

Lecture Notes
for
B.TECH. III yr, VIth Semester
(Electrical Engg.)
Subject Code: EE604
Subject: Power Station Practices



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Unit- 2 (Diesel Electric Power Plant)

Diesel Electric Power Plant:

How Electrical Power Produce using Diesel Power Plant?

In a diesel power station, diesel engine is used as the prime mover. The diesel burns inside the engine and the products of this combustion act as the working fluid to produce mechanical energy. The diesel engine drives alternator which converts mechanical energy into electrical energy.

As the generation cost is considerable due to high price of diesel, therefore, such power stations are only used to produce small power. Although steam power stations and hydro-electric plants are invariably used to generate bulk power at cheaper costs, yet diesel power stations are finding favour at places where demand of power is less, sufficient quantity of coal and water is not available and the transportation facilities are inadequate. This plants are also standby sets for continuity of supply to important points such as hospitals, radio stations, cinema houses and telephone exchanges.

Definition of Diesel Electric Power Plant:

A generating station in which diesel engine is used as the prime mover for the generation of electrical energy is known as diesel power station.

For generating electrical power, it is essential to rotate the rotor of an alternator by means of a prime mover. The prime mover can be driven by different methods. Using diesel engine as prime mover is one of the popular methods of generating power. When prime mover of the alternators is diesel engine, the power station is called diesel power station.

The mechanical power required for driving alternator comes from combustion of diesel. As the diesel costs high, this type of power station is not suitable for producing power in large scale in our country. But for small scale production of electric power, and where, there is no other easily available alternatives of producing electric power, diesel power station are used.

Basic Principal of Diesel Electric Power Plant



Or

Chemical Energy of Diesel ↔ Heat Energy ↔ Mechanical Energy ↔ Electrical Energy

Uses of Diesel Electric Station:

1. Central Station
2. Standby Plant
3. Peak Load Plant
4. Emergency Plant
5. Mobile Plant
6. Nursery Plant
7. Supply Units for Cinemas, Hospitals etc

Selection of Site for a Diesel Power Station:

1. Near to Load Center:

As far as possible the plant should be installed near to load center, to reduce transmission & distribution cost of electrical energy.

2. Availability of Land:

For erection of diesel power plant, land should be available near to load center at low cost.

3. Availability of Water:

The soft water is freely available for the purpose of cooling.

4. Foundations:

As we know that, the diesel engines or a machine produces vibrations. So provide good foundation to erect the diesel engine.

5. Fuel Transportation:

The diesel plant is far away from fuel mines. So to provide fuel to the plant arrange good transportation facility like road, rail etc.

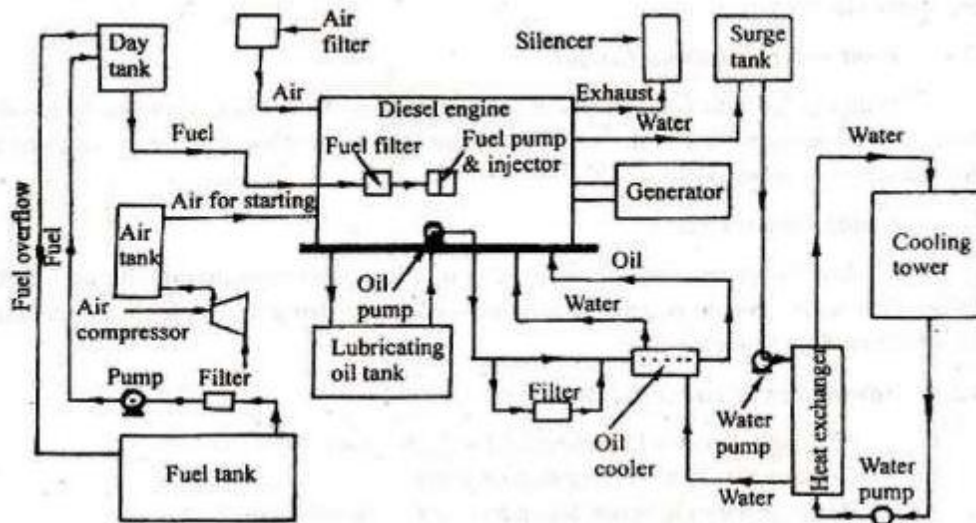
6. Local Conditions:

For increasing the demand of power & future expansion space available.

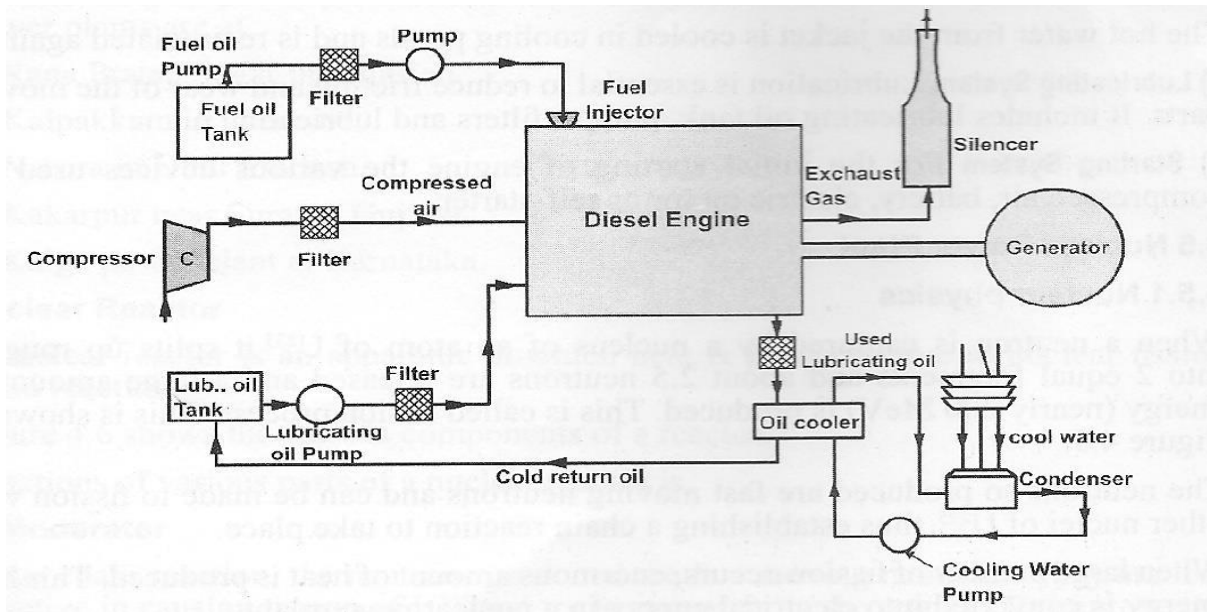
7. Noise Pollution:

The plant should away from populated areas, because it produces noise.

Schematic arrangement of Diesel-Electric Power Plant:



Or

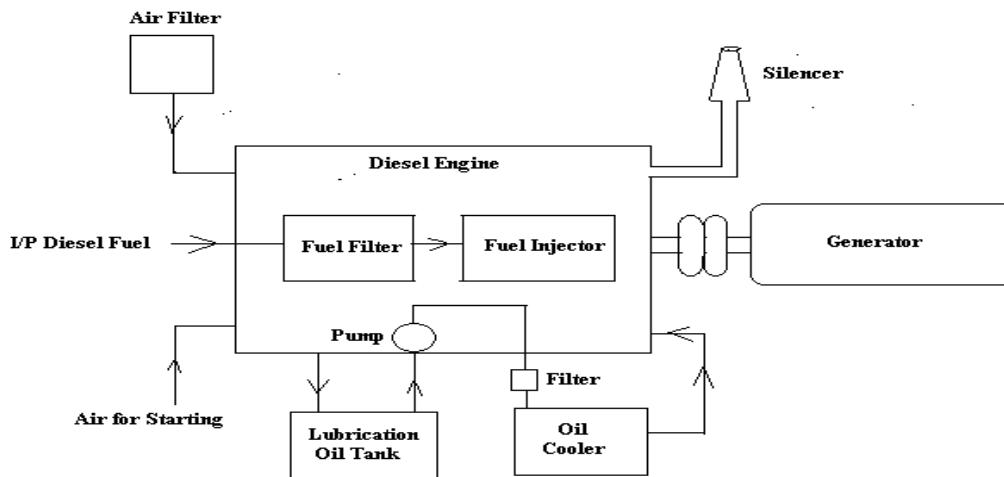


Main Components of Diesel Electric Power Plant:

The essential components of a diesel electric power plant are as follow:

1. Diesel Engine
2. Engine Fuel Supply System
3. Engine Air Intake System
4. Engine Exhaust System
5. Engine Cooling System
6. Engine Lubrication System.
7. Engine Starting System.
8. AC or DC Generators

Diesel Engine:



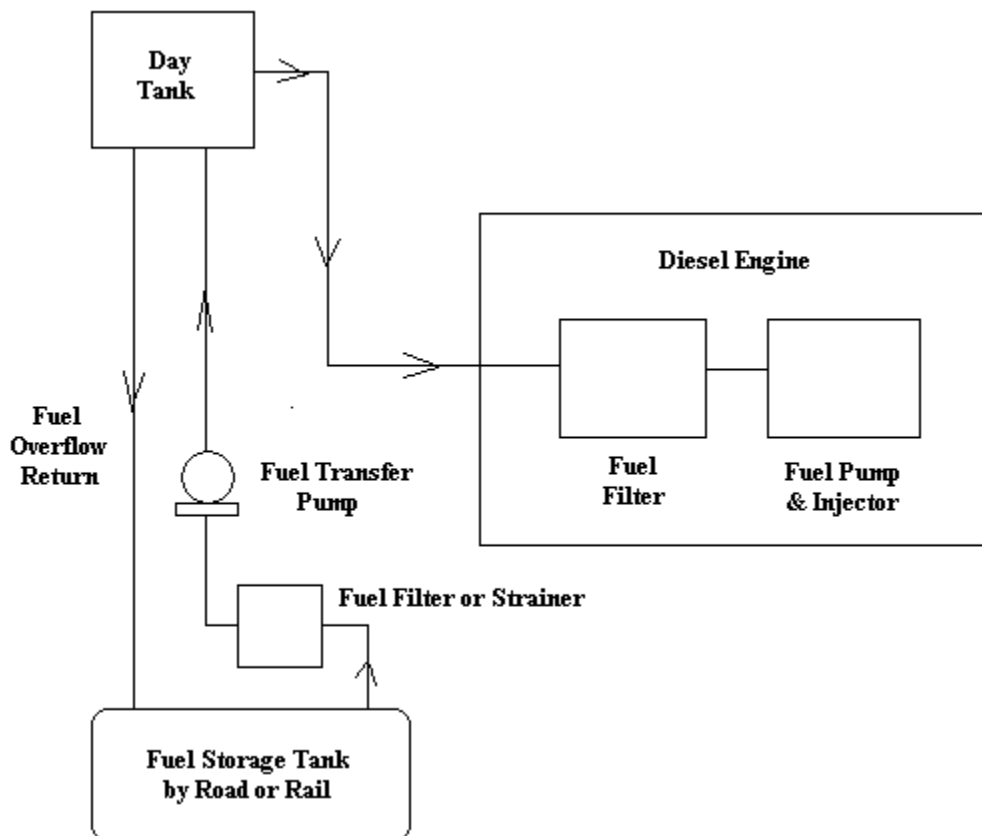
It is the main components used in diesel electric power plant for developing mechanical power. This mechanical power we use to run the generator & produce electrical energy. For producing the electrical energy the diesel engine is mechanically coupled to generator.

When the diesel fuel burning inside the engine, its start to produce a mechanical power. The combustion of diesel fuel produces increased temperature & pressure inside the engine. Due to this pressure gases are formed, this gas pushes the piston inside the diesel engine, and then mechanical power is produced. With the use of this mechanical power the shaft of diesel engine starts rotating.

Engine Fuel Supply System:

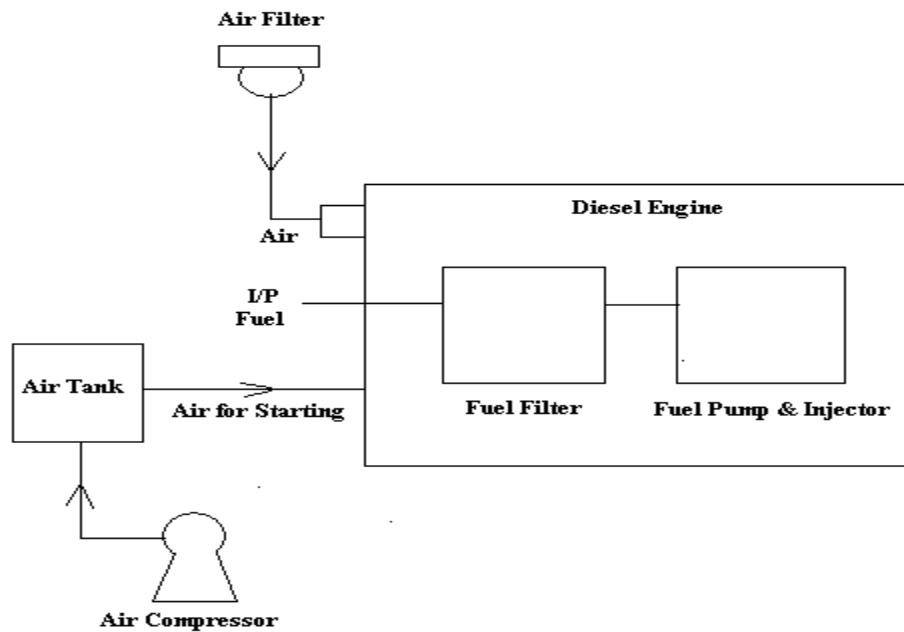
It consists of Fuel Storage Tank, Fuel Filter or Strainer, Fuel Transfer Pump, Day Tank, Heaters & Connecting Pipes.

First up all with the help of transportation facility available (road, rail etc.) the diesel fuel stored in storage tank. Then this diesel fuel transfer to day tank, the function of day tank is how much quantity of diesel required for 24 hours is store. If the day tank is full or overflow occurs, then excessive diesel returned to storage tank. The filter or strainer is used to purify diesel. With the help of fuel transfer pump the diesel is transfer to day tank.



Engine Air-Intake System

This System includes air filters, air tank, compressor & connecting pipes. The air filters are used to supply the fresh air to diesel engine for the purpose of combustion. Engine required fresh air because, if dust particles in the air entered into the engine will cause disastrous effect to valve, cylinder & pistons. The compressor or Supercharger is used to increase pressure of the air supplied to the engine. This will helps to increase the output power.



Engine Exhaust System:

These systems consist of silencers & connecting ducts. As the temperature of the exhaust gases is sufficiently high, it is used for heating the fuel oil or air supplied to the diesel engine. The exhaust gas is removed from engine, to the atmosphere by means of an exhaust system. A silencer is normally used in this system to reduce noise level of the engine.

Engine Cooling System

The Diesel Engine Cooling System Consist of coolant pumps, water cooling towers or spray pond, water treatment or filtration plant & Connecting Pipe Works.

The heat produced due to internal combustion, drives the engine. But some parts of this heat raise the temperature of different parts of the engine. High temperature may cause permanent damage to the machine. Hence, it is essential to maintain the overall temperature of the engine to a tolerable level. Cooling system of diesel power station does exactly so.

The cooling system is required to carry heat from diesel engine to keep its temperature within safe limits. The water pump circulates water to cylinder of diesel engine to carry away the heat. The cooling tower is used for the same water reused.

The cooling system requires a water source, water pump and cooling towers. The pump circulates water through cylinder and head jacket. The water takes away heat from the engine and it becomes hot. The hot water is cooled by cooling towers and is re-circulated for cooling.

The cooling system can be classified into two types:

1. **Open Cooling System:** A Plant near the river may utilize the river water for cooling & discharging again the hot water into river. This type of cooling system is known as open cooling system.
2. **Closed Cooling System:** The Cooling Water is circulated again & again and only water lost due to leakage, evaporation etc. is made up by taking make up water from supply source.

Engine Lubrication System:

Engine lubrication system consists of lubricating oil pump, oil tanks, filters, coolers, purifiers & connecting pipes. This system provides lubricating oil to moving parts of the system to reduce the friction between them wear & tear of the engine parts.

This system minimizes the wear of rubbing surface of the engine. Here lubricating oil is stored in main lubricating oil tank. This lubricating oil is drawn from the tank by means of oil pump. Then the oil is passed through the oil filter for removing impurities. From the filtering point, this clean lubricating oil is delivered to the different points of the machine where lubrication is required the oil cooler is provided in the system to keep the temperature of the lubricating oil as low as possible.

It is then cooled through heat exchanger by means of cold water and then it is fed to the engine.

Engine Starting System:

The function of starting system is to start the engine from stand still or cold conditions by supplying compressed air.

For starting a diesel engine, initial rotation of the engine shaft is required. Until the firing start and the unit runs with its own power. For small DG set, the initial rotation of the shaft is provided by handles but for large diesel power station. Compressed air is made for starting.

This system includes storage compressed air tank, self starter, auxiliary engines & electrical motors (battery) etc.

1. Starting of Small Engine:

Small sets or small capacity of diesel engines are started manually.

2. Starting with the help of Auxiliary Engine:

When it is started by auxiliary engine, the auxiliary engine is disengaged by the main engine & started by hand. When it is warmed up, it is geared with the main engine so that it will start to rotate. After that within, few seconds auxiliary engine disengaging.

3. Starting with the help of batteries:

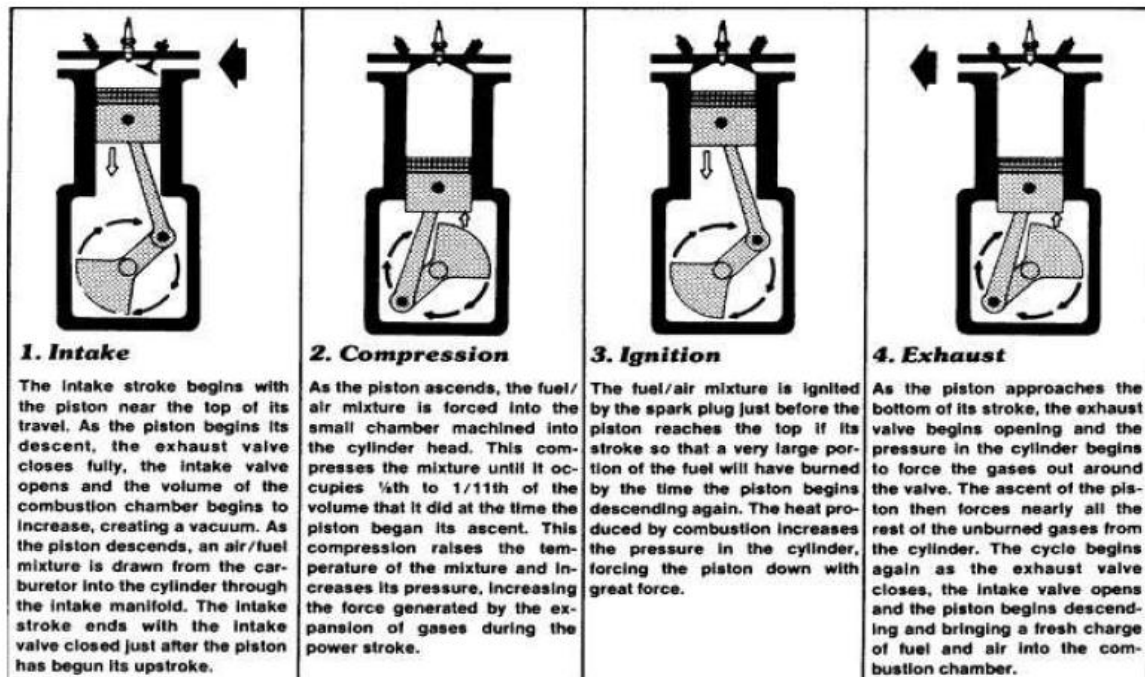
To start the electrical motor batteries are used, the motor is geared with diesel engine, it will start rotating with the motor & will start in few seconds & as it picks up the speed the motor gets disengaged automatically. In some cases the motor works as a generator, this will further helps to charge the batteries.

4. Starting with the help of compressed air:

A large capacity (above 75kW) capacity diesel engines are started with the help of compressed air. Diesel engines are started with the help of compressed air following procedure adopted:

1. First up all open the compressed air valve, then starting lever operated.
2. First up all air should be cut off in first combustion. Then open ventilating valve. Start the engine after two or three revolutions

WORKING OF FOUR-STROKE DIESEL ENGINE.



A four-stroke engine (also known as four-cycle) is an internal combustion (IC) engine in which the piston completes four separate strokes while turning a crankshaft. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are termed:

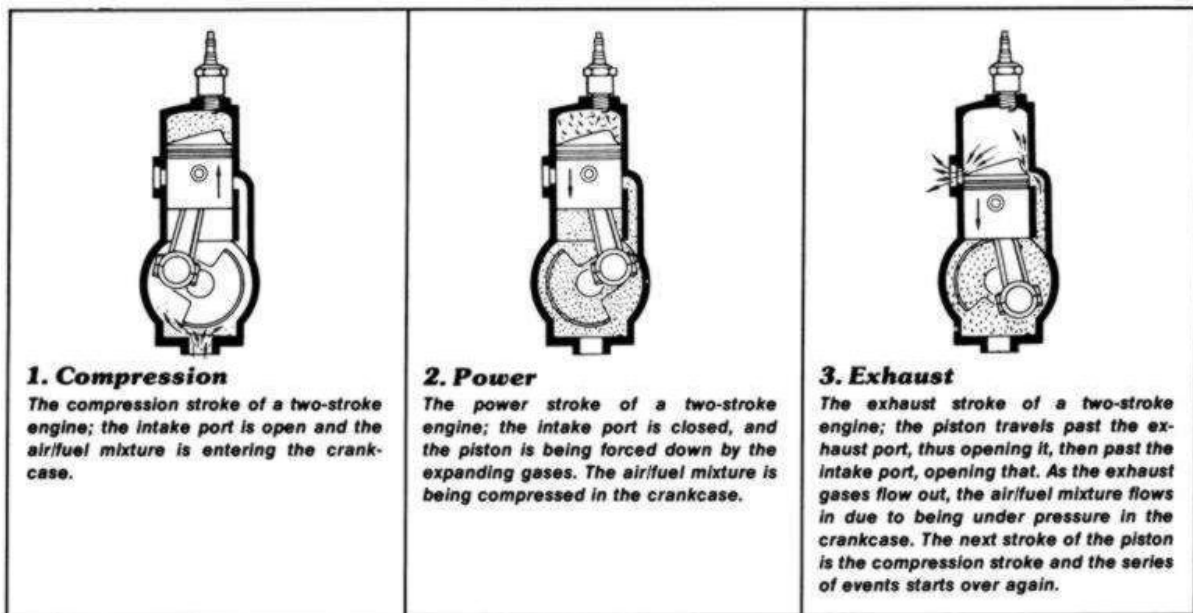
1. **Suction:** This stroke of the piston begins at top dead center (T.D.C.) and ends at bottom dead center (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing vacuum pressure into the cylinder through its downward motion.

2. **Compression:** This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.

3. **Power:** This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 180° revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine) or by heat generated by high compression (diesel engines), forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.

4. **Exhaust:** During the exhaust stroke, the piston once again returns to T.D.C from B.D.C while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust valve.

WORKING OF Two-STROKE DIESEL ENGINE.



Comparism between Four & Two Stroke Engines

Sr .N o.	Particulars	4 Stroke	2 Stroke
1	Stroke Per Cycle	4 Piston Stroke	2 Piston Stroke
2	Crank Rotation per Cycle	Two Crank Rotation	Four Crank Rotation
3	Power Stroke per Cycle	Half to Speed of Crankshaft	Full to Speed of Crankshaft
4	Power	In Every Alternate Revolution	In Every Revolution
5	Flywheel	Heavy	Light
6	Size of Engine	Heavier, Larger	Lighter, More Compact
7	Space Required	More	Less
8	Valve	Inlet & Exhaust	In Place of Valve parts are there
9	Crankcase	It is not hermetically Sealed	Hermetically Sealed
10	Crankshaft Direction of Rotation	In One Direction	In Both Direction
11	Lubricant Oil Consumption	Less	More
12	Thermal Efficiency	Higher	Less

13	Mechanical Efficiency	Low	High
14	Uses	Cars, Tractors, Buses	Mopeds, Scooters, Motor Cycles

Maintenance of Diesel Electric Power Plant

At the time of diesel engine or diesel electric power plant, following points are considered during maintenance period.

- a. To maintain the operating condition of diesel engine at every half hour.
- b. To maintain the correct record of the instrument reading in log sheet.
- c. To maintain the record of instrument temperature, pressure, electrical load, flow etc.
- d. To check the level of fuel oil periodically.
- e. Filterized the fuel and remove unwanted impurities.
- f. Clean the fuel tank at regular interval.

Advantages, Disadvantages & Application of Diesel Power Plant:

Advantages of Diesel Power Station

1. This is simple in design point of view.
2. Required very small space.
3. It can also be designed for portable use.
4. It has quick starting facility; the small diesel generator set can be started within few seconds.
5. It can also be stopped as when required stopping small size diesel power station, even easier than it's starting
6. As these machines can easily be started and stopped as when required, there may not be any standby loss in the system.
7. Cooling is easy and required smaller quantity of water in this type power station.
8. Initial cost is less than other types of power station.
9. Thermal efficiency of diesel is quite higher than of coal.
10. Small involvement is less than steam power station.
11. It requires less operating staff.
12. The overall cost is much less than that of steam power station of same capacity.

Disadvantages of Diesel Power Station

1. As we have already mentioned, the cost of diesel is very high compared to coal. This is the main reason for which a diesel power plant is not getting popularity over other means of generating power. In other words the running cost of this plant is higher compared to steam and hydro power plants.
2. The plant generally used to produce small power requirement.
3. Cost of lubricants is high.
4. Maintenance is quite complex and costs high.
5. The plant doesn't work satisfactorily under overload conditions for a longer period.
6. The cost of lubrication is generally high.

7. The maintenances charges are generally high

Applications:

1. The diesel oil is used as a fuel in power generation.
2. It produces AC as well as DC Voltages.
3. It is used where small power is generation is requirement.
4. In case of any emergency diesel engines are used.
5. It is also used for peal load during small period of time.
6. It is used to restart the boilers.
7. It is used in remote places.
8. It can be used in areas having low load factor.