



## Chapter 5...

# Diesel and Other Electric Power Stations

### Synopsis

- 5.1 Selection of Site for a Diesel Electric Power Station
- 5.2 Elements of Diesel Electric Power Plants and their Working (Block Diagrams)
- 5.3 Detailed Construction of Diesel Engine and its Working
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### 5.1 SELECTION OF SITE FOR A DIESEL ELECTRIC POWER STATION

- Following points should be taken into account at the time of selecting a site for diesel stations.
  - (a) **Distance from load centre:** As far as possible the plant should be installed near the load centre; if possible exactly at load centre.
  - (b) **Availability of land and water:** Land should be available near the load centre at low cost and also there should be soft water available for cooling purpose.
  - (c) **Foundations:** The soil should be such as to provide good foundation for the plant, building etc. Otherwise it will produce cracks in building and damage to the foundation due to machine vibrations.
  - (d) **Transport of fuel:** If the plant is away from fuel mines, it will need transportation of fuel, hence there shall be necessary rail track available for transportation of fuel oil.
  - (e) **Local conditions:** Local conditions shall be such that there shall be possibility of expansion of industry in nearby area and increase in load demand be possible.
  - (f) **Neighbourhood noise and nuisance:** The plant site should be so selected that it is not near to locality having dense population to avoid a nuisance and trouble of noise to them.

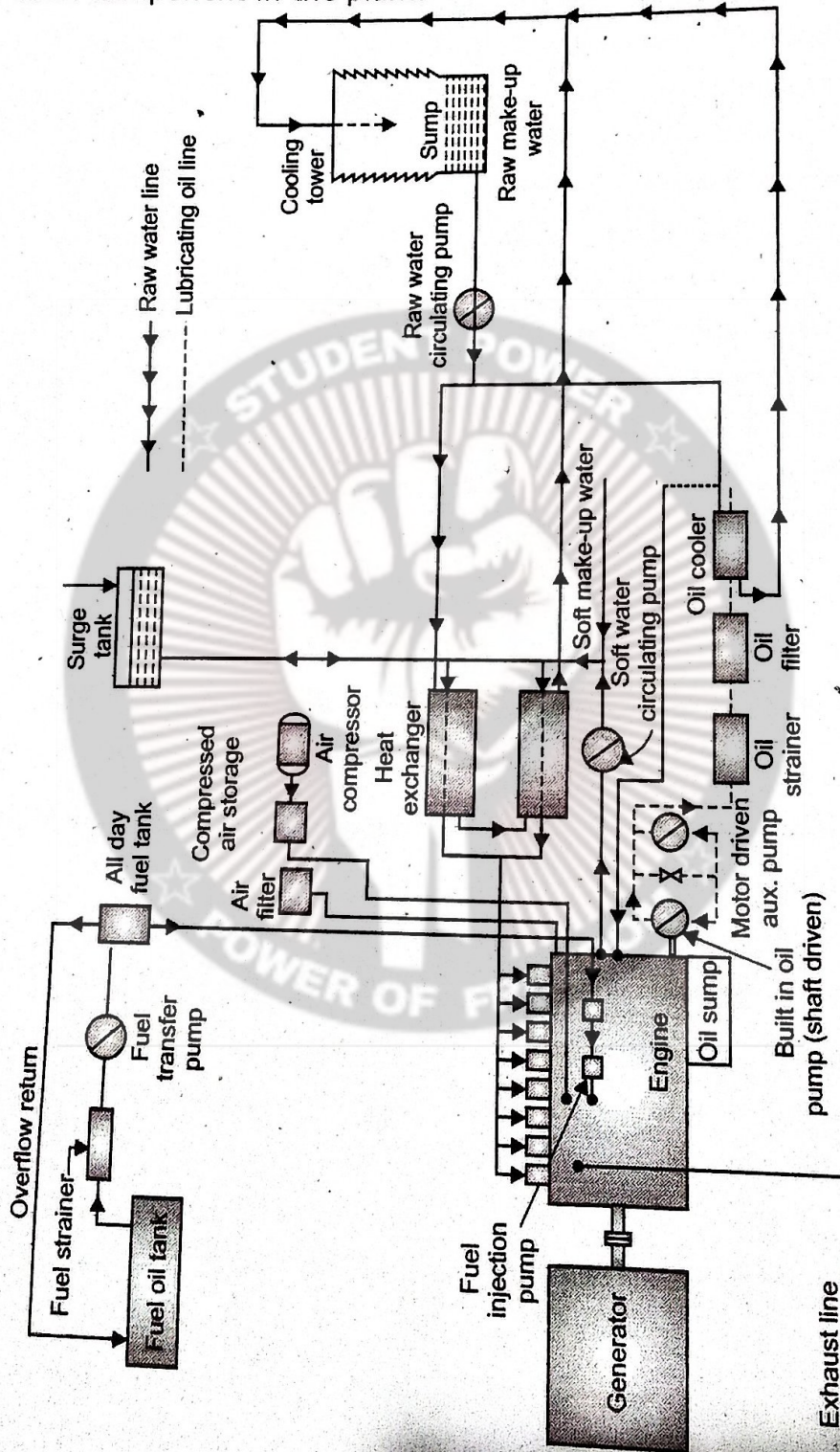


## 5.2 ELEMENTS OF DIESEL ELECTRIC POWER PLANTS AND THEIR WORKING (BLOCK DIAGRAMS)

**Main Components:** The essential components of a diesel electric power plant are as follows:

- (i) Engine.
- (ii) Engine fuel system.
- (iii) Engine air intake system.
- (iv) Engine exhaust system.
- (v) Engine cooling system.
- (vi) Engine lubrication system.
- (vii) Engine starting system.
- (viii) A.C. or D.C. generator.

- Fig. 5.1 represents the schematic arrangement for the diesel power plant. We will study in brief the function of each component in the plant.



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Fig. 5.1: Diesel Power Plant



- (i) **Engine:** It is the main component used in the plant for developing mechanical power to run the generator, it is coupled directly to the generator to produce electric power.
  - (ii) **Engine fuel system:** It consists of fuel storage tank, fuel transfer pump, strainers, heaters and connecting pipe work. Fuel transfer pumps are needed to transfer fuel from delivery point to storage tank and from storage tank to engine. Strainers clean the fuel. Use of heater is required especially during winter to heat the oil.
  - (iii) **Engine air intake system:** This system includes air filters, ducts and super-charger. Air filters remove dust from the air to be supplied to the engine for combustion. The super-charger increases the pressure of the air supplied to the engine, for increasing the power output. They are generally driven by the engines.
  - (iv) **Engine exhaust system:** This consists of silencers and connecting ducts. As the temperature of exhaust gases is sufficiently high, it is used for heating fuel oil or air supplied to the engine while the silencer reduces the noise level of the engine.
  - (v) **Engine cooling system:** The engine cooling system consists of coolant pumps, water cooling towers or spray ponds, water treatment or filtration plant and the connecting pipe work. The cooling system is required to carry heat from engine cylinder to keep its temperature within safe limits. The pump circulates water through cylinder and head jackets to carry away the heat. Hence, the cooling system consists of a water source, a pump and a pond. When the same water is to be reused then for cooling it, devices like radiator, evaporative coolers, cooling tower spray ponds etc. are required.
  - (vi) **Engine lubrication system:** Engine lubrication system consists of lubricating oil pumps, oil tanks, filters, coolers, purifiers and connecting pipe work. This system provides lubricating oil to the moving parts of the system to reduce the friction between them reducing wear and tear of the engine parts.
  - (vii) **Engine starting system:** The function of the starting system is to start the engine from stand still or cold condition by supplying compressed air. This system includes storage battery, compressed air tank, self starter etc. The system enables the engine to rotate initially while starting, until the firing starts, and the engine runs on its own power.
  - (viii) **A.C. or D.C. generators:** Generally, three phase, 50 Hz generators are coupled with the shaft of the engine. The voltage developed depends upon system voltage and may be 3.3 kV, 6.6 kV or 11 kV. The A.C. generators are salient-pole type, the number of poles depends upon the speed of the engine. Generally, speed of the engines are low, hence, 6 pole or 8 pole construction can be used. In the pole faces, damper windings are provided to obtain a stable operation of generator.
- In case of small and isolated units, single phase 230 V, 50 Hz generators can be used as per the requirement of isolated loads.
  - When D.C. generators are coupled they are mostly level compounded compound generators, developing 230 volts.

### 5.3 DETAILED CONSTRUCTION OF DIESEL ENGINE AND ITS WORKING

- To understand the working of diesel engine, we should know the main parts of diesel engine and the functions of each part. Fig. 5.2 represents the main working components of a compression ignition, four-stroke cycle diesel engine.
- The main parts are as listed below:
 

(a) Cylinder.	(b) Cylinder head.
(c) Piston and piston rings.	(d) Connecting rod.
(e) Crank shaft and crank webs.	(f) Main bearing.

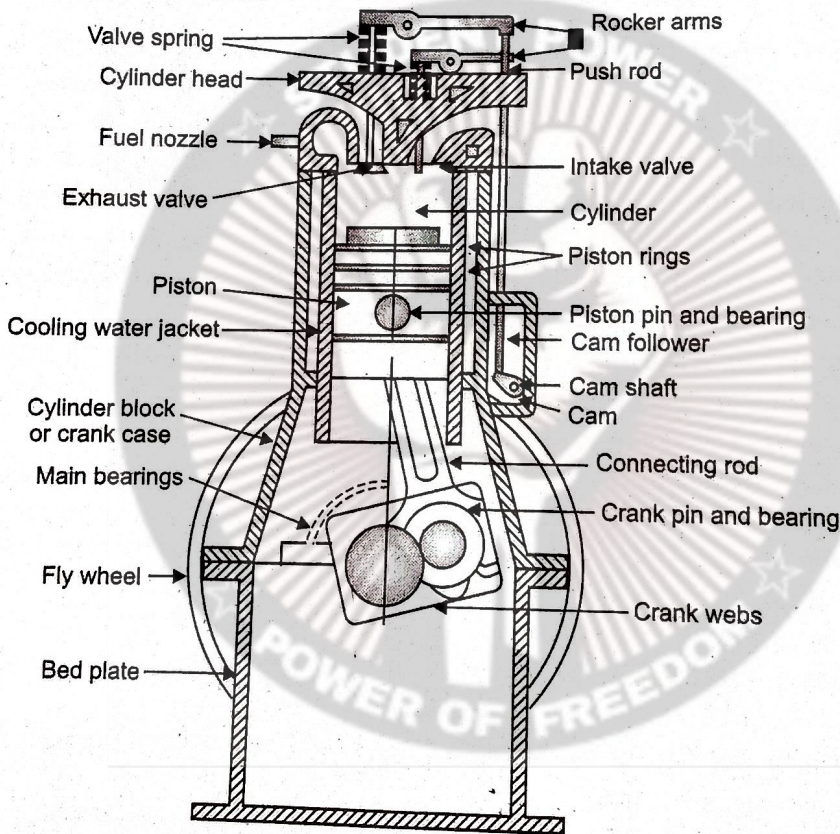


- (g) Crank pin and bearing.
  - (i) Piston pin and bearing.
  - (k) Cam shaft.
  - (m) Cylinder block or crank-case.
  - (o) Bed plate.
  - (h) Nozzle.
  - (j) Exhaust valve.
  - (l) Valve springs.
  - (n) Fly wheel.
  - (p) Cooling water jackets.
- We will discuss about the function of each part in brief.

**(a) Cylinder:** Cylinder is the main part of engine, fuel is burnt in it and develops the power. Inside of the cylinder is formed by a liner or sleeve. The inner diameter of cylinder is termed as bore and is used for movement of piston with rings.

**(b) Cylinder head:** It closes one end of the cylinder and usually contains the valves which admit the air and fuel and discharge the exhaust gases.

**(c) Piston and piston rings:** Piston closes the other end of the working space of the cylinder. It transmits the power developed by burning of fuel to the crank shaft. In this process, the distance travelled by it from one end of cylinder to the other is termed as stroke. The piston rings lubricated with engine oil produce gas-tight seal between the piston and the cylinder liner.



**Fig. 5.2: Major components of a diesel engine**

**(d) Connecting rod:** The function of the connecting rod is to change and transmit the reciprocating motion of the piston to the continuously rotating crank pin during the working stroke and vice-versa during other strokes. The small end of it is attached to the wrist pin located in the piston and the other end i.e. big end has a bearing for the crank pin.

**(e) Crank shaft:** It transmits the power from piston to the driven shaft. The parts of the crank shaft supported by and rotating in the main bearing are called as journals. It runs under the action of the crank webs or checks.

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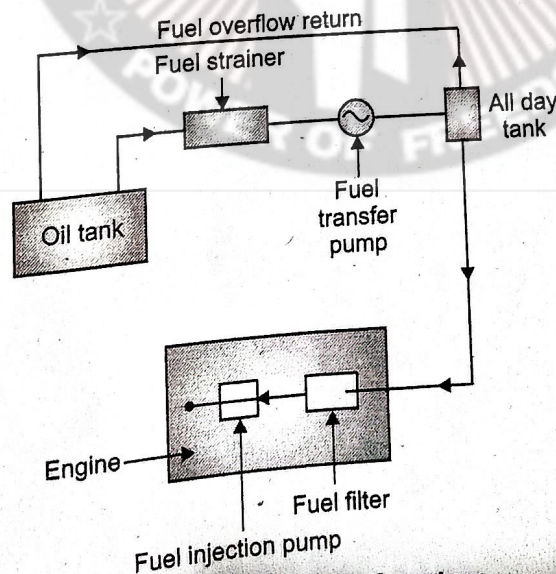
- (f) **Main bearing:** The main bearings support the crank shaft and the crank shaft is turning in these main bearings.
- (g) **Crank pin and bearing:** This is a bearing between the big end of the connecting rod and crank pin.
- (h) **Nozzle:** The fuel injection system consists of a fuel pump, fuel line and the fuel injector. Fuel is delivered into the combustion space of the cylinder by an injection system. The injector also called as fuel injection nozzle or spray nozzle delivers fuel in the form of fine spray under pressure through small hole.
- (i) **Piston pin and bearing:** Piston pin and bearing connects the piston with connecting rod, to make it possible to move the piston in the cylinder.
- (j) **Exhaust valve:** The products of combustion after doing work on the piston are removed from cylinder via this valve.
- (k) **Cam shaft:** It is driven from the crank shaft by a timing gear on a chain. It operates the intake valve and the exhaust valve through the cam, cam followers, push rods and rocker arms.
- (l) **Valve springs:** Valve springs serve to close the valve.
- (m) **Cylinder block or crank case:** The crank case holds together the cylinder, piston and crank shaft. It is also called as cylinder block if the cylinder liners are inserted into it.
- (n) **Fly wheels:** Fly wheels are used to take care of fluctuations of the cyclic variations in the speed. It stores energy during the power stroke and releases it during other strokes, giving nearly constant output torque.
- (o) **Bed plate:** The lower portion of the crank case which is bolted to the foundation is called the bed plate.
- (p) **Cooling water jackets:** The cooling water enters the jackets in the cylinder head which is comparatively hot and passes on to the jackets for the cylinder. Its purpose is to keep the combustion space walls cool.

**Working of Diesel Engine:**

- The diesel engine obtains its power from burning of fuel within the engine cylinder. The combustion of the fuel produces increased temperatures and pressures in the cylinder. The pressure of developed gases pushes the piston out of the cylinder. Thus, the mechanical power so developed is transmitted through the connecting rod to the crank shaft resulting into a turning effort; causing the motion of wheels of the engine.

**Engine Fuel System:**

- The fuel oil produced at the refinery is almost free from contamination etc. but it is liable to catch dust particles during transfer from storage tank to the engine, which may cause troubles in working of the engine, requiring repairs etc. Hence, it is necessary to filter the fuel oil by means of strainers of fine mesh screen or by filters. Fig. 5.3 represents the fuel system of diesel engine.



realme 5.3: Engine fuel system  
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- The main components are as represented in the circuit.

**Starting Systems:**

- The starting of diesel engines is carried out by the following ways:
  - By use of compressed air.
  - By use of auxillary engine.
  - By use of an electric motor.

**Diesel Power Plants in the Country:**

**In Jammu & Kashmir**

- Bemina P.S. : 2 MW
- Kamah Diesel Power Station : 0.06 MW
- Leh Diesel Power Station : 2.18 MW
- Upper Sindh : 1.7 MW

**In Karnataka**

: 6 × 21.32 MW

**In Kerala**

: 5 × 21.32 Mw

**In Sikkim**

: 4 MW

**5.3.1 Maintenance of Diesel Plants**

- It is necessary to maintain a correct record of instrument readings and conditions of operation at regular intervals, say every half hour. Such records form log sheets. For proper plant maintenance, various temperatures, pressures, electrical loads etc. have to be recorded, temperature and flow etc. of fuel oil have to be checked periodically.
- Maintenance includes cleaning of fuel oil from dirt and other impurities by means of filters. If dirt is present in the fuel oil, it will ruin the fine lap of fuel injection pumps and plugs, injection nozzle orifice. Occasionally, all the fuel should be drained and the fuel tank cleaned thoroughly. The temperature and flow of coolant, lubricating oil and exhaust gases should be checked at regular intervals.

**5.4 MERITS AND DEMERITS OF DIESEL POWER STATIONS**

**Merits of Diesel Power Stations:**

- It can be installed at the load centre.
- It can be started in short time and can take up load immediately.
- Its layout design and construction are simple.
- Space required for installation is less, hence cost of land is less.
- Number of accessories required is less, the number is further reduced if similar units are installed, this reduces the cost of spares.
- Water required for cooling purpose is less.
- Overall efficiency is high.
- The plants are comparatively neat and clean as compared with thermal power plants.
- Number of skilled staff required is less.
- The overall cost per kW of installed capacity is less in comparison to thermal power station.

**Demerits of Diesel Power Stations:**

- The fuel used being diesel, cost is more and required to be imported from other countries which increases running cost of diesel power station.
- Overload capacity of such stations is limited, and they cannot work under overload condition for long period.
- Generating capacity of such plants is limited, as large capacity plants cannot be installed due to high cost of fuel.
- Cost of lubricant is more and repair of engines etc. cost more.

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### 5.4.1 Applications of Diesel Electric Stations

- Following are the main fields of application of this plant:
  - (a) Central station.
  - (b) Standby plant.
  - (c) Peak-load plant.
  - (d) Emergency plant.
  - (e) Mobile plant.
  - (f) Nursery stations.
  - (g) Supply units for cinemas, hospitals, municipalities etc.

### 5.5 PERFORMANCE AND THERMAL EFFICIENCY OF DIESEL ELECTRIC POWER PLANT

In the diesel electric power plant at various stages the power is lost.

- Energy lost in cooling water: 30%.
- Energy lost through exhaust gases: 25%.
- Energy lost in radiations, friction: 11%.
- So overall efficiency is very less.
 
$$100 - [30 + 25 + 11\%] = 34\%$$
 only which is poor.
- This shows that part load operation of diesel power plants is not economical.
- Specific fuel consumption at full load = 0.23 kg per kWh of energy output (kg/kilo-watt hours).

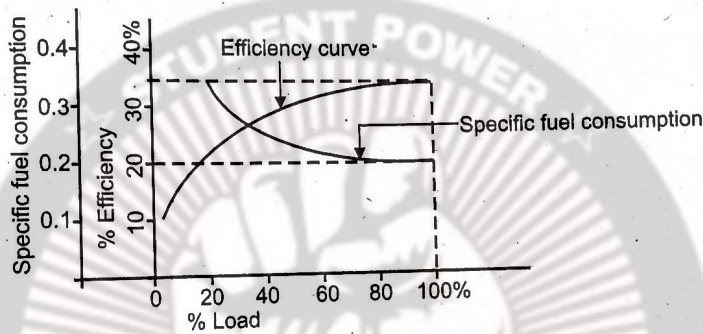


Fig. 5.4: Performance curve of Diesel electric power plant

### 5.6 CONCEPTS OF THE FOLLOWING POWER STATIONS

1. Solar power station
  2. Wind power station
  3. Tidal (ocean) power station
  4. Geothermal power station
- These power stations come under the category of non-conventional type stations. Deep study of these stations is not expected as per the syllabus. Hence, these are explained in Question Answer type.

#### 5.6.1 Solar Power Station

- Fluid used - Low boiling point refrigerant (R-11).
- Solar collector used - Flat plate solar collector.
- Working fluid temperature - 60°C to 100°C.
- Efficiency of plant - Very low, 2 to 3% only.
- Components - Solar collector, Heat exchange, turbine, generator, condenser, circulating pump.
- These components are shown connected in a block diagram in Fig. 5.5.