AI 3401 TRACTORS AND ENGINE SYSTEMS

UNIT II NOTES

AIR CLEANER

It is a device, which cleans and filters the air before entering the combustion chamber of an engine. Unfiltered air may contain millions of particles of abrasive dust and other matter, which could cause rapid wear.

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

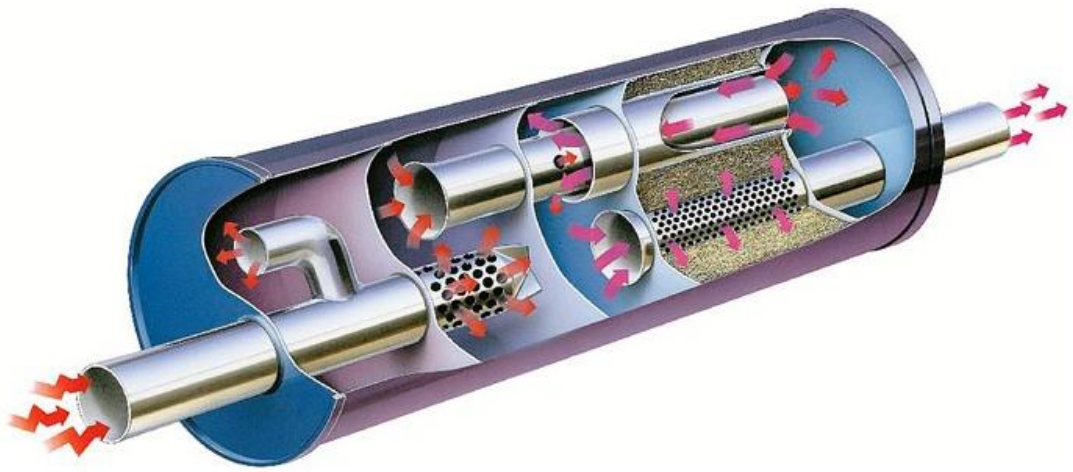
Exhaust system

The exhaust system collects the exhaust gases from the cylinders, removes harmful substances, reduces the level of noise and discharges the purified exhaust gases at a suitable point of the vehicle away from its occupants

Function

The exhaust system collects the exhaust gases from the cylinders, removes harmful substances, reduces the level of noise and discharges the purified exhaust gases at a suitable point of the vehicle away from its occupants. The exhaust system can consist of one or two channels depending on the engine. The flow resistance must be selected so that the exhaust backpressure affects engine performance as little as possible. To ensure that the exhaust system functions perfectly, it must be viewed as a whole and developed accordingly. This means that its components must be coordinated by the design engineers in line with the specific vehicle and engine.

SILENCER



Every internal combustion engine produces "exhaust noise" due to the pulsating emission of gases from the cylinders. This noise has to be silenced by reducing the sound energy of the exhaust gas flow. There are two basic options here: Absorption and reflection of the sound in the silencer. These two principles are generally combined in a single silencer. Exhaust chambers and exhaust flaps are other sound-absorbing and sound-modifying elements that can be used to eliminate especially undesirable frequencies from the outlet noise.Catalytic converters also have a sound-absorbing effect.

The exhaust system is itself a system subject to vibration, it produces noise itself through natural frequencies and vibration which are transmitted to the car body. Careful

coordination of the entire system is therefore necessary here. This includes design and positioning of the individual elements of the exhaust system and their flexible mountings

OTHER FUNCTIONS

In addition to all the complex functions which the exhaust system has to perform, it is also subject to extreme stresses. The fuel-air mixture in the cylinders is abruptly heated to temperatures up to 2,400 °C. This causes it to expand greatly before escaping into the exhaust system at supersonic speed. This noise level resembles the crack of an explosion and must be reduced by approx. 50 dB(A) as it travels from the engine exhaust valve to the end of the exhaust system. Apart from temperature and pressure stresses, the exhaust system must also cope with vibrations from the engine and bodywork as well as vibrations and jolting from the carriageway. The exhaust system additionally has to resist corrosion attacking from the inside caused by hot gases and acid, and from the outside in the form of moisture, splashed water and salt water. There is also the risk that the catalyst may be poisoned through sulphur or lead present in the fuel.

STRUCTURE OF AN EXHAUST SYSTEM

Today's exhaust systems have very little in common with the simple exhausts used in the past. In more modern cars, they basically consist of a front section with

- the exhaust manifold,
- the purification system and
- the connecting pipes, together with a rear section with the silencer system and pipes.

The entire system is connected to the floor pan by means of flexible mounting elements. The number of catalytic converters and silencers depends on the type of engine, engine performance and the required emission values

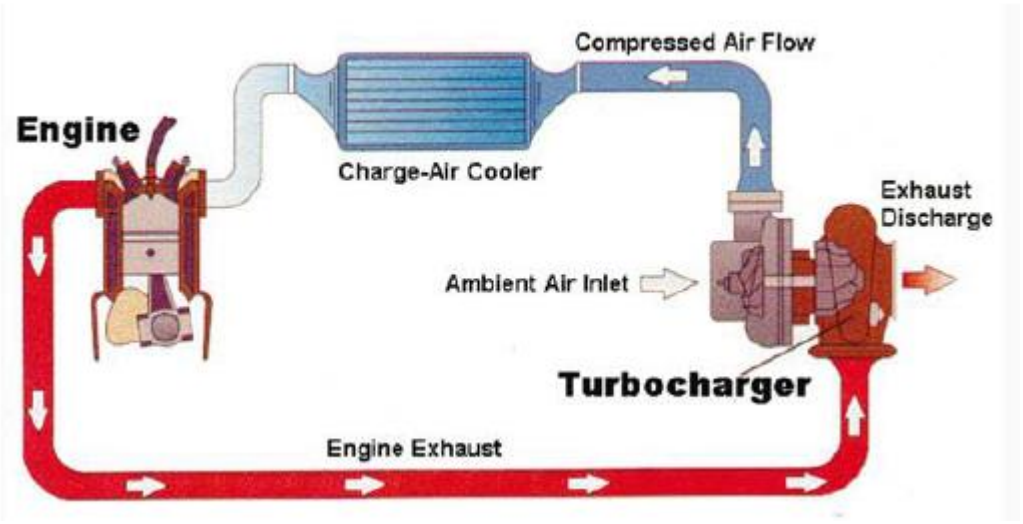
Exhaust Mufflers

A well-designed exhaust system and muffler will **collect exhaust gases** from your engine cylinder and discharge it as quickly and silently as possible. A well-designed system should include the following considerations:

- A muffler that minimizes resistance to gas flow (back pressure) while keeping it within the limits specified for the engine model and rating to provide maximum efficiency.
- **Reducing exhaust noise emission** to meet local regulations and application requirements

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

COOLING SYSTEM

Fuel is burnt inside the cylinder of an internal combustion engine to produce power. The temperature produced on the power stroke of an engine can be as high as 1600°C and this is greater than melting point of engine parts.

The cylinder and cylinder head are usually made of cast iron and piston in most cases are made of aluminium alloy. It is estimated that about 40% of total heat produced is passed to the atmosphere via the exhaust, 30% is removed by cooling system and only about 30% is used to produce useful power.

Bad effect of high temperature in the engine:

1. Cylinder and piston may expand to such an extent that the piston would seize in the cylinder and stop the engine.
2. Lubricating quality of the oil inside the cylinder would be destroyed due to high temperature and there may not be sucking of air in the cylinder.
3. Pre-ignition of fuel mixture would take place and would cause engine knocking as well as loss of power. For satisfactory performance of the engine, neither overheating nor over-cooling is desirable. Experiments have shown that best operating temperature of I.C. engine lies between 140°F to 200°F, depending upon types of engines and load conditions.

Purpose of cooling:

1. To maintain optimum temperature of engine for efficient operation under all conditions.
2. To dissipate surplus heat for protection of engine components like cylinder, cylinder head, piston, piston rings and valves.
3. To maintain the lubricating property of the oil inside the enginecylinder for normal functioning of the engine.

There are two different methods of cooling:

1. Air cooling and
2. Water cooling

AIR COOLING:

Air cooled engines are those engines, in which heat is conducted from the working components of the engine to the atmosphere directly In such engines, cylinders are generally not grouped in a block.

Principle of air cooling:

The cylinder of an air cooled engine has fins to increase the area of contact of air for speedy cooling. The cylinder is normally enclosed in a sheet metal casing called Cowling. The flywheel has blades projecting from its face, so that it acts like a fan drawing air through a hole in the cowling and directing it around the finned cylinder. For maintenance of air cooling system, passage of air is kept clean by removing grasses etc. This is done by removing the cowling and cleaning out the dirt etc. by a stiff brush or compressed air. When separate fan is provided, the belt

tension is to be checked and adjusted if necessary.

Advantages of air cooled engine:

WATER COOLING

Engines, using water as cooling medium is called "water cooled engines". The liquid is circulated round the cylinders to absorb heat from the cylinder walls. In general, water is used as cooling liquid.

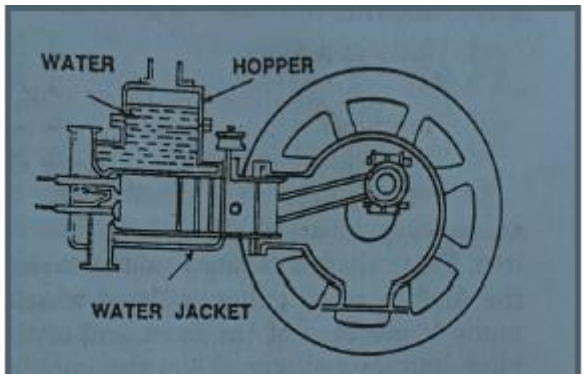
The heated water is conducted through a radiator which helps in cooling the water.

There are three common methods of water cooling.

1. Open jacket or hopper method
2. Thermosiphon method
3. Forced circulation method

1. Open jacket or hopper method:

There is a hopper or a jacket containing water, which surrounds the engine cylinder. So long as the hopper contains water, the engine continues to operate satisfactorily. As soon as the water starts boiling, it is replaced by cold water. The hopper is large enough to run for several hours without refilling. A drain plug is provided in a low accessible position for draining water as and when required. This system is not common in present days.



Open jacket or hopper system

2. Thermosiphon method:

It consists of radiator, water jacket, fan, temperature gauge and hose connections. The system is based on the principle that heated water which surrounds the cylinder becomes lighter in weight and it rises upwards in liquid column. Hot water goes to the radiator, where it passes through tubes surrounded by air. Circulation of water takes place due to the reason that water jacket and the radiator are connected at both sides i.e. at the top and the bottom. A fan is driven with the help of a V-belt to suck air through tubes of the radiator unit, cooling radiator water. The disadvantage of the system is that circulation of water is greatly reduced by accumulation of scale or foreign matter in the passage and consequently it causes overheating of the engine.

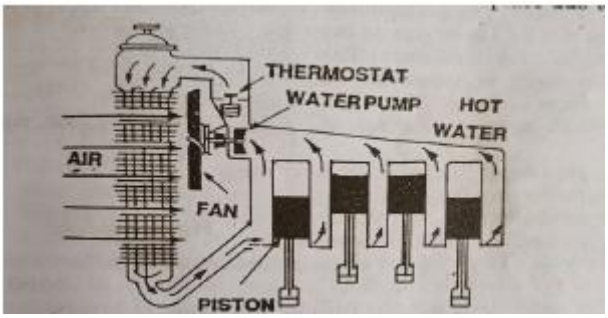
3. Forced Circulation method:

In this method, a Water pump is used to force water from the radiator to the water jacket of the engine. After circulating the entire run of water jacket, water comes back to the radiator where it loses its heat by the process of radiation. To maintain the correct engine temperature, a thermostat valve is placed at the outer end of cylinder head. Cooling liquid is by-passed through the water jacket of the engine until the engine attains the desired temperature. Then thermostat valve opens and the by-pass is closed, allowing the water to go to the radiator. The system consists of

1. Water pump
2. Radiator
3. Fan
4. Fan-belt
5. Water jacket
6. Thermostat valve
7. Temperature gauge
8. Hose pipe.

Water pump: It is a centrifugal type pump. It has a casing and an impeller, mounted on a shaft. The casing is usually made of cast iron. Pump shaft is made of some non-corrosive material. At the end of the shaft, a small pulley is fitted which is driven by a V-belt. Water pump is mounted at the front end of the cylinder block between the block and the radiator. When the impeller rotates, the water between the impeller blades is thrown outward by centrifugal force and thus water goes to the cylinder under pressure. The pump outlet is

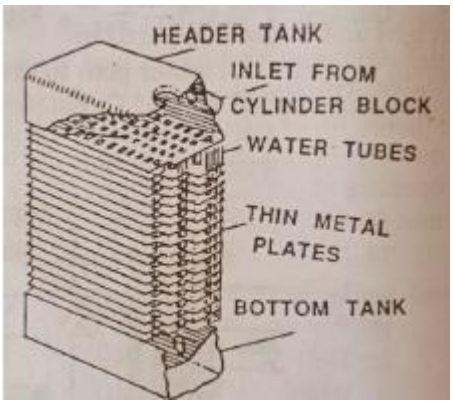
connected by a hose pipe to the bottom of the radiator. The impeller shaft is supported on one or more bearings. There is a seal which prevents leakage of water.



Forced circulation system

Radiator: Radiator is a device for cooling the circulating water in the engine. It holds a large volume of water in close contact with a large volume of air, so that heat is transferred from the water to the air easily.

Hot water flows into the radiator at the top and cold water flows out from the bottom. Tubes or passages carry the water from the top of the radiator to the bottom, passing it over a large metal surface. Air flows between the tubes or through the cells at right angles to the downward flowing water. This helps in transferring the heat from the water to the atmosphere



Radiator

On the basis of fabrication, the radiator is of two types:

(a) Tubular type and

(b) Cellular type

(a) Tubular type radiator: It has round or flat water tubes, leading from the top to the bottom of the radiator. They may be soldered, brazed or welded in place

or fastened by means of a stuffing box at each end. Fins or folded strips of light sheet metal, placed between the tubes, increase the radiating surface and improve the heat transfer.

(b) Cellular type radiator: It has a core made of short air tubes which are laid horizontally and soldered together at the ends with space between them to allow water to flow. It is also called Honey comb type radiator.

Thermostat valve: It is a control valve, used in the cooling system to control the flow of water when activated by a temperature signal. It is a special type of valve, which closes the inlet passage of the water connected to the radiator. The thermostat is placed in the water passage between the cylinder head and the top of radiator. Its purpose is to close this passage when the engine is cold, so that water circulation is restricted, causing the engine to reach operating temperature more quickly. Thermostats are designed to start opening at 70°C to 75°C and then fully open at 82°C for petrol engine and 88-90°C for diesel engine