

Q-1 GIVE THE DETAIL CLASSIFICATION FOR THE FUEL FEED SYSTEM PETROL AND DIESEL ENGINE

❖ Engine Fuel Feed System:-

- The main purpose of the fuel feed system is to control the fuel supply to the engine. To supply the fuel from the fuel tank to the engine cylinders, manufacturers use the following methods in case of a [petrol engine](#).
- Types of Fuel Feed systems of a petrol engine:

1. Gravity Feed System:

The 'gravity system' is confined to smaller vehicles such as entry-level two-wheelers, bikes, and quads only. In this design, the engineers mount the fuel tank at the highest position. It feeds the fuel into the [carburetor](#) float chamber by gravity. This system has a very simple design and hence, cheaper to produce and maintain. However, the disadvantage is that you need to place the fuel tank over the carburetor for this system to work correctly.

2. Pressure Feed system:

The pressure feed system uses a hermetically sealed (airtight) fuel tank. In this design, a separate air pump or engine exhaust creates pressure in the tank. However, for starting the engine; you need to hand prime the pump. Thus, it creates pressure and forces the fuel to flow to the carburetor. Although there are chances of leaking of pressure, you can place the fuel tank at any suitable location in the vehicle which is an advantage.

3. Vacuum System:

This system uses [engine](#) suction pressure to suck the fuel from the main tank to an auxiliary tank. From there, the fuel flows to the [carburetor](#) float chamber by gravity. This system is now obsolete.

4. Pump Feed System:

Most present-day cars use this system. This system uses a steel pipe to supply the [petrol](#) to the fuel pump which then pumps it into the [carburetor](#) float chamber thru' flexible pipe. If it is a mechanical fuel pump, then it gets the drive from the engine camshaft. Hence, it is attached to the engine. On the other hand, electrically operated fuel pumps can be placed anywhere. So, manufacturers place it inside the fuel tank to reduce the chance of vapor-lock.

5. Fuel Injection System:

Modern/present-day vehicles use [petrol injection system](#) which replaced the carburetor. The [injector](#) nozzle atomizes the fuel and forces it into the air stream. Newer generation engines use separate injector for each cylinder. The [air-fuel](#) mixture for different load and speed conditions is controlled either mechanically or electronically. Hence, this makes the fuel system more accurate. For more information, read about the [EFI, MPFI & GDI](#).

❖ Fuel Supply System in Diesel Engine

The fuel injection systems are of 2 types:

1. Air Injection System:

In this case fuel is injected under the pressure of air. For supplying high pressure air multistage air compressors are required, which are very much costly and hence this system is not in use.

2. Solid Injection System:

In this case diesel fuel is directly injected by fuel pump

Further these are of 3 types of solid injection systems:

A. Individual Pump System:

- As shown fuel will flow from the storage tank to filters to low pressure pumps. This low pressure pump pumps the fuel to 4 separate metering and pressure pumps.
- These separate metering and pressure pumps will pump the fuel to individual injectors which are provided in the cylinder heads. These are used in large slow speed engines.

B. Distributor System:

Fuel will flow from storage tank to low pressure pump through filters, then to metering and pressure pumps. This metering and pressure pump pumps the fuels to distributor unit which distributes and sends required quantity of fuel to each injectors/each cylinders. Used in small and medium size engines.

C. Common Rail System:

In this case fuel flows from storage tank to low pressure pump through filters. Low pressure pump, pumps the fuel to high pressure pump, which pumps the fuel to high pressure pump, which pumps the fuel to common rail. Thus high pressure fuel is collected in common rail and from here through the metering devices required quantity of fuel goes to injectors/cylinders. Generally Cummins and multi-cylinder engines use this system.

Q.2 - GIVE THE CLASSIFICATION FUEL INJECTION SYSTEM.

- A fuel injector in CI engine and SI engine is a precisely controlled mechanical tool designed to deliver the correct quantity of fuel into the engine, ensuring the creation of an ideal air-fuel mixture for efficient combustion.

- Working of Fuel Injection System:-
 - o The Engine Control Unit (ECU) plays a pivotal role in managing the fuel injection process, using input from internal sensors to assess engine conditions and requirements.
 - o Fuel is drawn from the vehicle's tank and transported through dedicated fuel lines to reach the injection system.
 - o Fuel pumps pressurise the fuel to ensure it's delivered at the correct pressure for injection.
 - o A fuel pressure regulator is employed to maintain the fuel pressure within the optimal range.
 - o In many cases, a fuel rail is utilised to distribute fuel to the various engine cylinders evenly.
 - o The ECU precisely controls the injectors, dictating when and how much fuel should be injected into each cylinder.
 - o The fuel-to-air ratio is adjusted as per the specific engine type, fuel used, and real-time engine requirements, whether it's for achieving higher power, better fuel economy, or stricter emission control.

- **Types of Fuel Injection Systems:-**

- **Single-Point or Throttle Body Fuel Injection:-**

- o Single-Point or Throttle Body Fuel Injection (TBFI) was an early injection system. It combines fuel with incoming air in the intake manifold before distributing it to the cylinders. While TBFI is cost-effective and requires minimal maintenance, it lacks accuracy. Excess fuel may cause performance issues and reduced fuel efficiency when you release the accelerator.\

- **Multiport Fuel Injection:-**

- o Multiport injection improved upon TBFI by placing smaller, more accurate injectors closer to each cylinder. This allowed for precise fuel distribution to each cylinder, enhancing fuel economy. However, all injectors spray simultaneously, potentially leading to unburned fuel during rapid acceleration or deceleration.

- **Sequential Fuel Injection**

- o Sequential fuel delivery systems build on multiport systems but inject fuel in precise timing, matching cylinder actions. This results in improved fuel economy and performance. Since fuel remains in the port for a short time, sequential injectors tend to stay cleaner and last longer.

- **Direct Fuel Injection**

- o Direct Injection introduces fuel directly into the cylinder, bypassing the intake. While common in diesel engines, it's primarily found in high-performance gasoline vehicles. Direct injection offers excellent

performance but demands meticulous maintenance for optimal engine operation.

- **Advantages of Fuel Injection System**

- o Improved fuel efficiency.
- o Precise control of air-fuel mixture.
- o Better engine performance.
- o Lower emissions.
- o Enhanced cold starting.
- o Reduced maintenance compared to carburetors

- **Disadvantages of Fuel Injection System**

- o Higher initial cost.
- o Complex system requiring skilled technicians for repair.
- o Sensitive to poor fuel quality.
- o Vulnerable to electronic or sensor failures.
- o Limited compatibility with older engines.
- o Difficulty in diagnosing and repairing issues for some.

Q.3 - EXPLAIN SIMPLE CARBURETOR IN DETAIL.

- A simple carburettor is a device that mixes air and fuel to create a combustible mixture for a gasoline engine. It consists of a float chamber, main fuel jet, venturi, jet tube, and throttle valve. The float chamber contains a float, which helps to maintain a constant level of fuel.

❖ Working of a simple carburetor:

1. As we know, there is a float chamber in a simple carburetor that is open to the atmosphere. It keeps atmospheric pressure in the float chamber.
2. Fuel from the external fuel tank is supplied to the float chamber with the help of the fuel pump. This fuel from the fuel tank is filtered using the strainer which removes any solid particles from the fuel.
3. Now fuel from the float chamber is supplied to the main nozzle which is a part of the jet tube. This flow of fuel from the float chamber to the main nozzle is carried out by the main fuel jet.
4. The engine sucks air from the atmosphere through the choke valve. This air passes through the venturi, it causes a reduction of the area of a cross-section at the throat of venturi.
5. Due to this, the pressure at the main nozzle decreases and the velocity of air increases.
6. This difference in pressure-induced at the float chamber and the main nozzle causes the mixture of fuel and incoming atmospheric air.
7. Increased [velocity](#) of air after the venturi partially vapourize the engine fuel which is then totally evaporated by the heat in the intake manifolds of the combustion chamber and cylinder walls.
8. Carburetors only install in a petrol engine because petrol engines are quantity governed.
9. When we open the throttle valve present at the bottom of the jet tube, it allows more air flows through the venturi tube and a more quantity of the air-fuel mixture is supplied to the engine, causes, the engine develops more power.
10. When we close the throttle valve, reverse action takes place and the power of the engine reduces.

➤ **Construction of Simple Carburetor:-**

It construct by Float Chamber, Float, Nozzle, Throttle Valve, Inlet Valve etc..

➤ **Advantages of Simple Carburettor**

- Simplicity and cost-effectiveness in design and manufacturing.
- Suitable for small engines and applications where precise fuel control is not critical.
- Minimal maintenance requirements.

➤ **Limitations of a simple carburetor:**

- In this carburetor, the air-fuel mixture totally depends upon the position of the throttle valve.
- Also, the air-fuel ratio decreases when the speed of the engine increases.
- The main limitation or disadvantage of a simple carburetor is that when speed is too low, we get a strong mixture which causes trouble in the ignition of the mixture.

❖ **Application of simple carburetor:**

- **This is only used in small and stationary engines, not any modern engines.**

Q.4 -Describe in detail the MPFI system.

- **Multi-Point Fuel Injection (MPFI)** refers to a method of injecting fuel through multiple ports on each cylinder's intake valve. This precision enhances combustion efficiency, improving engine performance and fuel economy.

➤ Components of MPFI System:-

- **Fuel Injectors:** These electronically controlled valves deliver fuel directly into the intake valves in a precise spray pattern.
- **Fuel Pump:** It pressurises the fuel to ensure smooth delivery to the injectors.
- **Engine Control Unit (ECU):** The ECU is the brain of the MPFI system, monitoring various engine parameters and controlling the fuel injection process accordingly.
- **Sensors:** Various sensors, such as the throttle position sensor, oxygen sensor, and coolant temperature sensor, provide vital information to the ECU, enabling it to optimise fuel delivery.

➤ How does the MPFI System Work?

- **Data Gathering:** The sensors collect data on engine parameters like throttle position, engine speed, and temperature.
- **Data Processing:** The ECU receives and processes the gathered data to determine the optimum air-fuel mixture for each cylinder.
- **Fuel Injection:** Based on the calculations, the ECU triggers the fuel injectors to spray the precise amount of fuel into each cylinder's intake valve.

- **Combustion:** The fuel mixes with the incoming air, creating a highly combustible mixture ignited by the spark plugs, resulting in efficient combustion.

➤ **Advantages of Multi-Point Fuel Injection System**

- Improved Engine Performance
- Fuel Efficiency
- Emissions Reduction
- Reliability

➤ **Disadvantages of Multi-Point Fuel Injection System**

- Complex Design
- Higher Cost
- Vulnerability to Electrical Issues
- Limited Compatibility

Q.5 -Describe in detail the CRDI system

- Common Rail Direct Injection (CRDi) is a fuel injection system that uses high-pressure fuel power diesel engines

➤ **Components of Common Rail Direct Injection System**

❖ **High-Pressure Fuel Pump**

The high-pressure fuel pump is a key component responsible for supplying pressurised fuel from the fuel tank to the common fuel rail.

❖ **Common Fuel Rail**

The common fuel rail serves as a distribution system that receives pressurised fuel from the high-pressure pump and delivers it to the

individual injectors. It maintains consistent fuel pressure throughout the system, optimising injection accuracy and engine performance.

❖ **Injectors**

Injectors are crucial components that directly introduce fuel into the combustion chambers. They are precisely controlled by the engine control unit (ECU) to deliver the right amount of fuel at the right time, ensuring efficient combustion, power generation, and emissions control.

❖ **Engine Control Unit (ECU)**

The engine control unit, often referred to as the ECU or engine control module (ECM), is the brain of the CRDi system. It receives input from various sensors that monitor engine conditions and adjust the fuel injection process accordingly. The ECU optimises fuel delivery for performance, efficiency, and emissions compliance, ensuring the CRDi system's seamless operation.

➤ **Working of a Common Rail Direct Injection System:**

In common rail direct injection system, the fuel is collected from the tank and further supplied into the pressure pump through the fuel filters, the pressure pump used to increase the pressure of the fuel and supplied to the fuel rail, in fuel rail section the pressurized fuel is supplied into the injectors with same quantity and same pressure in all injectors and further the fuel in the injectors is supplied into the cylinders for combustion process.

➤ **Functions of Common Rail Direct Injection System:-**

- Efficiently delivers high-pressure fuel to injectors.
- Reduces noise and vibration during combustion.
- Allows for multiple injections per cycle for better control.
- Increases fuel efficiency and reduces emissions.

➤ **Advantages of Common Rail Direct Injection System:-**

- **Better Fuel Efficiency:** More precise fuel injection leads to better fuel economy.
- **Reduced Emissions:** Efficient combustion results in fewer harmful emissions.
- **Increased Power:** The CRDI system optimizes fuel delivery, leading to improved engine performance.
- **Smooth Engine Operation:** The system's electronic control ensures smoother running and better response.

Q.6 -Discuss in detail on engine cooling system

(Air cooling and Water cooling)

- Engines generate a lot of heat inside a combustion chamber. Some of it is used to move the piston, some is vented via the tailpipe, some is used to overcome friction, and some is absorbed by the engine components.
- As the engine completes thousands of combustion cycles in a minute, the heat absorbed by the engine components is significantly higher which can harm the engine. The cooling system helps to carry away heat and lowers the temperature of the engine.

➤ **What is an Engine cooling system?**

- The cooling system in the vehicles is the system that maintains the optimum operating temperature of the engine by extracting extra heat from the engine block and engine head thus avoiding the effects of overheating and ensuring better performance.
- Thus, without a cooling system, the engine has to face severe damage, it can even ruin the engine completely.

➤ **Functions of engine cooling system:**

1] **Removes extra heat:** It is the main function of the engine cooling system to carry away the excess heat generated by the engine.

2] **Helps to attain optimum temperature faster:** The optimum temperature means the temperature at which the engine gives better performance. Thus, after starting the engine, it is necessary that the engine should quickly reach its optimum temperature.

3] **Regulate engine temperature:** The cooling system has a thermostat that controls the flow of coolant passing through the radiator

• **There are two types of cooling system**

1) **Air cooling system**

2) **Water cooling system(liquid cooling system)**

1) **Air cooling system**

- Air cooled system is generally used in small engines say up to 15-20 kW and in aero plane engines.
- In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc. Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air.

- *The amount of heat dissipated to air depends upon:*
 - (a) *Amount of air flowing through the fins*
 - (b) *Fin surface area*
 - (c) *Thermal conductivity of metal used for fins*

➤ **Advantages of air cooled engines**

1. Its design of air-cooled engine is simple.
2. It is lighter in weight than water-cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.
3. It is cheaper to manufacture.
4. It needs less care and maintenance.

➤ **Disadvantages of air cooled engines**

- Relatively large amount of power is used to drive the cooling fan.
- Engines give low power output.
- Cooling fins under certain conditions may vibrate and amplify the noise level.

2) Water cooling system

- In a liquid cooling system (Radiator cooling system), liquid coolant is circulated through the coolant passages made in the engine.
- This coolant takes heat from the engine parts and reaches the radiator where it emits heat into the atmosphere.
- This method is a more efficient way to cool the engines than air cooling, thus it is used in most modern vehicles to regulate the engine temperature.
- It is more complex than the air-cooling system and consists of a number of components.

➤ **Advantages of a water cooling system:**

- The volumetric efficiency of water-cooled engines is higher than that of air-cooled engines.
- The compact design of engines with an appreciably smaller frontal area is possible.
- Engine is less noisy as compared with air-cooled engines, as it has water for damping noise

➤ **Disadvantages of a water cooling system:**

- The system requires more maintenance.
- The engine performance becomes sensitive to climatic conditions.
- In the event of failure of the cooling system serious damage may be caused to the engine.

Q.7 -Discuss in detail about properties of engine lubricants or lubricating oil.

- A lubricant is a substance that helps to reduce friction between surfaces in mutual contact, which ultimately reduces the heat generated when the surfaces move. It may also have the function of transmitting forces, transporting foreign particles, or heating or cooling the surfaces.

❖ **Properties of Lubricants**

Following are the 18 properties of lubricants:

#1 Viscosity

Viscosity is a measure of the resistance to flow or the internal friction of an oil. The viscosity of an oil is usually as the time in seconds that it takes for a

given amount of the oil to flow by gravity through a standard sized orifice at a given temperature. Viscosity is one of the most important properties of engine lubricating oil. It is used universally to grade lubricants.

#2 Flash Point

The flashpoint is defined as the lowest temperature at which the lubricating oil will flash when a small flame crosses its surface. When the oil is heated, it reaches a temperature at which, if a small flame is brought near it, a flash spreads across the oil.

#3 Fire Point

If the oil is heated further after the flashpoint has been reached, the lowest temperature, at which the oil will burn continuously is called the fire point. The fire point also must be high in lubricating oil, so that the oil does not burn in service.

#4 Cloud Point

The oil changes from a liquid state to plastic or solid-state when subjected to low temperature. Temperatures in some cases the oil starts solidifying which makes it appear cloudy. The temperature at which this occurs is identified as the cloud point.

#5 Pour Point

This is the lowest temperature at which lubricating oil will be pour. The pour point of an oil use lubrication of its ability to move at low temperatures. This property must be considered because of its effect on starting an engine in cold weather and on the free circulation of oil through exterior feed pipes when pressure is not applied.

#6 Oiliness

Oiliness is the characteristics property of oil. Oil is said to be oil when it has oiliness. This property highly desirable in helping the lubricant to adhere to the cylinder walls.

#7 Emulsification

A lubricating oil, when mixed with water, loses its lubricating properties. The emulsification number is an index of the tendency of an oil to emulsify with water.

#8 Physical Stability

Lubricating oil must be stable physically at the lower and the highest temperature between which the oil is to be used. At the lowest temperature, there should not be any separation of solids, and at the highest temperature, it should not vaporise beyond a certain limit.

#9 Chemical Stability

A lubricating oil should also be stable chemically. There should be no tendency for oxide to form. Oil should not decompose even at high temperatures to form carbon, which makes the [spark plugs](#) and valves defective to function.

#10 Neutralization number

An oil may contain impurities that are not removed while refining. It may contain alkaline or acid products. The neutralization number test is a simple procedure to determine acidity or alkalinity of the oil.

#11 Film Strength

It has the lubricating properties of the oil due to which this oil maintains a thin film between the two surfaces even at high speeds and loads. The film does not break and the two surfaces do not come in direct contact.

#12 Cleanliness

Lubricating oil must be clean. It should not contain dust and dirt particles. These impurities may either be filtered out or removed with the change of oil at periodic intervals.

#13 Adhesiveness

It has the property of lubricating the oil, causing the oil particles to stick to the metal surfaces.

#14 Specific Gravity

Specific gravity is a measure of the density of oil. It is determined by a hydrometer which floats in the oil, and the gravity is read on the scale of the hydrometer at the surface of the oil. The scale used is the one recommended by the American petrol institute, and the result is called the API gravity.

Q.8 -What are the function of Engine lubricating system.

Function of lubrication :

(a) Reducing frictional effect:

The primary purpose of the lubrication is to reduce friction and wear between two rubbing surfaces. Two rubbing surfaces always produce friction. The continuous friction produces heat which causes wearing of parts and loss of power. In order to avoid friction, the contact of two sliding surfaces must be reduced as far as possible. This can be done by proper lubrication only. Lubrication forms an oil film between two moving surfaces. Lubrication also reduces noise produced by the movement of two metal surfaces over each other.

(b) Cooling effect:

The heat, generated by piston, cylinder, and bearings is removed by lubrication to a great extent. Lubrication creates cooling effect on the engine parts

(c) Sealing effect:

The lubricant enters into the gap between the cylinder liner, piston and piston rings. Thus, it prevents leakage of gases from the engine cylinder.

(d) Cleaning effect:

Lubrication keeps the engine clean by removing dirt or carbon from inside of the engine along with the oil.

[1] It should have a high viscosity index.

[2] It should have flash and fire points higher than the operating temperature of the machine.

[3] It should have high oiliness.

[4] The cloud and pour points of a good lubricant should always be lower than the operating temperature of the machine.

[5] The volatility of the lubricating oil should be low.

[6] It should deposit least amount of carbon during use.

[7] It should have higher aniline point.

[8] It should possess a higher resistance towards oxidation and corrosion.

[9] It should have good detergent quality.

Q.9 -Discuss in detail about the petrol lubrication system and splash lubrication system.

❖ Types of Lubrication System:-

- ❖ Petroil system
- ❖ Splash system

#1 Petroil System:-

- In these types of the lubrication system, it is commonly used in the [two-stroke petrol engines](#) such as scooters and [motorcycles](#). It is the simplest form of the lubricating system. For lubrication purpose, it does not have any separate part like an oil pump.
- But the lubricating oil is added to the petrol itself during filling in the petrol tank of the vehicle in a specified ratio. When fuel enters the crank chamber during engine operation, oil particles go down into [the bearing](#) surfaces and lubricate them. The piston rings, cylinder walls, [piston pins](#), etc. are easily lubricated in the same way.
- If the engine is allowed to remain unused for a considerable time, the lubricating oil separates off from petrol and starts to clogging of passages in [the carburettor](#), occurring in engine start problems. Thus is the main disadvantages of this system.

#2 Splash System:-

- In these types of lubrication system, the lubricating oil accumulates in an oil trough or sump. A scoop or dipper is made in the lowest part of the [connecting rod](#). When the engine runs, the dipper dips in the oil once in every revolution of the crankshaft and cause the oil to splash on the cylinder walls.
- This action affects engine walls, piston rings, [crankshaft](#) bearings, and large end bearings. Splash

system mostly works in connection with the pressure system in an engine, some parts being lubricated by splash system and the other by a pressure system.

Q.10 -*Explain in detail the types of forced lubricating system{Dry sump, Wet sump}.*

➤ **Dry Sump System**

- The system in which lubricating oil collects in the oil sump is known as a wet sump system as a pressure system. But the system in which the lubricating oil is not located in the oil sump is known as the dry pump system.
- A dry sump lubricating system is used for the supply of oil and is carried out in an external tank.
- To remove heat from the oil, separate oil cooler with either water or air as the cooling medium is provided in the dry-sump system.

➤ **Wet Sump System**

- In this system, oil is transported to various engine parts with a sump strainer. In this wet sump system, oil pressure is of about 4 to 5 kg/cm². After lubrication, the oil is carried back to the oil sump. In this case, the oil is present in the sump. Therefore, it is called a wet sump lubrication system.

- Most of the oil from the pump goes directly to the engine bearings and a portion of the oil passes through a cartridge filter which removes the fluid particles from the oil.
- This reduces the amount of contamination from carbon dust and other impurities present in the oil. Since all the oil coming from the pump does not pass directly through the filter.
- This filtering system is called a bypass filtering system
- The benefits of a wet sump system are its simplicity. And the oil is close to where it will be applied, doesn't have a lot of parts to repair, and is relatively safe to build in a car.