Unit 6

Intake, Exhaust System and Combustion Chamber

Contents

Learning Objectives

- To learn about the engine emissions along with its impact on humans and environment.
- To learn about the engine firing procedure.

6.0 INTRODUCTION

In the earth, all the living organisms, animals and human beings are living with the help of oxygen present in nature (or) atmosphere. For producing power and food they use energy obtained from burning the fuel. Human beings use different fuels to get their heat energy according to their needs. In the same way they use heat energy obtained from burning the fuel for operating their automobiles. Human beings use different approaches for burning the fuels to produce energy or power. For attaining such strategies, they using separate systems for transferring fuel from the fuel tank in to combustion chamber. The system used to perform this function is called as the intake system. The exhaust gases produced from the combustion of fuel inside the combustion chamber are sent out of the engine by another system called as the exhaust system.

6.1 EFFECTS OF POLLUTANTS

The exhaust emissions released from the engine combustion chamber are toxic to the human beings and highly pollute the environment. Hence it is advisable to produce less emission from the engines. It can be achieved by burning the fuels completely in the engine combustion chamber. By controlling the pollutants from the automotive engines, the environment can be maintained as clean and all the human beings, animals and all the plants can live peacefully without any diseases. The following are the important pollutant emissions coming out from the internal combustion engines.

1. Carbon Monoxide
2. Nitric Oxide
3. Hydro Carbon
4. Smoke
5. Particulate (solid, liquid pollution)
6. Sulfur Dioxide and etc.,

The following picture and table present the effects of the above pollutants on human beings

In order to reduce the formation of the above hazardous pollutants the fuel must be burnt completely inside the

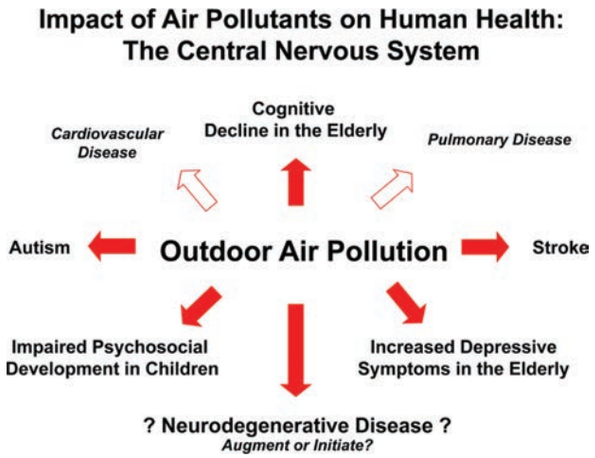

Figure 6.1

Table 6.1 Effects of pollutants

Pollutants	Effects
1. Carbon monoxide	Reduces the oxidation in the blood. It affects the nerves, the heart and the eyes.
2. Nitric oxide	Affects human's cells and blood flow.
3. Hydro carbon	It affects the human eyes.
4. smoke	It affects the human eyes.
5. Particulate matter (solid, liquid pollution)	It leads to cancer, bronchitis and allergy like diseases by inhaling.
6. Sulfur dioxide	It affects human beings and plants.

engine itself in the vehicle. The way of supplying the fuel and air inside the engine combustion chamber plays an important role in achieving complete combustion. The system used for supplying appropriate air and fuel at the appropriate timing inside the combustion chamber of the engine is called as the "intake system". The important components of the engine intake system are

1. Fuel Tank
2. Fuel Filter (Petrol & Diesel)
3. Air Filter
4. Fuel Pump (Petrol and Diesel)
5. Feeding Pump
6. Inlet Manifold
7. Carburettor
8. Injector
9. Nozzle
10. Combustion chamber.

6.2. FUEL TANK

The fuel tank is used to store the fuel needed to produce output energy in the vehicle. It is made of Galvanized Iron by pressing process. This fuel tank varies depending on the cubic capacity of the vehicle. Similarly, the location of this tank in the vehicle will vary depends on the type of vehicle. A separate tank will be generally mounted on the top of the vehicle chassis frame according to the fuel filling system. The fuel tank is shown in Figure 6.2.

Figure 6.2 Fuel Tank

6.3. FUEL FILTER

There is a possibility of having fuel contaminated with dust particles while filling the fuel or during storage. If the contaminated fuel is supplied to the chamber, it leads to incomplete combustion

Figure 6.3 Fuel filter

Figure 6.4 Air filter

and creates problem in reciprocating movement of the piston up and down. The incomplete combustion causes formation of pollutants in the exhaust. Hence fuel filter is used in path way of the fuel supply line to avoid the above said problems. It removes the dust particles and sends the purified fuel to the fuel injector and to the combustion chamber. Figure 6.3 shows the Fuel Filter

6.4. AIR FILTER

In any diesel or petrol engine for achieving combustion of the fuel sufficient amount of oxygen or pure air is required. Hence before sending the atmospheric air into the carburettor in petrol engines or directly into the combustion chamber in diesel engines, the air must be purified. In automobiles there are number of designs in air filters based on the engine used. If it is a gasoline engine air filter is mounted at the carburettor inlet, where as the filter is fitted at the intake manifold in diesel engine. There are different types air filters used in vehicles. Figure 6.4 shows the Air Filter. They are

1. Dry Type Air Cleaner (filter)
2. Oil bath type Air Cleaner (filter)
3. Oil coated air filter (Oil wetted type air cleaner)

Air filters applications (Uses of Air cleaner)

Though there are many usages of the air filters in many different applications, the important usages of the air filter in automobile are,

1. To send clean air without dust and contaminates to the carburettor.
2. To avoid mal-functioning of the engine and prevent damages of the engine parts due to incomplete combustion
3. To reduce the pressure difference occurs in the intake manifold and lowers the noise level. Figure 6.4 shows the Air Filter

6.4.1 Dry Type Air Cleaner

In this type of air filters, the cover, filtering part and bottle housing are coupled with each other. When the air is inducted to the filter through the filter cover, the dust particles and contaminations in the air are removed. Then purified air passes

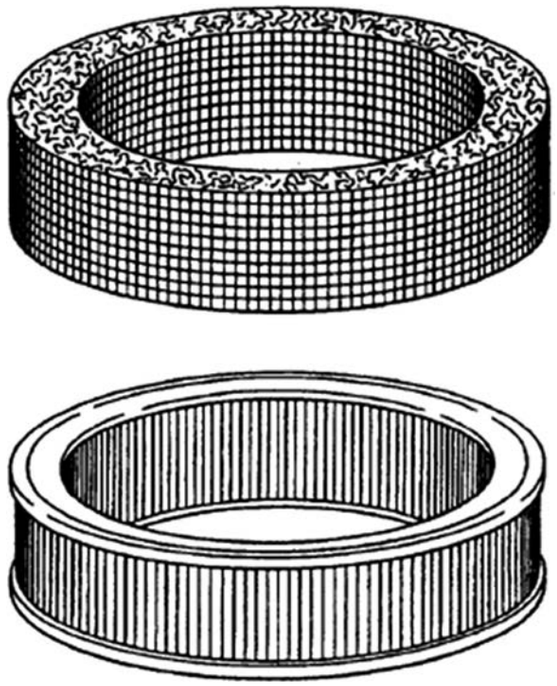

Figure 6.4.1 Dry Type Air Cleaner

to the upper section of the carburettor through the filter outlet in the intake air path and enters into the carburettor. In this type of filters, a number of folded paper elements are used as a filter. Figure 6.4.1 shows the Dry Type Air Cleaner.

6.4.2 Oil Bath Type Air Cleaner

In oil bath type, the air filter is filled with oil in the container such as a tank. This type of filter is made up of copper metal and looks like a spider net in ring shape. It is enclosed in the middle of the tank filled with oil and the upper cover kept in closed position. Due to the reciprocating downward movement of piston the air is sucked in to the engine through the intake manifold where the air filter is fixed. The air is initially passed through the oil present in the filter tank, where surface of the oil absorbs larger size dust particles in it. After that the smaller size dust particles in the air are removed

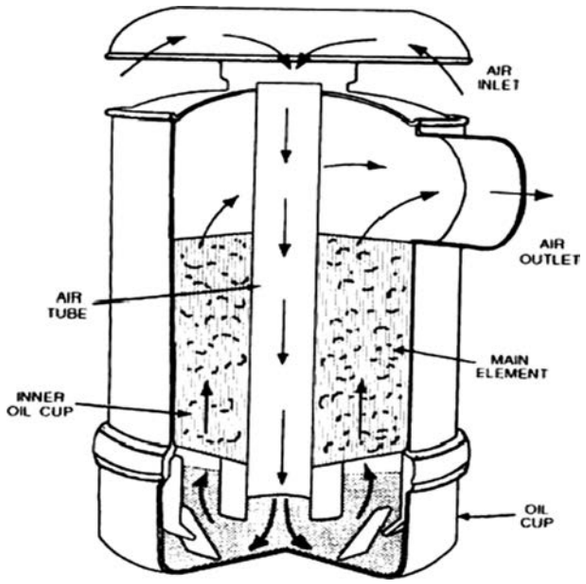

Figure 6.4.2 Oil Bath Type Air Cleaner

by the filter. The filtration components and oil container are fitted separately in this type of filters. Figure 6.4.2 shows the Oil Bath Type Air Cleaner.

6.4.3 Oil Wetted Type Air Cleaner

In this type of filter, the filter is not dipped in the oil in the tank. Instead, the surface of the filter will be coated with oil. The air passing through the filter initially touches the oil on the filter and removes larger size dust particles and impurities. After that the air is passed into the net shaped filter and the air gets purified again and the cleaned air is sent to the engine. Generally, in automobiles after running for 8000 kilometers the filter is

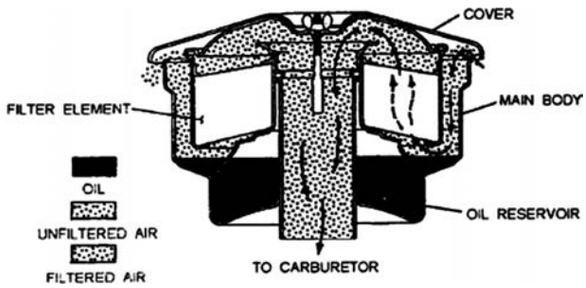

Figure 6.4.3 Oil Wetted Type Air Cleaner

cleaned with petrol or paraffin and can be reused. Figure 6.4.3 shows the Oil Wetted Type Air Cleaner.

6.5. FUEL PUMP

The required amount of fuel (for producing power) pumped from the fuel tank to the combustion chamber is transferred by the device called fuel pump.

It is classified according to the fuel used as,

1. Fuel Pump (Petrol Engine)
2. Fuel diesel pump (diesel engine)

6.5.1 Petrol Fuel Pumps

A fuel pump is used to transfer the fuel from the fuel tank through the filter with appropriate pressure to the float chamber of the carburettor in gasoline engines to drive the vehicle. Petrol Fuel pumps are classified in two types as

1. A.C. Mechanical Fuel Pump
2. S.U. Electric Fuel Pump

Fig 6.5.1(a) A.C. Mechanical Fuel Pump

Fig 6.5.1(b) S.U. Electric Fuel Pump

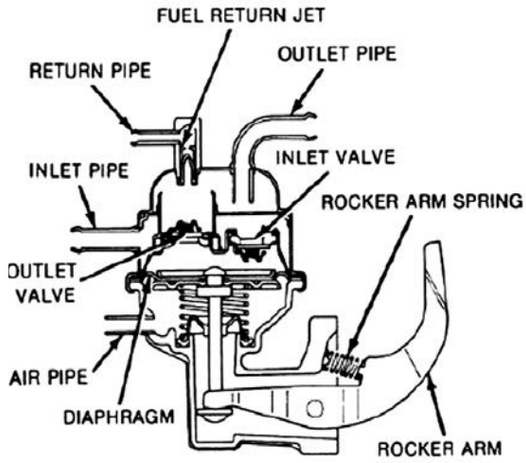

Figure 6.5.1 (a) Schematic of A.C. Mechanical Fuel Pump.

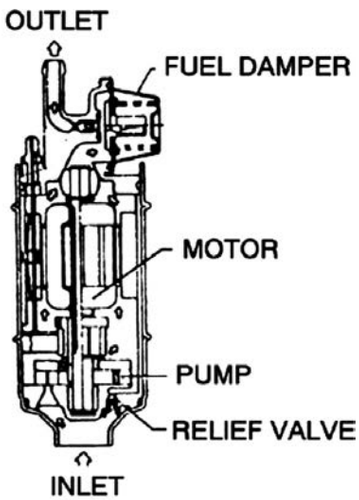

Figure 6.5.1 (b) S.U. Electrical Fuel Pump.

6.5.2 Diesel Fuel Injection Pump

Unlike in petrol engines, in diesel engines diesel stored in the fuel tank is sucked by the Diesel fuel injection pump. The fuel from the fuel tank is passed through the fuel filter and feed to the fuel injection pump. The fuel injection pump develops high pressure and the pressurized fuel is sent to the fuel injector and sprayed into the engine's combustion chamber. This fuel injection pump is classified into two types. They are,

a) Inline Pump

b) Distributer Pump

6.6 FEED PUMP

Feed pump is another pump arrangement located between the diesel fuel tank and the filter in the diesel **Fuel Injection Pump** (FIP) block. The drive for the fuel feed pump is given from the camshaft of the fuel injection pump by cam or eccentric. The fuel feed pump is designed to operate manually by hand for purging the air in the fuel line when air bubbles are present. This fuel feed pump is classified into two types based on the delivery of fuel continuously or intermittent while the fuel injection pump is running. They are

1. Single acting pump
2. Double acting pump

6.6.1 Single Acting Pump

Construction

This type of pump is mounted on the body of the fuel injection pump. This single acting pump is driven by the cam or eccentric of the fuel injection pump's cam shaft. The components such as roller tapper, pressure spindle and plunger are in contact with each other and placed inside the pump body. For emergency purpose, hand priming device is used to increase the pressure of fuel. Figure 6.6.1 shows the Single Acting Pump.

Working Principle

When the engine is started the drive is received from the engine's crank shaft and given to the FIP cam shaft through timing gears. Now the cam shaft of the FIP rotates and while rotating the roller tappet the feed pump is actuated by the cam or eccentric in the cam shaft. Hence the plunger is actuated by the action of the roller tappet. Pressure spindle is now actuated by the plunger. Therefore, the fuel in the pressure chamber is pressurized and sent to the FIP. At the same time the high-pressure fuel developed in the FIP is sent to the nozzle (injector) by the FIP. The quantity of fuel delivered is equal to swept volume or equal to stroke length. The delivery passage is closed by the pressure spindle with the spring force. This is the way how the single acting pump works.

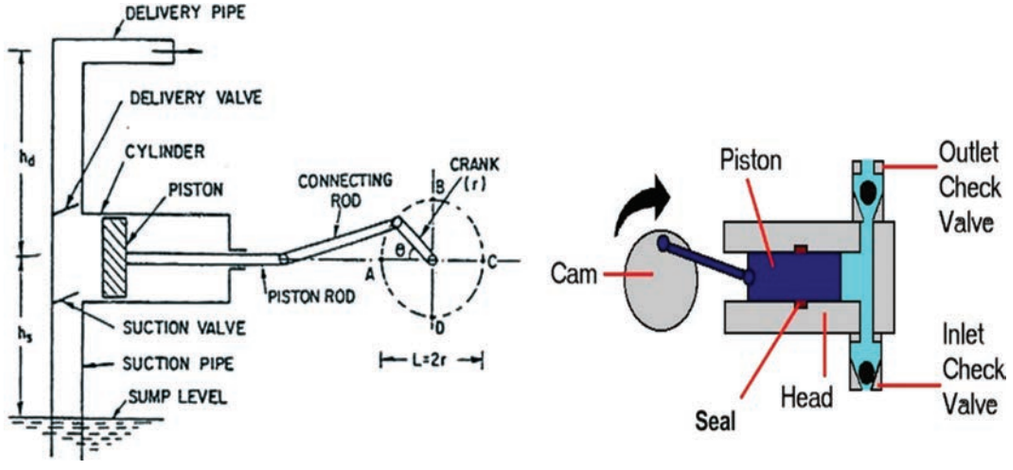

Figure 6.6.1 Single Acting Pump

6.6.2 Double Acting Pump

Construction

This type of pump is similar to the single acting pump in its construction. However, it differs from the single acting pump that the plunger in the pump is operated in such a way to achieve the suction and delivery of fuel at the same time. Figure 6.6.2 shows the Double Acting Pump.

Working Principle

When the drive is received from the engine cam shaft, the cam shaft of the FIP starts rotating and actuates the roller tappet of the fuel pump. Hence the plunger moves downward and presses the pressure spring. Now the pressure valve and suction valve are opened at the same time. And the fuel suction and delivery are achieved at the same time. For each and every rotation of FIP camshaft, the pressurized fuel delivery and suction process are done simultaneously. Since the two actions are done at the same time, this pump is called as the double acting pump.

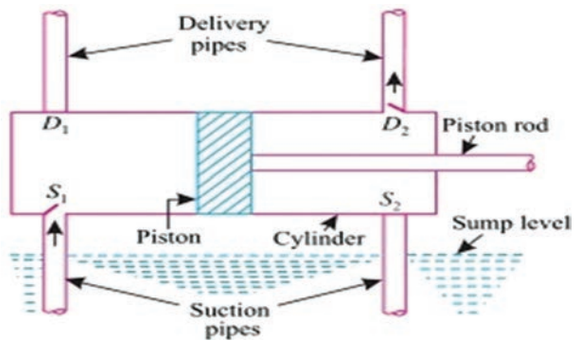

Figure 6.6.2 Double Acting Pump

6.7 Inlet Manifold

Inlet manifold is a pipe which is made up of cast iron or aluminium metal. It is used to send the air fuel mixture from the carburettor to the engine inlet port in petrol engines and air to the combustion chamber in diesel engines. It is also a place to locate the carburettor in petrol engines. The governor or super charger can't be fitted here. In L-head engine the inlet manifold is situated at the adjacent of cylinder block, and in I- head engine it is situated at the adjacent of cylinder head. In V- shape engine it is situated between the two cylinders. Since the exhaust and coolant supply are placed close to the intake manifold there may be possibilities for the inlet manifold to get heated. Hence a thermostat valve with coolant circulation is provided in modern engines to avoid heating of the intake manifold. Therefore, by using the thermostat valve, the inlet manifold can be cooled. The engine is also heated easily by using the thermostat valve from low temperature. Therefore, engine can be started easily. The inlet manifold of the engine is classified into two types. They are

1. Dual intake manifold
2. Four-barrel intake manifold

Dual Intake Manifold

Four-Barrel Intake Manifold.

Figure 6.7 Dual and Four-Barrel Intake Manifold.

Figure 6.7 shows the Dual Intake Manifold and Four-barrel intake manifold

6.8 CARBURETTORS

Carburettor is a device which is used to atomize the petrol and mix it with the air in the proportion depending upon the speed and torque of the engine. This mixture enters into the engine via inlet manifold with the help of carburettor. The venture in the carburettor is used to mix the fuel with the air to the required proportion. After mixing the air fuel mixture is introduced into the engine cylinder. Figure 6.8 shows the Carburettors

The carburettor is classified into several categories. They are as follows,

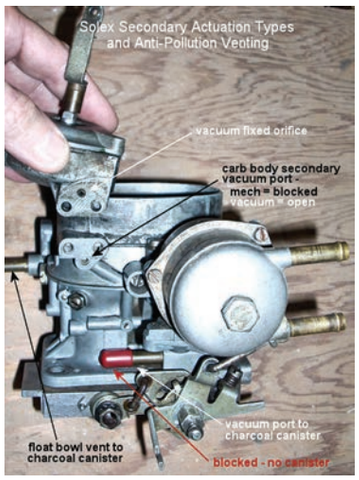

Figure 6.8 Carburattors

1. According to the float chamber
   a) Eccentric
   b) Concentric
2. According to the path of air flow
   a) Down Draft
   b) Side Draft

SPARK PLUG

Albert Champion

During the early 1900s, France was the dominant manufacturer of spark plugs.

Frenchman, Albert Champion was a bicycle and motorcycle racer who immigrated to the United States in 1889 to race. As a sideline, Champion manufactured and sold spark plugs to support himself.

In 1904, Champion moved to Flint, Michigan where he started the Champion Ignition Company for the manufacturing of spark plugs.

He later lost control of his company and in 1908 started the AC Spark Plug Company with backing from Buick Motor Co. AC presumably stood for Albert Champion.

His AC spark plugs were used in aviation, notably for the trans-Atlantic flights of Charles LIndbergh and Amelia Earhart. They also were used in the Apollo rocket stages.

c) Up Draft
d) Semi-Down Draft

3. According to the package
   a) Single Unit
   b) Double Unit
   c) Four-Barrel Unit.
4. According to the Types of Metering System
   a) Air-Bleed jet
   b) Metering Rod Type
5. According to the type of venturi
   a) Plain Venturi
   b) Double Venturi
   c) Vane Venturi
   d) Nozzle-Bar Venturi
   e) Triple Venturi
6. Also, it is classified based on the placement of the carburettor, they are
   a) Simple Carburettor
   b) S.U Carburettor
   c) Solex Carburettor
   d) Zenith Carburettor
   e) Cartor Carburettor

6.9 FUEL INJECTORS

Injector plays an important role in injecting the diesel into the cylinder of the diesel engine. It injects equal amount of the fuel to each cylinder as per the firing order. Injector is used to spray the diesel fuel into the cylinder in the form of very fine particles in the range of 20 to 100 micrometers. Due to this, the diesel fuel is completely mixed with the air. This leads to complete combustion. Figure 6.9 shows the Fuel Injector.

The diesel fuel injectors have the following components,

1. Nozzle body
2. Cap unit
3. Delivery unit

Nozzle body consists of nozzle valve; spindle, springs, adjusting nut are placed together. A passage is made on the injector to pass the high-pressure fuel to inject into the combustion chamber and the bypass unit

Figure 6.9 Fuel Injector

is used to let the fuel to go back to the fuel tank. Figure 6.9 shows the Fuel Injector.

Working Principle of Injectors

By the rotation of engine crankshaft, the camshaft rotates by using the timing gear connected with it. Hence the camshaft connected to the fuel injection pump also rotates and high pressure is developed in the fuel injection pump. The pressurized fuel the fuel tank is supplied to the fuel injector through the high-pressure fuel line. The diesel fuel entering the injector reaches the nozzle and starts to spray with the help of spring force acting inside the nozzle. Diesel fuel enters into the nozzle at very high pressure opens the nozzle valve by lifting against spring force acting inside the spindle. Hence the nozzle valve opens and high-pressure diesel fuel in the nozzle is injected into the chamber generally at the pressure of 200 bars in the form of very fine droplets. The droplets of the diesel fuel then vaporize and mix with the air inside the combustion chamber to attain proper mixture for burning. When the injection process is over the pressure getting reduced in the spring inside the nozzle, hence the spindle moves the nozzle valve downward. Hence the nozzle valve gets closed. In this way the diesel fuel injector works.

6.10 NOZZLE

Nozzle is the important component used for injecting the diesel at very high pressure at correct timing for the maximum power output of the engine. It is a part of injector which is placed at the cylinder head and has contact with combustion chamber in order to inject the fuel. It helps in injecting the fuel as per the requirements

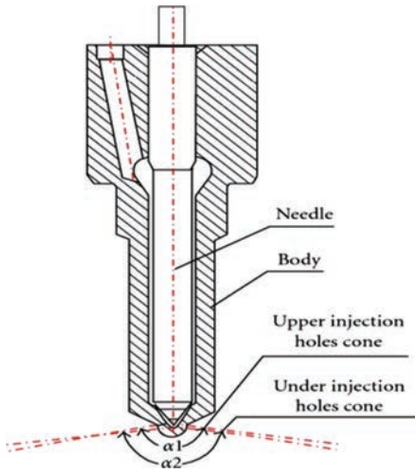

Figure 6.10 Nozzle

of the engine at different pressures and at constant temperature with accurate metering. Nozzle is designed to fit in to the nozzle valve and it can be assembled only by the authorized company. A hole for supplying fuel is available at the tip of nozzle valve. The diesel entering into the injector at high pressure is used for opening the valve and the returning action is taken by springs provided in the valve. Figure 6.10 shows the Nozzle.

There are different types of nozzles,

1. Single Hole Nozzle
2. Multi Hole Nozzle
3. Long Stem Nozzle

6.10.1 Single Hole Nozzle

It has a single hole at the tip for injecting a fuel. The nozzle has a cone shaped spindle which is used for opening and closing the nozzle hole. Figure 6.10.1 shows the Single Whole nozzle.

6.10.2 Multi Hole Nozzle

It has a multi holes for injecting the fuel depending upon the engine

Figure 6.10.1 Single Whole Nozzle

Figure 6.10.2 Multi Whole Nozzle

requirements. Figure 6.10.2 shows the Multi Whole nozzle.

6.10.3 Long Stem Nozzle

The long stem nozzle is mainly used for the direct injection into combustion chambers.

Small Stem Nozzles are commonly not used for these types (direct injection) of engines. Figure 6.10.3 shows the Long Stem Nozzle.

Some of the long stem nozzles are,

a. Pintle Nozzle
b. Pintaux Nozzle
c. Delay Nozzle

a) Pintle Nozzle:

This type of nozzle injects the fuel which is in the form of pencil's cone edge. It is mainly used in the swirl type of combustion chamber, air cell chamber

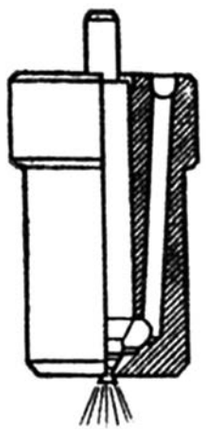

Figure 6.10.3(a) Pintle Nozzle

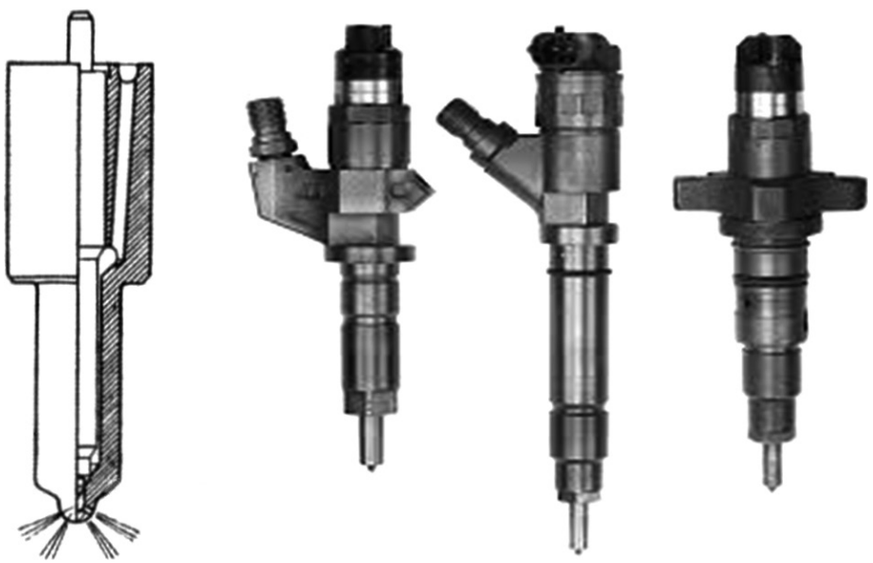

Figure 6.10.3 Long Stem Nozzle

and Pre-combustion chamber engines. Figure 6.10.3(a) shows the Pintle Nozzle.

b) Pintaux Nozzle:

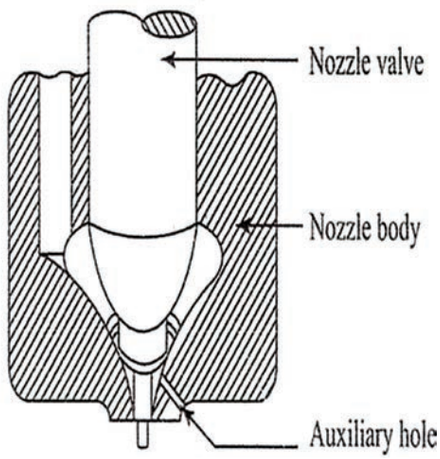

Figure 6.10.3(b) Pintaux Nozzle

This type of nozzle is advancement in the pintle nozzle type. This type of nozzle has the tip projected outside and has a hole in the centre for injecting the fuel. This type of nozzle can achieve combustion even in cold starting condition of engine. Figure 6.10.3(b) shows the Pintaux Nozzle

c) Delay Nozzle:

It is the further advancement in pintle type nozzle in which the fuel injection and the amount of fuel injected into the combustion chamber are controlled depending on engine speed. This type of nozzle is called as delay nozzle.

6.11 COMBUSTION CHAMBERS

The combustion chamber is the place where the air fuel mixture is burnt. It is the space covered by the cylinder head, cylinder wall and piston top. Above the piston there are inlet and exhaust valves and a spark plug present in the cylinder head. Depending on the position of the valves, spark plug and the combustion chamber the engines can be classified as

- L – Head engine
- I – Head engine
- F – Head engine
- T – Head engine
- Spherical shape

L – Head Engine

This type of engine is used for slow and high speed applications. In this type of engines the inlet and exhaust valves are placed in the cylinder block itself and the valves open the intake and exhaust ports by moving upward motion. The spark plug is fitted at the top of the engine cylinder head. Figure 6.11(a) shows the 'L' Head Engine.

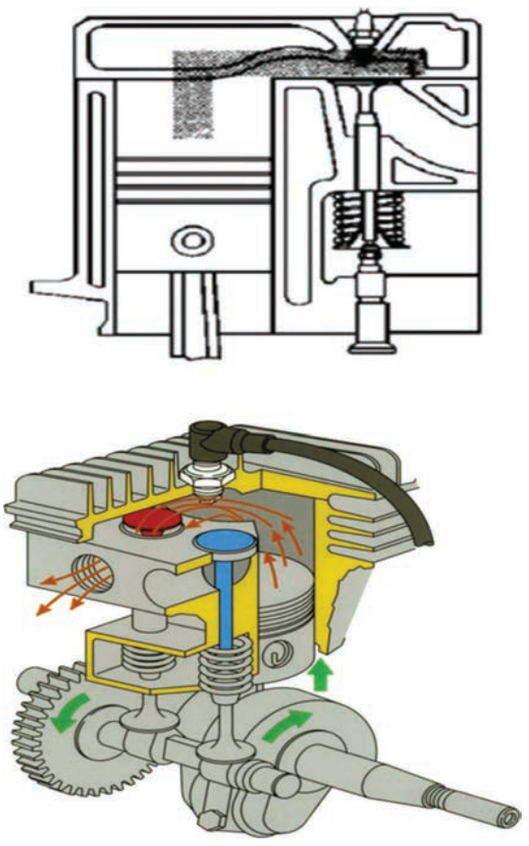

Figure 6.11(a) L – Head Engine

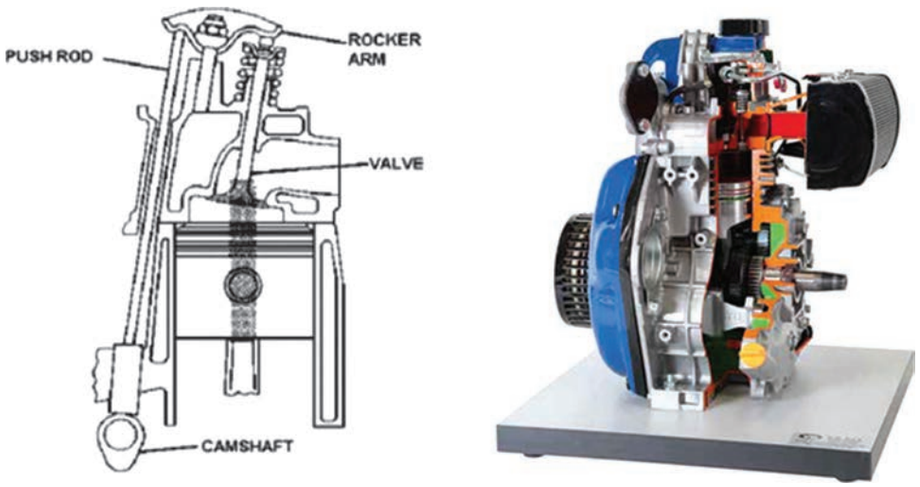

Figure 6.11(b): I– Head Engine

I– Head engine

This type of engine is used in high speed vehicle and racing vehicle. The inlet and exhaust valves replaced in the cylinder head and the spark plug is fitted at the side of cylinder head. Figure 6.11(b) shows the 'I' Head Engine.

F– Head engine

In this engine the combustion chamber is designed in stretched manner at the side way of the engine. The inlet valve is fitted on the upper side of cylinder head which moves in downward motion and exhaust valve is fitted in lower side of cylinder head which moves in upward direction and the spark plug is in the side of cylinder head. Figure 6.11(c) shows the 'F' Head Engine.

T– Head engine

It is designed in stretched manner in both lateral sides, the inlet and exhaust valves are fitted at the lower side of cylinder

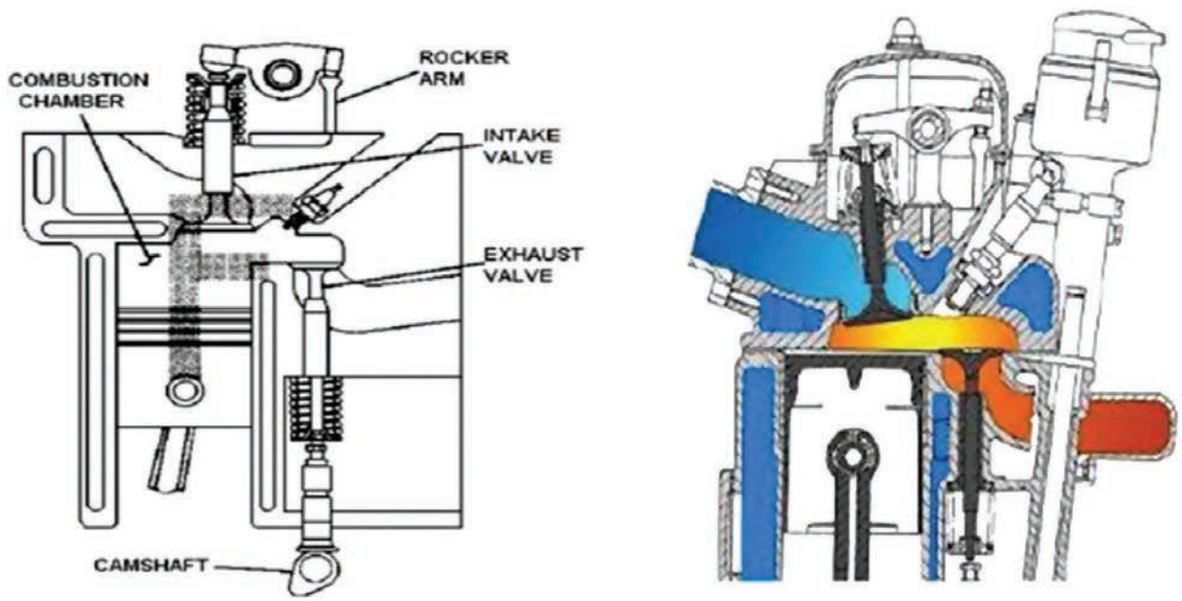

Figure 6.11(c): F – Head Engine

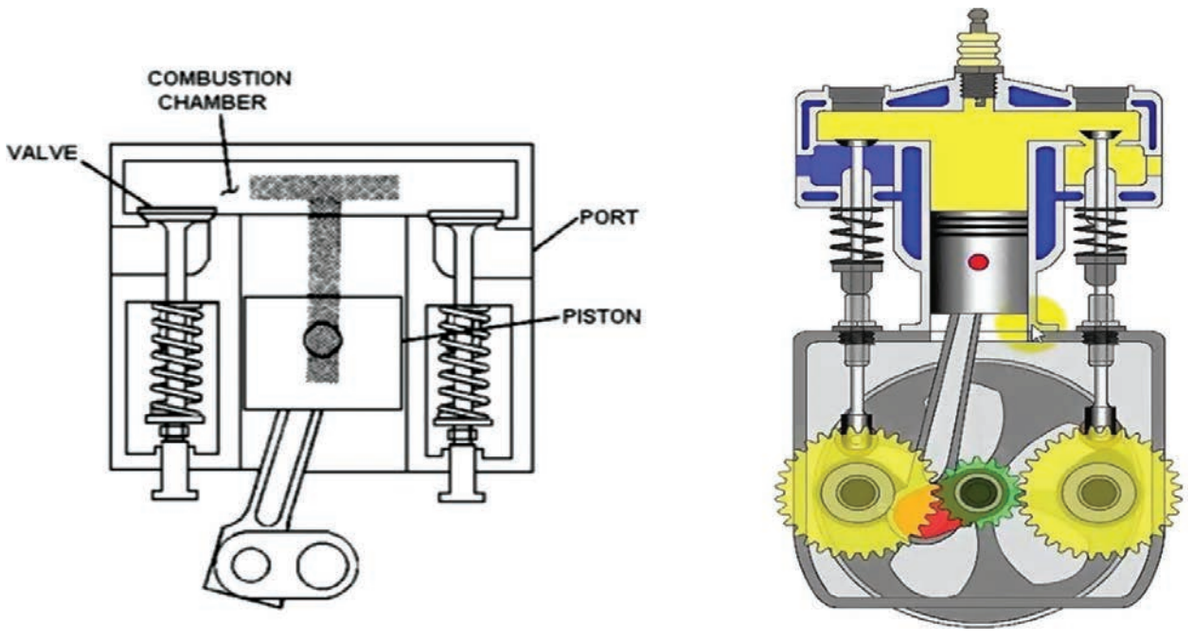

Figure 6.11(d): T – Head Engine

head in which the valves move in upward direction and the spark plug is fitted at the top of cylinder head. Figure 6.11(d) shows the 'T' Head Engine.

Spherical shape

In engine's combustion chamber, if the cylinder head or the piston top has internally or externally a spherical shape then the combustion chamber can be called as spherical combustion chamber. The inlet and exhaust valves are fitted at the opposite direction and the spark plug is fitted either centre or at lateral sides in such engines.

6.11.1 Types of combustion chambers of diesel engines

Due to high power output of diesel engines, the combustion chambers are designed in different types depending on the engines torque and speed requirements. The diesel engine combustion chambers are mainly of the following,

a. Open Combustion chamber
b. Pre-Combustion chamber
c. Swirl Combustion chamber
d. Squish Combustion chamber
e. Air cell and energy cell

(a) Open Combustion chamber

This type of combustion is mainly used in slow and high-speed engines. The piston head is designed in such a way to have a (semi spherical) bowl shape and the injector of the engine is mounted on the cylinder head. Figure 6.11.1(a) shows the Open Combustion Chamber.

(b) Pre-Combustion chamber

It is mainly used in high speed engines. It consists of two chambers such as auxiliary (or pre) combustion chamber and other called as the main combustion chamber. The auxiliary combustion chamber is small and is used for igniting the small amount of the air fuel mixture.

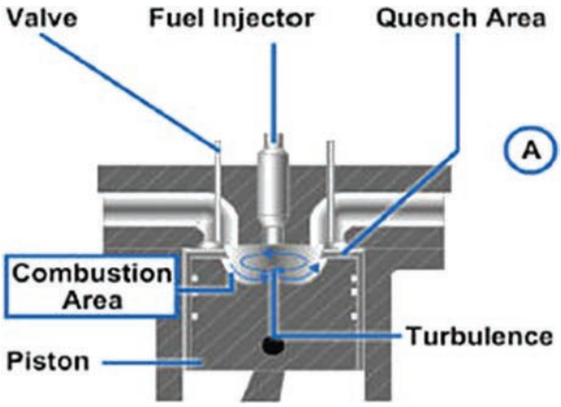

Figure 6.11.1(a) Open Combustion Chamber

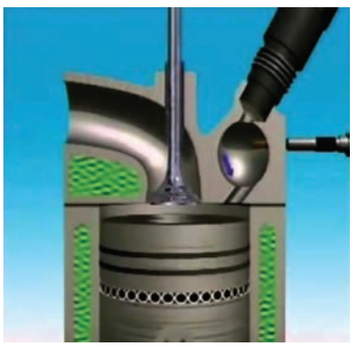

Figure 6.11.1(b) Pre-Combustion Chamber

The mixture first starts ignited in the auxiliary chamber and the combustion flame travels towards the main combustion chamber for the burning the rest of the air fuel mixture. Normally Glow plug is used to initiate combustion of the mixture. The glow plug will be located at the auxiliary chamber. Figure 6.11.1(b) shows the Pre-Combustion Chamber.

(c) Swirl Combustion chamber

It is also known as the turbulent chamber. The air enters into the combustion chamber in swirl motion in which the fuel is injected on the swirl air motion, allowed to mix with the air and achieves

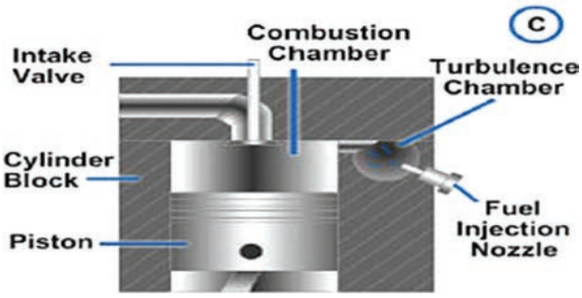

Figure 6.11.1(c) Swirl Combustion Chamber

combustion. Figure 6.11.1(c) shows the Swirl Combustion Chamber.

(d) Squish Combustion chamber

The piston head has the bowl shape in which the air motion is travelled from the side to centre of chamber. The radically inward movement of the air is called as squish. As the piston moves from BDC to TDC, the squish motion is created and the fuel is injected and ignited. Figure 6.11.1(d) shows the Squish Combustion Chamber.

(e) Air cell and energy cell

Air cell

The Air cell design has two (called as air cell and main) chambers in which they

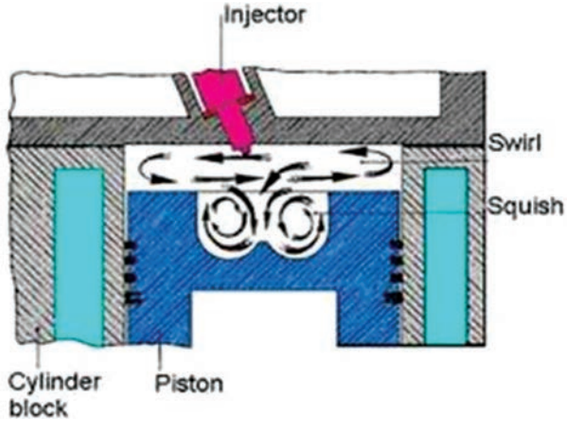

Figure 6.11.1(d) Squish Combustion chamber

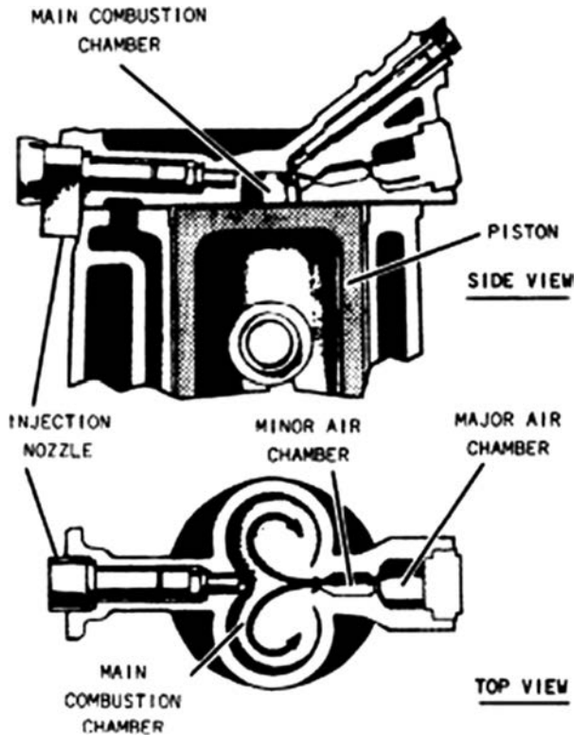

Figure 6.11.1(e) Air Cell and Energy Cell

are connected together by a narrow passage. Due to this arrangement the pressure of the inlet air increases in the air cell chamber and the pressurized air enters into the main chamber in which the fuel is injected and combustion is achieved. Figure 6.11.1(e) shows the Air Cell and Energy Cell.

Energy cell

It is also known as Lenovo combustion chamber. It combines the Air cell and Pre combustion chamber modes. In this type of chamber the energy cell is connected via the narrow passage with main chamber. When the engine runs, the pressure of the air in the energy cell is increased due to the narrow path and fuel is also injected in the similar way as pre chamber. The combustion at the energy cell is continued in the main chamber where the main combustion takes place. By this way the energy is utilized by injecting fuel in the energy cell. Due to piston movement from TDC to BDC and depending on pressure difference between the chambers the mixture is combusted completely.

6.12 EXHAUST SYSTEM

In an engine the products of combustion (pollutants) formed during the combustion process must be taken out of the engine. This system is called as the exhaust system. This system includes exhaust port, exhaust manifold, exhaust pipe, muffler and a catalytic converter.

6.12.1 Exhaust manifold

Exhaust manifold is a part of the exhaust system that is used for removing unwanted gases such as carbon monoxide, carbon dioxide, smoke, unburned hydrocarbon etc., which are formed during the combustion process. Through the exhaust port of the engine the exhaust products are passed to the exhaust manifold. The unwanted gases coming out from the all cylinders in the engine are collected in the exhaust manifold and sent to the exhaust pipe called as tail pipe. This is the main purpose of the exhaust manifold present in the engine. Exhaust manifold is generally made up of cast iron. Figure 6.12.1 shows the Exhaust Manifold.

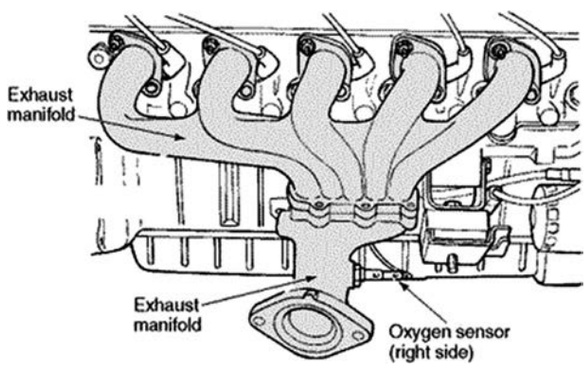

Figure 6.12.1 Exhaust Manifold

6.12.2 Exhaust Pipe

Exhaust pipe is the one which connects exhaust manifold and muffler. It is around 5cm in radius and 1cm in thickness generally. The exhaust pipe arrests the vibrations to the muffler which is coming from the engine.

6.12.3 Exhaust Mufflers

The exhaust mufflers are used to send heat, gas and sound without any destruction. To do these the mufflers have to perform the following operations.

1. Reduce the temperature of exhaust gas
2. Reduce the speed of the exhaust gas
3. Reduce the sound of the exhaust gas
4. Reduce the strength hot and unburned gas

Different types of mufflers are used to perform the above functions. They are of

a) Baffle type
b) Wave cancellation type
c) Resonance type
d) Absorber type
e) Combined absorber and resonance type

6.12.3(a) Baffle type

This type of mufflers will be in cylindrical shape. This will be divided into many rooms. Hence the exhaust gas speed gets reduced and the energy also gets reduced. Fig 6.12.3(a) shows the baffle type muffler.

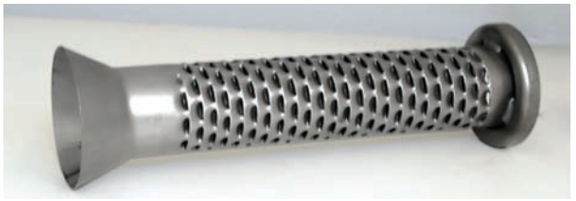

Figure 6.12.3(a) Baffle Type Muffler

6.12.3(b) Wave cancellation type

In this type the burnt gases are separated and again combined and expelled out to the atmosphere. In this type the speed of the gas can be reduced but the sound can't be reduced completely. Fig 6.12.3(b) shows the wave cancellation type.

6.12.3(c) Resonance type

In this type of mufflers the serially arranged resonators absorb the sound of the out coming gases. So that the sound as well as heat gets reduced. Fig 6.12.3(c) shows the resonance type.

6.12.3(d) Absorber type

In this type the exhaust pipe is surrounded by special type of materials which could absorb the sound. When the exhaust enters into this muffler the absorber material absorbs the sound. Fig 6.12.3(d) shows the absorber type.

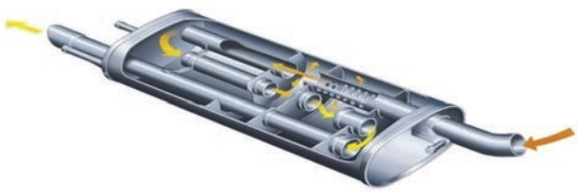

Figure 6.12.3(b) Wave Cancellation Type Muffler

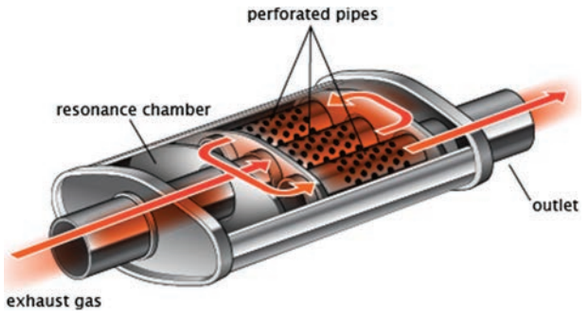

Figure 6.12.3(c) Resonance Type Muffler

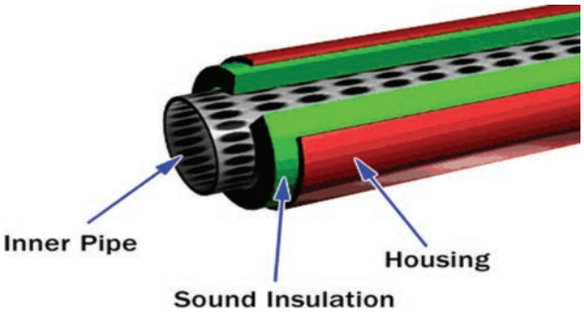

Figure 6.12.3(d) Absorber Type

6.12.3(e) Combined absorber & resonance type

In the combined type mufflers in addition to the absorber material resonators are also fixed on the exhaust path. In this type of mufflers both heat and vibrations are absorbed. Fig 6.12.3(e) shows the Combined absorber & resonance type.

6.13 CATALYTIC CONVERTORS

The exhaust gases coming out from the exhaust manifold are highly toxic to human beings and plants. The catalytic convertor fitted with the exhaust pipe could reduce the harmful emissions such as unburned hydrocarbon, nitrogen oxides and carbon monoxide emissions. In catalytic

Combined resonance and absorber type muffler: 1. Inlet; 2. Noise absorbant; 3. Access port; 4. Outlet; 5. Resonant

Figure 6.12.3(e) Combined Resonence and Absorber Type

convertors platinum, palladium and rhodium chemicals are used as catalysts which are coated in the form of honey comb like structures and being used in vehicles. A secondary passage is also made to supply oxygen into the convertor. When the toxic gases (such as hydrocarbon and carbon monoxide) are passed into the catalytic convertors, they are converted into water and carbon dioxide. Three way catalytic convertors reduce the nitrogen oxides also by the way of reduction action to nitrogen and oxygen. Fig 6.13 shows the catalytic convertor.

6.14 ENGINE TUNE-UP PROCEDURE

Checking the engine components and adjusting the components for better engine's performance is called as engine tuning. Tuning the engine for better performance increases the life of the engine. The flow chart shown in Figure 6.14 presents the engine tuning procedure on various components of the engine.

To improve the engine's performance (efficiency) the following components must be maintained in good condition.

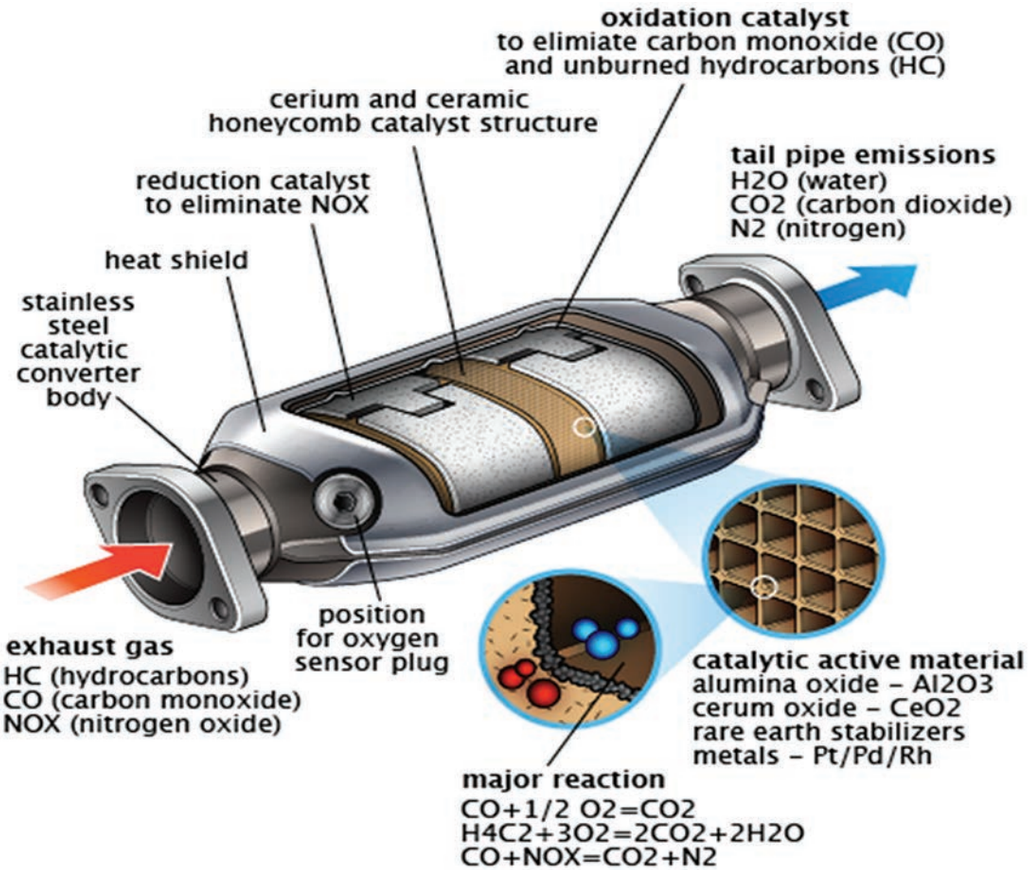

Figure 6.13 Catalytic Convertors

(1) Air inlet and exhaust system

- The Air filter should be cleaned
- The air inlet manifold should be cleaned
- Pre cleaner should be cleaned
- The crank case ventilation should be checked
- Exhaust system and muffler should be tested

(2) Engine testing

- The intake manifold of the system should be tested.
- Should check the air bubbles on the radiator.
- In the cylinder head gasket leakage should be tested
- Cylinder head bolts should be tightened well
- Have to check the valve clearance
- Have to check pressure of all the cylinder

(3) Ignition system testing

- The Spark plug should be cleaned
- Connection to the ignition coil should be tested
- Distributor cap and rotor should be checked
- The Condenser should be tested
- Ignition timing should be adjusted correctly

(4) Fuel system testing

- The leak (or) block in the fuel line should be tested

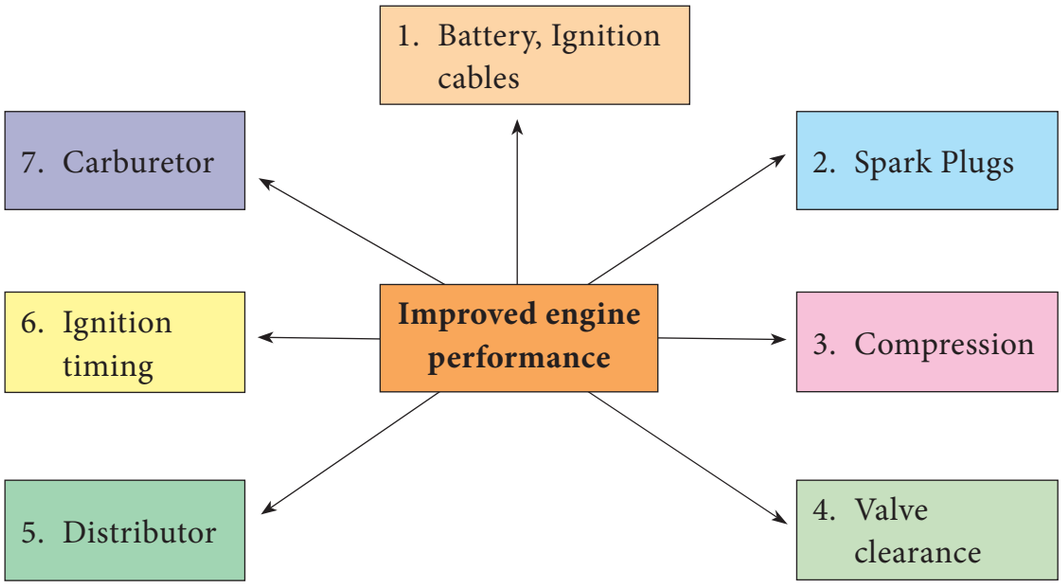

Figure 6.14 Engine tune-up procedure

- The Fuel pump should be cleaned
- The carburettor should be cleaned
- Diesel injection pump should be cleaned well
- Diesel injector should be cleaned well

(5) Lubricating System

- Pressure gas working should be tested
- Oil filter should be cleaned
- Crank case oil level should be tested
- Engine oil pressure should be checked

(6) Cooling unit testing

- Have to check the end play and a leak in the water pump
- Should check the leak in the radiator hose
- Fan belt should be checked

(7) Electrical system testing

- Battery, wire connection should be cleaned
- To test the battery condition, electrolyte test should be performed
- Generator connection should be checked
- Starter switch should be checked

(8) Clutch plate should be checked

(9) With the help of the dynamo the engine performance should be measured

6.15 POLLUTION

In this world, human and many living organisms inhale oxygen from air to survive. So that the air should be clean and make it free from pollution. In doing this we have to know the formation of pollutants and measures to reduce them. Every human inhales nearly 15 kg of oxygen. So if the air is polluted all the living organisms will be affected. Pollutants and its effects are already reffered in Table 6.1.

Pollution Control

To control pollution, the below said three techniques are being used,

a) Reduce pollution before it occurs
b) Reduce the pollutant during their formation stages
c) Reduce pollution once it is formed.

(1) Reduce pollution before it occurs,
- Low compression ratio
- Changing the combustion chamber geometry
- Changing the piston design
- Lean mixture operation
- Maintaining piston and piston ring function

(2) Reduce the pollutant during their formation stages
- Fuel modifications
- Engine modifications
- Modifying the operating parameters for complete combustion

(3) Reduce pollution once it is formed,
- Using burner
- More air supply to inlet manifold

(4) Control of carbon monoxide,
- Lean mixture operation
- After burner
- Catalytic converter

(5) Control of oxides of nitrogen,
- Re inducting the exhaust gas into inlet manifold
- Mixing of non-fired things with fired things

Smoke Control

- To control the smoke we have to maintain the vehicle in good condition and barium salt to the fuel

Various Methods of Reducing Emissions

- Re setting of valve timing
- Inspecting cooling and fuel supply system
- Changing combustion chamber design
- Re inducting the exhaust gas into inlet manifold
- lean mixture operation

Student Activity

1. Students should visit the nearby workshops to study intake and exhuast system of a motorcycle and a car and should have a hands-on experience on engine dismantling and assembling inlet manifold.
2. Students should visit the nearby workshops to dismandle the cylinder head and sketch the components.

Glossary

Purified	-	சுத்தப்படுத்துதல்
Contamination	-	மாசுபடுதல்
Intermittent	-	விட்டு விட்டு
Venturi	-	குறுகிய வழி
Ignition	-	பற்றி எரிதல்
Nozzle	-	நுனிக்குழாய்
Idle Speed	-	நிலையியக்க வேகம்
Inlet Manifold	-	உள்ளிழு பன் மடிமம்
Out let manifold	-	வெளியேந்து பன் மடிமம்
Spark Plug	-	மின்பொறிக்கட்டை

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SAMPLE QUESTIONS

Choose the correct answer

1. How many types of air filters are used in I.C engines?

   a) Two b) Three c) Four

2. How many types of petrol pumps are used in engines?

   a) Two b) Three c) Four

3. How many types of diesel injection pumps are used in engines?

   a) Two b) Three c) Four

4. How many types of feed pumps are used in diesel engines?

   a) Two b) Three c) Four

5. How many types of silencers are used in I.C engines?

   a) Two b) Four c) Five

Answer the following questions

1. What are the pollutions in atmospheric air?
2. What are the effects of air pollution to the human?
3. Give the five parts of intake system?
4. What are the types of Air filters?
5. What are the uses of air filter?
6. What are the uses of oil bath type air cleaner?
7. Draw and explain the construction of A.C mechanical fuel pump?
8. What is carburettor?
9. Write the types of carburettor.
10. Draw and explain the construction diesel injector.
11. Write the types of nozzles.
12. Draw and explain any one nozzle.
13. What are the various types of combustion chambers in diesel engines?
14. What is muffler?
15. Write the types of muffler.
16. Draw and explain any one muffler.
17. What are the methods are used to control the air pollution?
18. Briefly explain about pollution control methods.