Air Cleaners

Since the air fuel mixture is to be burnt in the combustion chamber of the cylinder, just like fuel being filtered, air should also be filtered and cleaned before entering into the cylinder. The dust particles in the air when mixed with oil act like abrasive material which deteriorates the cylinder walls or liners, pistons or rings and hence decrease the engine performance. The characteristics of an ideal air cleaner include high efficiency in dust removal from air, small restriction to the air flow, small and simplicity in design and easy to mount, clean and low in cost. The location of air cleaner on the vehicle affects cleaning efficiency and it is one of the most important design parameter to be kept in mind while designing and developing the product. The dust concentration is maximum near the engine and is least in the region exactly above the engine. Hence, the air cleaners are mounted directly above the engine housing. Since, tractors are to be operated in the fields where dust is always significantly high, periodic cleaning of air cleaner becomes very important and essential to have maximum and consistent engine efficiency.

Oil bath type air cleaner

It consists of wire mesh element and oil reservoir at the bottom. The atmospheric air enters the air-cleaner through the windows at the top with a swirl action where some impurities are retained in the pre air cleaner chamber. The air passes through the air duct to the surface of oil bath and the air is reflected upward from the surface oil. The small impurities like dust and chaff etc. stick to the oil surface and are separated from the air. Then the air starts moving upward and passes through the mesh which further cleanse the air and oil drops in the air are separated while passing through this mesh. The left over impurities are also retained by the mesh and get settled in oil bath. These oil bath/bowl and pre cleaner chambers are to be cleaned periodically depending upon the dust conditions. The level of oil is to be maintained at a specific level, because the oil above the desired level results in restricting the air flow and might result in carrying/moving the oil with air reaching engine cylinders. This may lead to increase in sudden increase in speed and sometimes can cause damage to the engine components also.

Dry air cleaner

This type of air cleaner consists of a paper filter element with a row of plastic fins around it. As the air from the atmosphere enters the cleaner, the plastic fins give it a high rotational speed between the casting and the filter element. This causes impurities to separate out from air due to centrifugal action, which are thrown out to the casting walls from these flow down. Air without these dust particles then passes through the paper element, which removes any further impurities and clean air then goes to the engine.

Turbocharger : It is a centrifugal compressor driven by turbine which is run by exhaust gases to compress incoming air into the engine. With increased pressure, the weight or amount of fuel entering the same space inside the engine is increased. In this way, the burning of fuel is more efficient inside the engine chamber and it eventually results in greater performance of the vehicle from the same displacement of engine without need of a larger displacement engine.

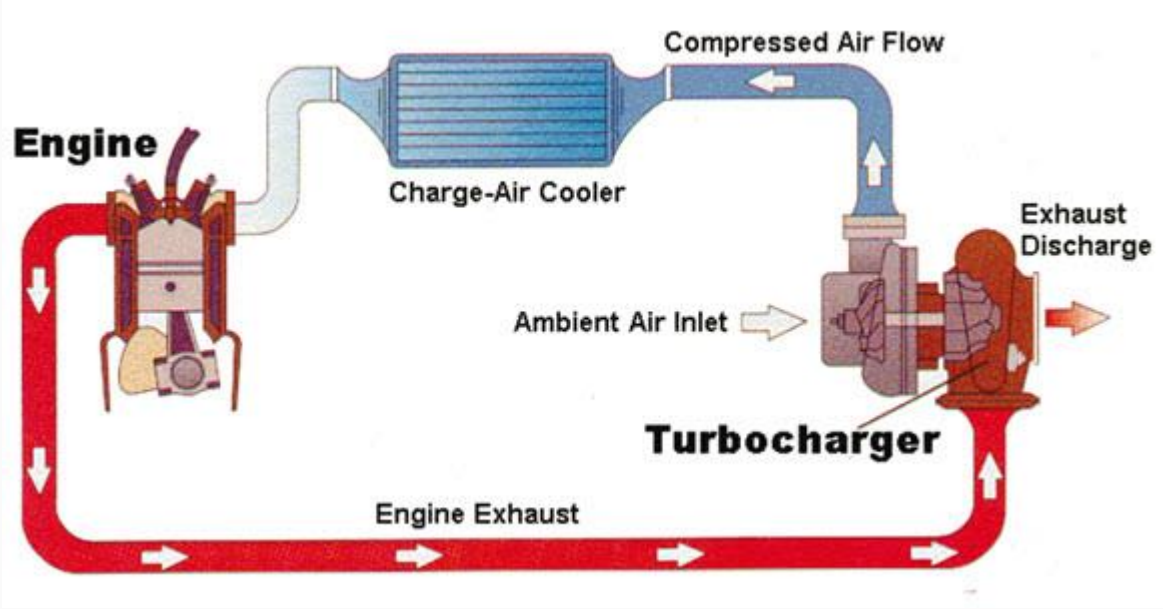
Exhaust gases contain a significant portion i.e around 30% of heat energy being generated due to burning of fuel. In turbocharger, exhaust gasses are used to drive a compressor which has following advantages to be used in diesel engines.

i) Engine output power is increased for a given engine displacement and has better Power/Weight ratio

ii) Engine torque characteristics are enhanced

iii) Better engine performance at higher altitudes

iv) Better fuel economy and exhaust gas emission



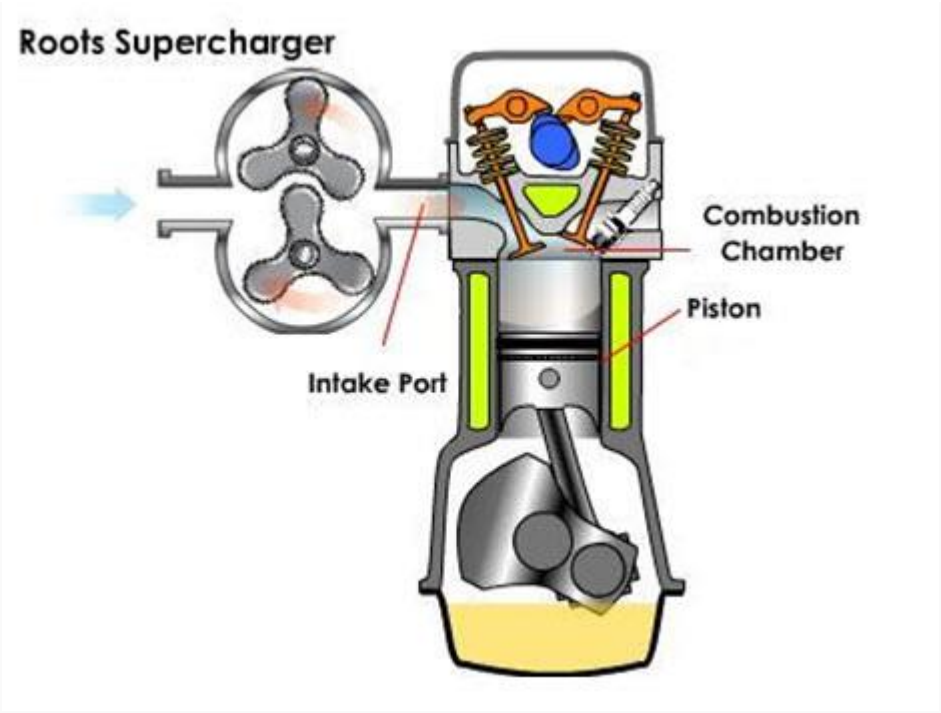
Superchargers: The device (compressor) powered by crankshaft used to compress incoming air of the engine is called supercharger. Supercharger is used to increase the volumetric efficiency of an engine by feeding both air and fuel at high pressure. The supercharger is driven directly by the engine through belts, the response of the same is instantaneous and a sudden increase in power can be obtained. Generally, in the natural aspirated engines, the charge is sucked in the cylinder by the vacuum created due to downward motion of the piston in the cylinder. With supercharger, the charge is induced with pressure which increases the density of the charge and hence the weight of charge per stroke is increased. As the weight of charge is increased , the power output also increase upto extent of 40% with supercharging.

At higher altitude, since the air gets thinner, the need of supercharger increases at it compensates the air intake by making relatively denser/heavier air into the cylinder during the suction stroke. Since, the supercharger increases the pressure, engine must be able to sustain the higher forces and also the fuel being used to have better anti-knock properties. However, in petrol engines when density of fuel is increased keeping the fuel of same octane number, the compression ratio is to be decreased to avoid detonation. But, with decrease in compression ratio, the thermal efficiency also decreases which is not preferred. Following are the three types of superchargers are being used.

i) Centrifugal supercharger

ii) Vane supercharger

iii) Root's supercharger



Centrifugal supercharger : This is one of the most commonly used supercharger which is driven by belt and pulley. The air fuel mixture enters into the impeller of the supercharger where this mixture is supercharged with pressure using the kinetic energy. The impeller runs at sufficiently high speed of around 80000 rpm. The impellers are made of special material like alloy steel which can with stand the high stress being generated due to such a high speed of impellers.

Vane supercharger : The rotating drum of supercharger is mounted with number of vanes which are made of laminates of linen or tufnol as these material have low friction, low coefficient of thermal expansion and also run without making any noise. As the drum rotates, the space between the body and drum decreases from inlet to outlet which decreases the volume and increase the pressure at outlet.

Root's supercharger : This consist of two rotors of epicycloid shape which are connected with each other by gear of same size to make these rotors run at same speed to generate pressure in the mixture coming out from the outlet just like it happens in gear type pumps.

Although turbochargers are similar to superchargers as far as the purpose of their usage is concerned. Both are used for increasing the density of air intake in the engine. But the major functional difference lies in their mode of driving mechanism. Turbochargers are driven by the exhaust gasses whereas the superchargers are directly driven by the bet pulley mechanism by taking a portion of power out of an engine. Although, superchargers are easier to install, but it costs more.

Fuel Delivery & Injection

It involves the flow of fuel from fuel tank to fuel nozzles for injecting the desired quantity of fuel with required pressure in the combustion chamber. Fuel travels fuel pipes from fuel tank to fuel feed pump through primary filter under gravity and then with the help of fuel injection pump, it further reaches to injecting nozzles with pressure through high pressure pipes. Engine speed tends to overshoot to hazardous values on reduction of load and also to very low speed (almost on the stage of engine halt) on increase in sudden and unexpected load application. To avoid such conditions, the engine speed is controlled by regulating the fuel supply by using engine governor which has been discussed in detail in lecture no. 22 & 23.

Fuel feed pump

The fuel comes from the fuel tank to the fuel feed pump which makes it to reach fuel injection pump after traveling through primar

y and secondary fuel filters. Sometimes this feed pump is also known as transfer pump or lift pump. Various types of feed pumps are used for the engines depending upon the application for which they are to be used. Fuel feed pumps can be of following types.

- Diaphragm type

- Gear type

- Vane type

- Plunger type

The hand priming pump is meant to bleed the fuel supply system when required. If the engine has not been working for a considerable period, the fuel can be transferred rapidly from the fuel tank to the fuel injection by hand-priming pump.

Fuel injection

The fuel injection system is required to inject the atomized fuel coming from fuel injection pump at high pressure to inject into cylinders/combustion chamber in exact and desired amount of fuel at desired time. Usually solid injection system is the most common system being used these days for injecting the liquid fuel which has been further classified into following two types.

- Common rail fuel injection system
- Individual pump fuel injection system.

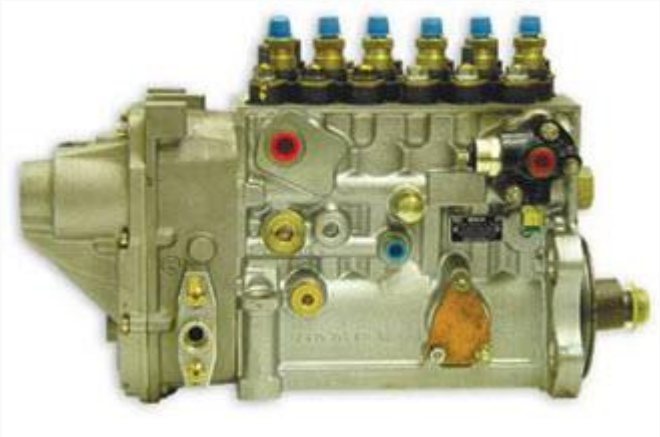
Common rail fuel injection system

Common rail fuel injection system has single injection pump with individual injector which is also known as unit injector on each cylinder injector. These individual injectors are operated by rocker arms and springs connected with control racks through the linkage to control the fuel injection in all cylinders simultaneously.

Individual pump fuel injection system

Plunger type or the diaphragm type in-line fuel feed pumps are used to inject fuel in the cylinders. The fuel travels from fuel tank with the help of fuel feed pump being driven by injection pump camshaft. Hand-priming lever is provided in the fuel feed pump to initiate the fuel flow and also to blow the air out from pump. The fuel then travels through filters and injection pump to reach engine cylinders in the desired quantity according to the firing order.

Fuel injection pump



The fuel injection pump is used to deliver an accurate and metered quantity of fuel under high pressure, at the correct instant and in the correct sequence, to the injector fitted on each engine cylinder. The injection pressures generally varies in the range from 7 to 30 MP and can be exceptional high as 200 MPa. The fuel injection pump is driven by timing gears and is controlled by the operator through

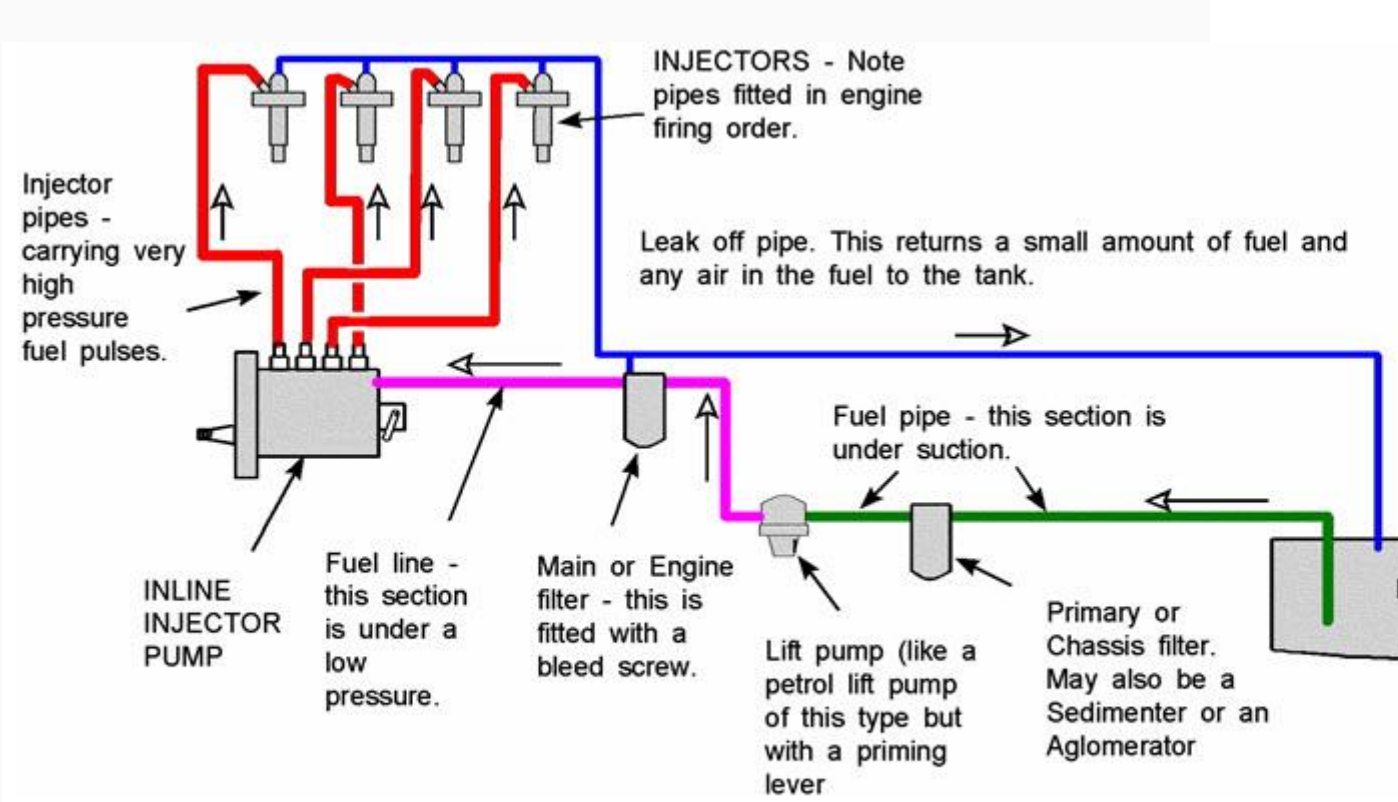
hand or foot accelerator in a tractor. These fuel injection pumps are designed and manufactured with high precision as these are used for metering very low volume of fuel and very high frequency of injection

The fuel injection pumps are generally of jerk pump type. However, in many cases, distributor type pumps are also used. Both of these will be discussed here.

Inline type fuel injection pump

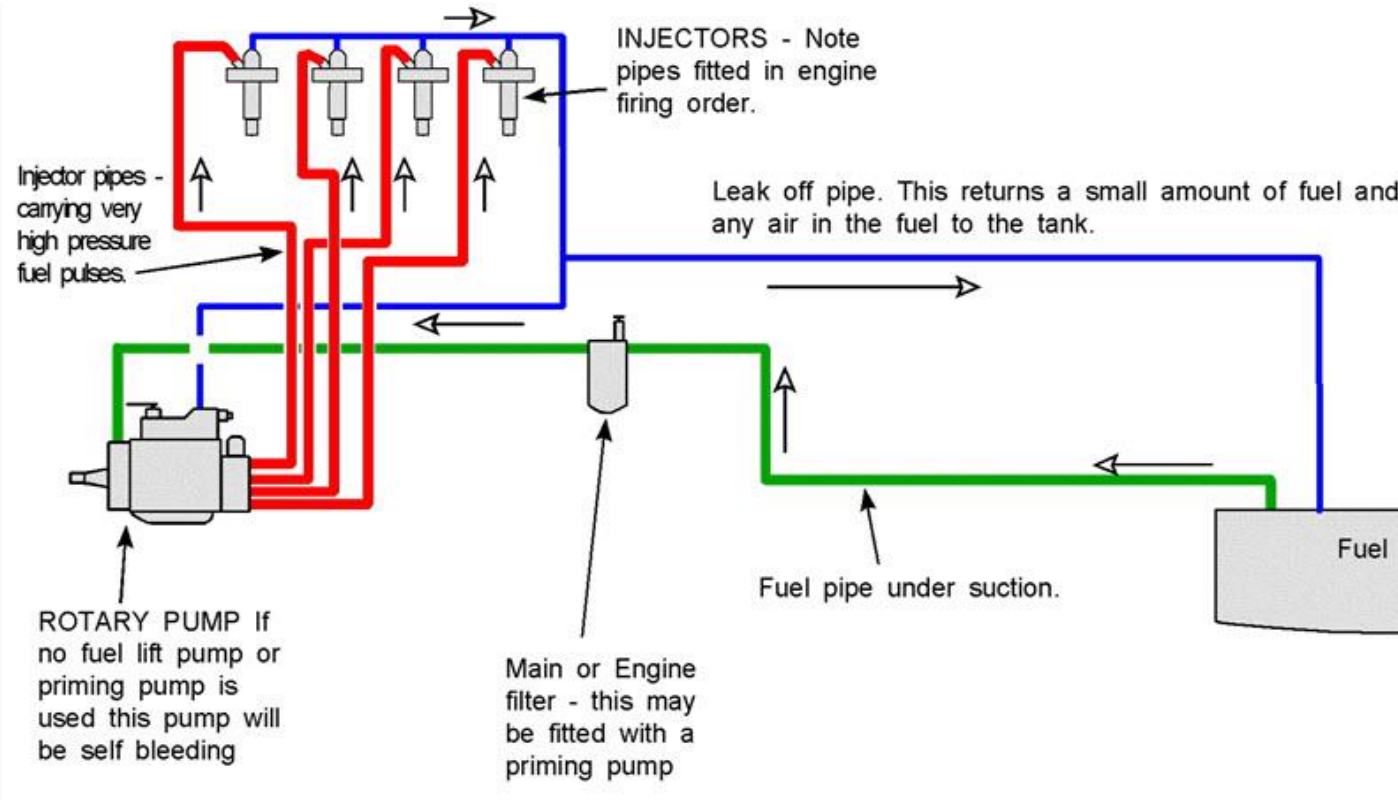
Inline type fuel injection pumps are also known as jerk type fuel pumps. These can be used for both single cylinder and multi-cylinder engines. Mainly it consists of spring loaded delivery valve, the plunger, the control sleeve and the control rack. The plunger contains a helix at its upper end which is operated by cam and tappet to controls the quantity of fuel to be injected.

In multi-cylinder engines, multiple pump assemblies, one for each cylinder, are assembled into one unit to give a compact construction. Fuel comes out from the injection pump with such a high pressure that specially designed and manufactured high pressure delivery lines are used to transfer this pressurized fuel to different fuel injectors mounted on each cylinders. In-line pumps are consist of pump housing, governor housing, camshaft-tappet assemblies and the pumping elements. The function of the camshaft is to generate plunger movement for each pump in the prescribed firing order and at the correct instant. The pump housing is made of aluminum alloy casting which contains camshaft-tappet assemblies, control mechanism and governor and the pumping head.



Rotary type fuel injection pump

These rotary type fuel injection pumps are also known as distributor pumps in which the fuel is distributed to each cylinder by means of a rotor. The rotor has a set of radial holes (suction and delivery ports) equal to the number of engine cylinders. Each of the delivery ports is connected to the high pressure delivery lines leading to injectors mounted on the each cylinder in multi-cylinder engines. As the rotor revolves, the suction ports align with the intake metering port one by one, while the distribution port aligns with the delivery ports in turn. Internal cam ring is used to control the fuel injection timing in these rotary pumps. With the increase in engine speed, the fuel feed pump delivery pressure increases which moves the cam in an advance direction to provide more timing. Rotary fuel injection pumps are compact, small in size and have less weight. Since there is a single rotor being used for delivering fuels to the multiple cylinders through individual high pressure pipes, the equal quantity of fuel is delivered which helps in even combustion of fuel in all the cylinders as per the firing order and generating consistent power strokes.



Fuel nozzles

These are also known as injectors, atomizers or fuel valves. Nozzles are used to inject the fuel in the combustion chamber/cylinder in a desired atomized form and in exact quantity on exact time. Generally, replaceable nozzles are provided with screw caps to ease the change of nozzle whenever required. A spring-loaded spindle is used to keep the nozzle valve pressed against its seat in the nozzle body. As the fuel is supplied by fuel injection pump with sufficient pressure to lift the nozzle valve against the spring force, then a spray of atomized fuel is fed into the combustion chamber. The fuel spray continues till the nozzle valve closes back on its seat. The pressure at which the nozzle valve opens is adjusted by a screw provided at the top of nozzle. Following are the two types of nozzles being used in engines these days.

- Hole type nozzles

- Pintle type nozzles

Hole type nozzles are the most commonly used in engines having open type combustion chambers, whereas pintle type nozzles are common in engines with pre-combustion chambers and some special swirl chambers. The pintle type nozzles carry an extension, which produces a hollow cone type spray. Such nozzles have the advantage of being self-cleaning. The opening pressure of hole

type nozzles varies from 17 to 34 MPa, whereas that of pintle type nozzles varies from 7 to 15 MPa.