

Lecture Notes on
**GENERATION TRANSMISSION &
DISTRIBUTION**

**4 SEMESTER
DIPLOMA**

**IN
ENGINEERING**

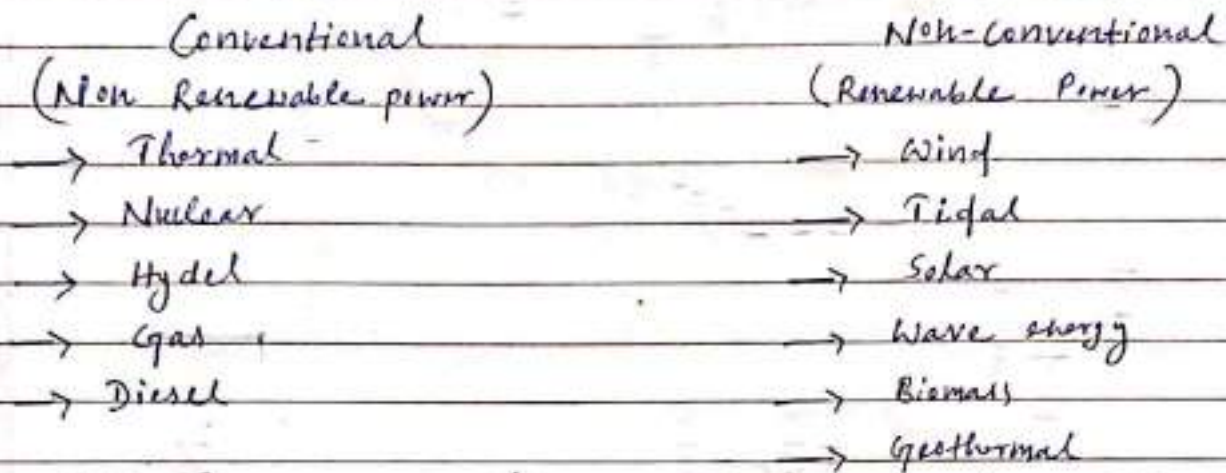
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GENERATION OF ELECTRICITY

Power Generation



Ministry of Power → (Power installed capacity in India)

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Electrical Energy:-

- The available mechanical energy is able to convert into electrical energy.
- The mechanical energy will be available in the form of either non-conventional (Renewable) or conventional (Non-renewable).
- The amount of power over a period of time is considered as electrical energy.

$$\text{Electrical Energy} = \text{Power} \times \text{Time}$$

Selection of the site for thermal power plant:-

- Availability of the land at economical rates.
- * For any power generation 3-4 acres of lands are required.
- Provision for availability of water in ample quantity.
- It should be accessible by rail and road transport.
- In case of larger capacity of thermal plant the coal requirement is very high, so, that it is preferable to locate near to the coal mines in order to reduce the cost of coal transportation.
- In case of smaller quantity capacity of thermal plant it is preferable to locate at load center in order to minimise transmission network.

Principle of Operation of Thermal power plant:-

The coal from the coal mines is transported to thermal power plant by using rail transportation, road transportation and sea transportation.

1. Coal Handling Plant:

The activities in coal handling plant are as follows

- Unloading (by using Dipper)
- Preparation of the coal (Magnetic separation) etc.
- Transportation of the coal (conveyor belt)
- Coal storage (Stacker and reclaimer)

The preparation of the coal involves separation for removal of unwanted material, crusher in order to make the coal into smaller pieces and dryer in order to remove the moisture on the surface of the coal.

The prepared coal from the coal yard is transported near to the boiler by using belt conveyor.

→ The coal is pass through Ball mill in order to prepare pulverized coal, i.e., a fine coal powder so, that heating and burning properties of the coal will increase.

2. Boiler:-

In order to generate the steam by utilizing the heat released by the combination of fuel (coal) the boiler is made.

It consists of no. of tubes made of cast iron. There are two types of tubes

- ① Water tube boiler
 - ② Fire tube boiler
- In case of water tube boiler the tubes are filled with water and the heat will surround the tubes.
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Water

For effective utilisation of fire it is preferable to have water tube boiler in the thermal power plant.

→ The boiler tubes are filled with de-mineralised water in order to avoid the deposition of debris (garbage) on the boiler tube so, that puncture of the tube can be prevented.

- * The pH value of DM water is slightly greater than 7.
- The water from the reservoir will be brought to the thermal plant through a canal and most of the water is utilised for the Campanar (CWS), some amount of water (CWS) is utilised for the preparation of the DM water.
- The preparation of the DM water by having the following treatment.

- ① Sedimentation (removal of most particles)
- ② Degasification (removal of gas)
- ③ Chemical treatment (removal of minerals)

→ The steam which is collected from the steam train having a pressure of $110-115 \text{ kg/cm}^2$ with a temp. of 300°C is allowed to pass on the super heater.

3. Super Heaters:-

A super heater is the one which is having series of tubes inside the tubes. The steam is allowed to flow on the surface of the tubes and flue gases are flowing above the tubes. The temp. of flue gases are extracted by the steam, i.e., that the temp. of the steam will be rising up to 500°C without changing the pressure. The evolution of the coal in the boiler will result as the waste materials is called as ash.

A ash is classified as

- ① Bottom ash
 - ② Heavy ash
 - ③ Fly ash or light ash
- The Bottom ash is at the bottom of the boiler furnace and the fly ash is mixed with flue gases.
- * In India coal 20-40% of the ash is going to collected.

4. Ash Handling plant:-

To collect the bottom ash the following mechanism are followed.

- ① Mechanical system
- ② Pneumatic system
- ③ Jet-up steam system

④ Hydraulic system

(Most preferred)

In all thermal plant the ash will be handled by using hydraulic system in which the ash is mixed with water and it will be carried out to the Ash pond by using centrifugal pump.

5. Speed Governor:-

The load on the generator is having a continuous variation so, that the mechanical input to the turbine should also be controlled for which the speed governor is employed.

6. Turbine:-

It will act as a prime mover in order to rotate the generator which is mechanically coupled in the turbine so, that the mechanical energy is able to convert.

Types:-

- ① Impulse (piston wheel)
- ② Reaction (Francis or Kaplan)

* In thermal power plant combination of impulse turbine and reaction turbine are employed.

7. Sync. generator:-

In case of thermal plant the sync. generator are employed having cylindrical rotor combination of 2-pole mechanism having a speed of 3000 rpm , they are also called as Turbine generator.

→ In High speed system network the Turbine generator are available from $500-1000 \text{ MW}$ capacity.

→ The generator is having mechanical losses and also copper loss (I^2R), the losses are converted into heat. The amount of heat generation should be dissipated for which cooling system to be employed.

→ For the generator 1000 MW and above air cooling is employed.

* For more than 1000 MW , H_2 gas cooling is employed.

* The pressure of the H_2 gas is 0.035 kg/cm^2

$$\eta_{\text{overall}} = \eta_{\text{boiler}} \times \eta_{\text{turbine}} \times \eta_{\text{generator}}$$

* Generally, overall efficiency of thermal power plant is very very low about 25-30%.

8- HP Heater And LP Heater:-

→ HP heater is able to convert the steam into low pressure and low temp.
→ LP heater convert the water to steam.

9- Condenser:-

The purpose of condenser is reduce the pressure and temp of the steam so that water can be extracted from the steam. There are 2 types of condenser

① Jet type

② Surface type

* The surface type condenser are normally employed in thermal power plant.

→ The condenser is connected to the turbine by a gradually increasing diameter of the tubes so that the pressure of the steam will be reduced and the temp of the steam will also be reduced by allowing the cold water in other side of condenser and it will become hot water in other side of condenser.
* At the condenser the pressure and temp are bringing to 0.04 kg/cm^2 and 40°C

10- Condensate Extraction Pump:-

It is employed in order to collect the water from steam which is called Condensate extraction water

11- Economiser:-

→ It will act as one of the accessories for the boiler.
→ It is having series of tubes in which the flued water is allow to flow and over the surface of the tubes the flue gases are flowing. The temp of flue gases is extracted by the feed water so that the temp of the flue water

further increases, hence the amount of coal required in the boiler furnace will be reduced in order to generate the steam.

* The economiser are installed in a thermal plant where the working pressure of steam is more than 10 kg/cm^2
eg - NTPC Kankaria

12- Air preheater:-

For the effective combustion of coal it is require to have hot air in the boiler furnace when compared to atmosphere air.

→ The purpose of the air preheater is to supply the hot air to the boiler furnace, so that it will act as another accessories to the boiler

13- ED Fan:- (Force Draft)

ED Fan supply the required air to the air preheater and over the tubes of air preheater the flue gas are allow to flow, the temp of the flue gas are extracted by the air and it will become hot air.

14- ESP:- (Electrostatic Precipitator)

The combustion of the coal in the boiler furnace will release the flue gas

The flue gas are having fly ash particles and also poisonous gas like SO_2 (sulphur dioxide), CO_2 , carbon monoxide.

→ The ESP is employed in order to collect fly ash particles and other poisonous gas.
→ The efficiency of ESP is normally 99.5 to 99.9%

15- ID Fan:- (Inverted Draft)

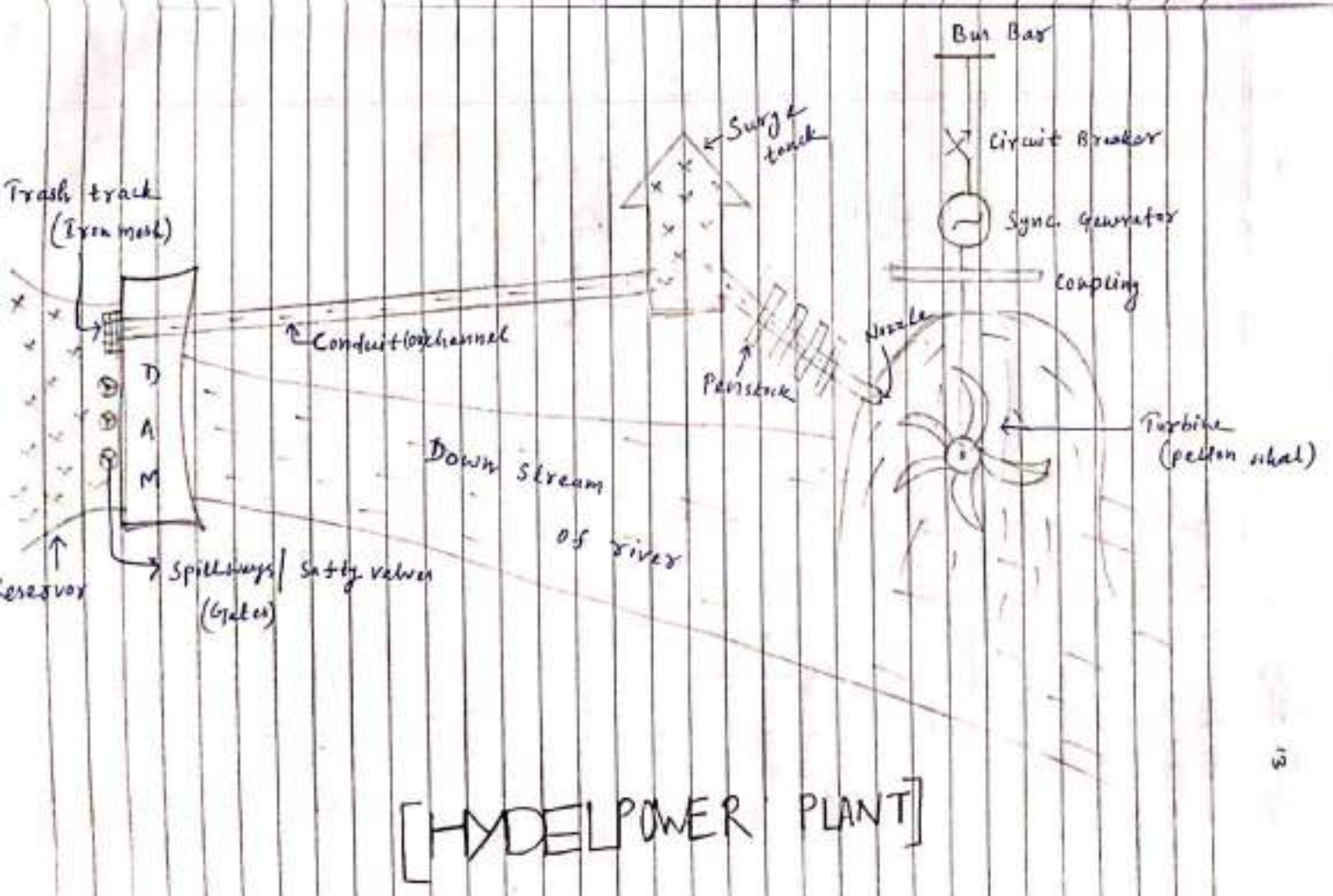
The purpose of ID fan is to collect remaining waste particles from ESP and to be exhausted to the atmosphere through chimney.

16- Cooling Tower:-

In order to reutilized the water in the condenser the cooling tower is employed.

→ The hot water from the condenser is collected and it is fall into the ground from certain height into the cooling tower. So, that the vapour particles which are lightest particles will go to the atmosphere and heavy particles are collected at the bottom which is called cooled water and it can be reutilized in the condenser.

→ The ED fan is employed at the bottom of the cooling tower in order to develop a high pressure at the bottom. So, that the vapour particles will exhaust into the atmosphere.



Principle of operation:-

Most of the hydro power plant are reservoir type.

- The potential energy of the stored water in the reservoir will be brought into kinetic energy.
- The kinetic energy of the flow of water (mechanical energy) is able to convert into electrical energy.

The overall efficiency of the hydro power plant is →

$$\eta_{\text{overall}} = \eta_t \times \eta_g \times \eta_e \quad (\text{where } \eta_t = \text{turbine efficiency, } \eta_g = \text{generator efficiency})$$

Selection of site of hydro power plant:-

- Availability of water in a ample quantity.
- There should be facility in order to store the water.
- Availability of the head of water.
- It should be accessible by road transportation (transportation of machinery, equipment, materials).
- Facility for the construction of the Dam, part of the Dam are constructed on hilly area in order to get the maximum support of the Dam. The hilly area are at remote places.
- The hydro power plants are located at the remote places.
- , that the cost of the transmission network will be increased.
- The capital cost of hydro power plant is more compared to thermal power plant.

Classification of hydro power plant:-

- 1- Based on the installed capacity.
- 2- Based on availability of head of water.
- 3- Based on availability of water.
- 4- Based on the application of head.

1- Based on installed capacity:

- i) Micro or mini hydro power plant (power generation < 5 MW)
- ii) Medium capacity hydro power plant (power generation 5-100 MW)
- iii) Large capacity hydro power plant (power generation 100-1000 MW)
- iv) Super capacity hydro power plant (power generation > 1000 MW)

2- Based on availability of head of water:

- i) Low head plant (where the height is $\leq 30m$)
- ii) Medium head plant (where the height is 30-300m)
- iii) High head plant (where the height is $\geq 300m$)

3- Based on availability of water:

- i) Run-off river without impoundage
- ii) Run-off river with impoundage
- iii) Reservoir tank
- iv) Pumped storage plant

4- Based on the application of head:

- i) Base load plant
- ii) Peak load plant

Hydrology

4. Precipitation: It is the amount of water available on the earth surface either because of direct rain or due to melting of ice after infiltration of soil.

2. Evaporation: The amount of water which we will get evaporated into the atmosphere when the water is flowing in the river in the form of steam of water.

3. Run-off: It is the actual amount of water which is available for the power generation.

$$R = P - E$$