flow.

This works much like the spray nozzle of a hose, ensuring that the fuel comes out as a fine mist. The fuel mixes with the air passing through the inlet manifold or port and the fuel/air mixture enters the combustion chamber. Some cars have multi-point fuel injection where each cylinder is fed by its own injector

Basically, the purpose of an injector is to spray the fuel in atomized or mist form so that it burns completely & uniformly. Fuel Injection Pump (FIP) supplies pressured diesel fuel through high pressure lines to the inlet port on each injector. However, the conventional or first generation injectors open with hydro-mechanical pressure. Inside the conventional injector, a spring holds the needle valve in ‘closed’ position until the high pressure fuel lines apply specified injection pressure. Earlier generation DI & IDI diesel engines used conventional-injectors as seen in diagram below.


Fuel Injector
(Cross Section)
FUEL
Solenoid
Fuel Filter
Spray Tip
Valve Spring
Plunger
Atomised Fuel
Solenoid Components
Fuel Injector Assembly

CHAPTER 4

4.1 working principle

The working principle of fuel injector tester is quite similar to that of fuel injection system of an automobile.

The fuel injector consist of several of part:

Fuel injector (to inject the rite amount of fuel in the rite spray pattern)

Fuel pump (to pump fuel from the fuel tank)

Distributor (to transfer fuel)

Battery (to provide current)

Carafes (to determine the amount of fuel injected)

Electrical motor (to actuate the distributer)

When the current from the battery flow through to the pump it will actuate the pump, then pump will pump the fuel from the fuel tank and supply it to the fuel gallery at the same time the electrical motor actuate the distributor that passes current to the fuel injector to actuate the injector coil and valve that allows the fuel to be injected the amount of fuel that is injected is collected inside a flasks along with the spray pattern which is seen through the glass of the flask

The amount of fuel that is collected in the flask is compared with the manufacturer standard amount of fuel 15second continuous operation; the spray pattern is also compared with the standard spray pattern provide by the manufacturer of the injector.

CHAPTER 5

5.1 Advantage

The fuel injector test has two advantage according to the view of economy and environment.

From economical point of view

A good fuel injector reduces the amount of unburnt fuel thus saves money. By optimizing the fuel flow rate and spray pattern the combustion is a complete combustion and no residue is formed in the cylinder than may cause any damage to the engine cylinder or the exhaust system thus improve their survivability

From environmental point of view

A good injector reduces the emission of harmful gases to the atmosphere such as Co,Co2, and fuel particle that are harmful to humans and all living being .as people became aware of the environmental problem that surround our world the contribution of every human is important to the wellbeing of earth.

5.2 Disadvantage

In case of improper implementation of the test in accurate result will be generated that may lead to improper diagnosis that will led to costly maintenance in the future and costly time delay.

By logical reasoning, FI being a newer tech should be better, but there are advantages and disadvantages. The working of the Fuel Injection system is more computerized and works on a lot of sensors. The fuel injection nozzle is provided directly in the combustion chamber.

CHAPTER 6

6.1 conclusion

The performance of fuel injector is completely dependent on the injector state so regular tests and checkups are of great importance to ensure that the injector is fully functioning

By ensuring the injector is properly functional the fuel consumption is reduced to an optimum amount thus saving money for the owner of the automobile

Also by ensuring the injector is properly functional the amount of green gases such as carbon monoxide or unburnt fuel that causes damage to the atmosphere or cause damage to the upper layers of the atmosphere

So by constant checking and examination we have served two sections both economical and environmental sections.

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