BASIC OF ELECTRICAL POWER SYSTEM

SEMESTER 01

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The Notes of BEPS Are Divided in part by part.

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NOTES PREPARED BY DIPLOMA WALLAH

Hydro Electrice power plant –

Hydro electric power is power obtained by carring potential energy in height, which futher converted to kinetic energy of turbine and then synchronous machince used to convert this energy to electrical energy.

$$P = W Q_s H \eta \times 9.81 \times 10^{-3} \text{ KW}$$

W = Specific wheight of wate kg/m³
Q_s = Rate of flow of water m³/sec.
H = Height of fall and head in m.
η = overall Efficency of operation.

Factors before constructing a plant –

- Capital cost of plant
- Capital cost of erecting and maintaing TL
- Energy Chemeration cost comparsion.

Elements of hydroelectric plants –

Storage reservoir – Stores water during excess flow periods (ie. rainy seasson). and supply some during lean-flow periods and thus it helps in suppling water to turbine.

Dam — The function of dam is not only to create artifical head by raising water surface of steam but also to provide pondage, storage or facility of diversion into conduits.

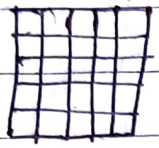
Fore bay — It serve as regulator reservior storing water temporality during light load period and providing the same for initial increase on account of increasing load during which water in canal is being.

Spillway — It acts as safety value. It discharges surflow water in down steam side when reservior is full during flood period.

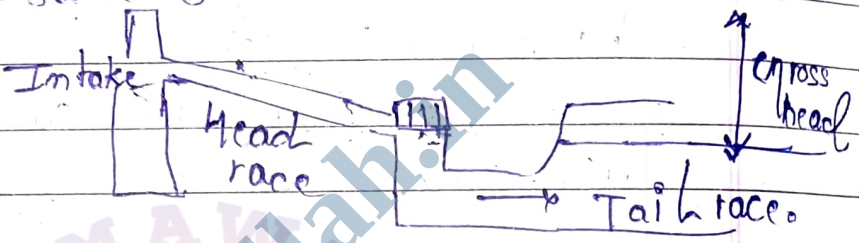
Intake — The intake includes the head work which are structures at the intake of conduits, tunnels and fumes.
These structures include booms, screens or trash racks, sluices to prevent entry of debris & ice into the turbine.

Values and gates — In low head plants, gates at entrance of turbine casing can shut off flow and provide unwatering to turbine for inspection

Trash racks :- To prevent ingress of floating and other material to the turbine.



Tail race :- The water after doing useful work in turbine is discharged to tail race which may lead it to same stream or to another one.



Draft tubes :- pipe carrying water from turbine to tail race.

Prime mover or Water turbine :- In hydro Electric power plant water turbine is used as prime mover and their function is to convert kinetic Energy water into mechanical ~~Energy~~ Energy.

Surge tank :- A reduction in ~~load on~~ load on generator causes the Governor to close the turbine gates and thus creates increased pressure in penstock. This results in water hammer phenomenon which will require pipe to extra-ordinary Strength to withstand otherwise penstock may burst.

Penstock:- it is a closed conduit which connects fore bay or surge tank to the scroll case of turbine.

→ In medium head plants, each unit is provided with its own penstock.

→ In high head plants a single penstock is used.

→ The thickness of penstock must be adequate to with stand both the normal hydrostatic pressure and sudden surges due to fluctuation in load

Classification according to extent of water flow regulation:-

01. Run-off river plants without pondage.
Some hydro plants are so located that water is taken from river directly and no pondage or storage is possible.

02 Run-off river plants with pondage:-
which makes it possible to cope hour to hour with fluctuations of load through a week or some longer period depending on size of pondage.
→ They can serve as based load or peak load plant depending on flow of stream.

03 Reservoir power plant:- When water is stored in a big reservior behind a dam, it is possible to control flow of water.

Classification according to water heads

→ Low head hydro power plants:- It consists of a dam across the steam to back up the river and create a fall the water flowing through.

→ If is created near the dam so no surge tank is required.

→ In low head plants, francis propeller or Kaplan turbine are employed.

→ Since for given output, large quantity of water is required and head is low. So pipes of larger diameter.

Medium head hydro power plant:-

→ River is usually trapped off to a fore bay on one bank of the river as in flow head plants.

→ Horizontal shaft francis propeller or kaplan turbines are used.

High head hydro electric power plants:-

→ If high head is available, a steep lateral valley can be dammed and a reservoir for storage of water is formed.

→ Surge tank can also acts as temporary reservoir to meet sudden increase in demand.

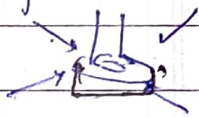
Classification according to the type of load.

01. Base load power plant –
02. Peak load power plant – pumped storage power plant.

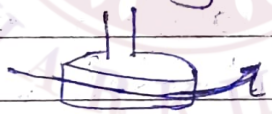
Water turbine –

Base on types of flow –

01 Axial flow turbine – water flow along the shaft axis.
02 Inward radial flow turbine – water flow along radius.



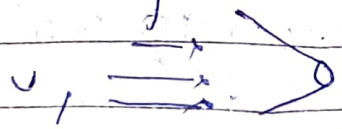
03 tangential or peripheral flow turbine.
water flow is along the tangential direction



04 – Mixed flow – Radial inlet and axial outlet.

Base on action of water

01 Impulse type – If entire pressure of water is converted into kinetic energy in a nozzle and the jet thus formed drives the wheel.



$A_1 > A_2$

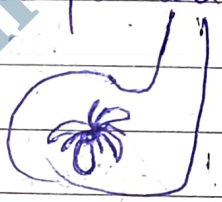
02 Reaction type – When water pressure combined with its velocity, work on running the turbine.

Pelton wheel.

↳ Suitable for high head and low flow

→ It has a rotor equipped with elliptical buckets along periphery of turbine.

→ This turbine is not suitable for water head below 200 m.



Francis turbine –

→ It is an inward mixed flow type of reaction turbine and is suitable for medium head & medium flow plant.

→ They develop power partly due to velocity of water and partly due to differnce in pressure acting on front and back of runner buckets.

→ Efficency 92%.

→ alternator is above the turbine.

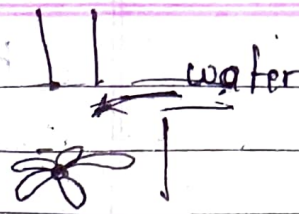
Propeller turbine –

It is an axial flow reaction type turbine. It has got no provision for changing ~~runner~~ runner blade with turbine in motion

→ Efficency 92% at full load

$P = \rho W H \eta \times g$

Kaplan turbine



- It is also a reaction type turbine and has gate and governing mechanism similar to francis turbine.
- In kaplan turbine water strike the turbine axially.
  - Efficiency - 90%.
  - pumbed storage.

Selection of site for Hydro Electric plant

01 Availability of water
02 Water storage
03 Water head.
   Depends on topography of area.
   High head reduce storage requirement.
04. Distance from load center.
05. Accessibility of site.

Merits of Hydro

- No fuel is required
- High reliability and cheaper operation.
- Plant can be run be varied quickly.
- No stand by losses.
- Plants and crabus it & have longer.

Demits.

larger area.
- construction cost is high.

Long TL is required as plants are long dry season.

Kaplan – low heach
francis – Medium head
pelton – high heach.

Why Electrical Energy:-

- Electrical Energy can transmit over a long distance but other form of energy can't be transfer over a long distance (i.e flexible Energy.
- It is neet and clean Energy.
- The operation of any device by electrical energy is quit fast.
- Better control.
- Electrical Energy can be transform into any other from of Energy Easily.

Source of Electrical Power.

There are mainly two sources of Electrical power:-

1. Conventional source of Energy.
2. Non-Conventional source of Energy.

1. Conventional Energy Sources:-
   - Conventional Energy sources are those that have been used for a long time and are well-established.
   - The includes fossil fuel (coal, oil, Natural gas). Nuclear power, Hydro power etc.
   - Conventional source of Energy are limited in supply can be harmful to the enviroment.

2.) Non-Conventional Energy source.

→ Non-conventional Energy sources are those that are newer and less well-established.

→ The includes solar power, Wind power, Geothermal power, biomass and ocean energy.

→ Conventional source of Energy are ~~limited supply~~ abundant and more enviormently friendly

Power sector scenario in India :-

- India's power generation sector is the third-largest in the world, and is made up of both conventional and renewable sources.

→ Thermal power plants are main source of Electricity in India, generating around 75% of the country's total.

→ from Renewable sources. These include wind, solar, biomass, and hydro-power, As of June 2024. India's installed renewable energy capacity was 203.19 GW. which is 45.5% of the country's total installed power capacity.

→ In FY 2023-24 India's total electricity generation was 1,949 TWh.

→ India's goal is to have 500 GW of non-fossil based Electricity installed capacity by 2030.

Conventional Sources:-

1. Fossil fuels:- Coal, oil and Natural gases are the most common fossil fuel used to generates electricity. They are burned to create heat, which is used to turn a turbine that generates electricity.
Fossil fuel are a non-renewable source, meaning that they will eventually run out. They also produces greenhouse gases, which contribute climate change.

2. Nuclear power:- Nuclear power plant use the heat generated by Nuclear fission to turn a turbine that generates electricity. Nuclear power is a clean source of energy that does not produces green house gases. However, there is risk of accident and nuclear waste disposal.

3. Hydroelectric power:- Hydroelectrice power plants use the force of flowing water to turn a turbine that generate electricity. Hydroelectric power is a renewable, sources of Energy that does not produces green house gases. However, it can have a negative impact on the enviroment such as flooding and disruption of fish migration.

Non-Conventional source of Energy:

1. Solar power:- Solar power plants uses Sun's energy to generate electricity. This can be done using photovoltaic cell converts sunlight directly into electricity. while solar thermal collector uses ~~sun~~ sunlight to heat water or air which can then be used to generates electricity. Solar power is a clean and renewable sources of energy. However it is not always reliable as it depends on the sunlights.

2. Wind power:- Wind turbines use the winds energy to turn a turbine that generates electricity Wind power is a clean and renewable source of energy. However it is not always reliable, as it depends on the wind blowing.

3 Biomass:- Biomass is organic matter that can be burned to creates heat. This heat can be used to turn a turbines that generates electricity. Biomass is a renewable source of energy but it can also contributes to greenhouse gas.

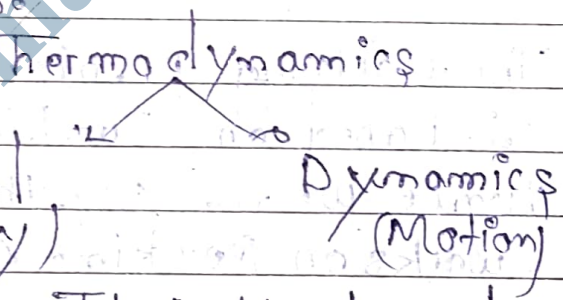
4. Ocean Energy:- This can be in the form of waves tides or thermal gradients. Ocean energy is a clean and renewable sources of energy. However it is not yet widely used as it is still in the development stage.

5. Geothermal power :- Geo-thermal power plants use the heat from that Earth's interior to generate Electricity. This can be done by drilling deep wells into the earth or by using hot spring. Geothermal power is a clean and renewable source of energy. However, it is not always available as it depends on the location of Hot springs.

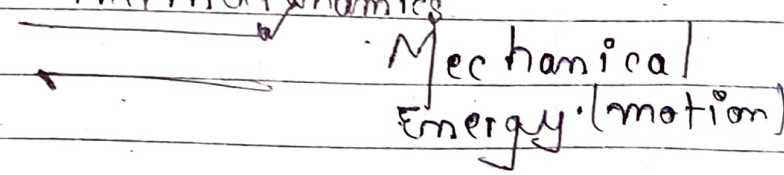
Thermal Power plants :-

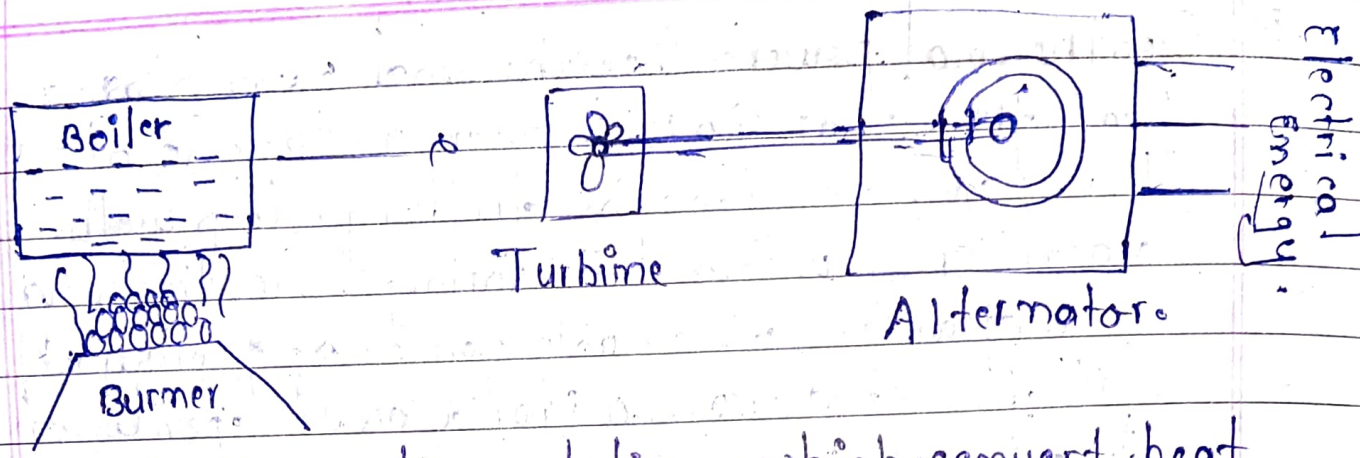
- Coal power plant.
- Steam power plant.

Thermal power plant :- The word "Thermal" derive form Thermodynamics

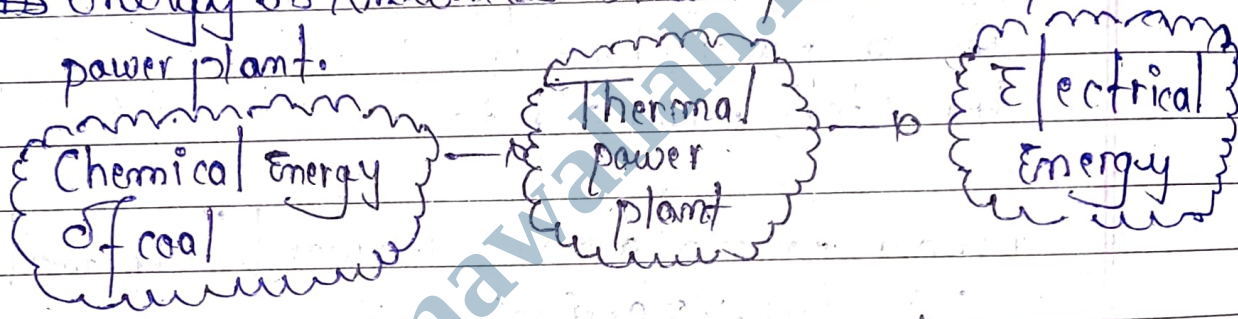


Thermodynamics :- It is the branch of physics which deals Relation between heat energy and other form of Energy (Basically Mechanical Energy).

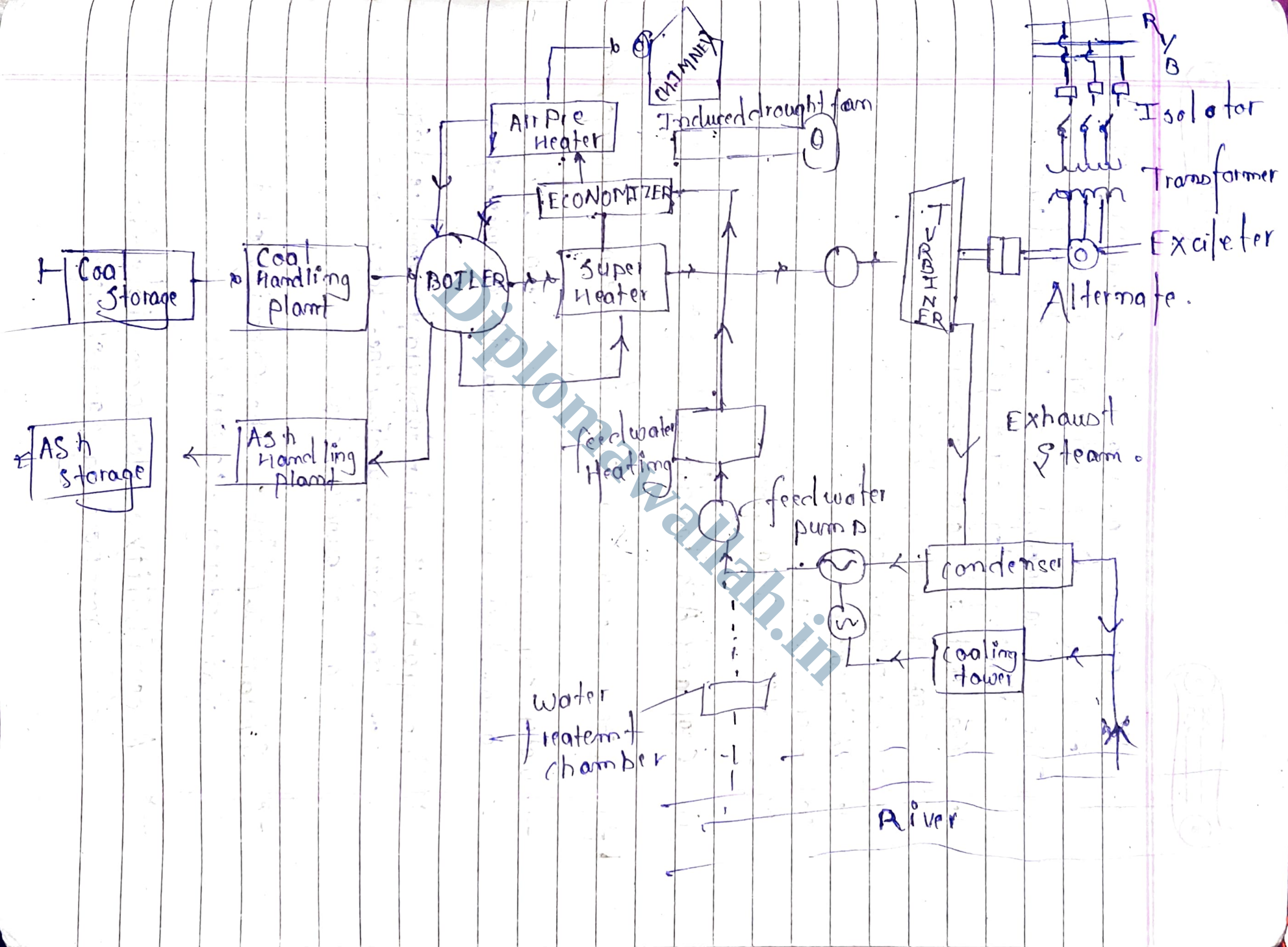




A. Generating station :- which convert heat (Thermal) energy of coal Buring into electrical energy is known as steam / Thermal / coal power plant.



Note:- The working principal of steam turbine is based on Rankine cycle.
Hence we can say that steam power plant works on Renkine cycle.



There are many arrangement are involve in thermal power plant for proper working and efficiency. The whole arrangement can be divided into the following stages for simplicity.

1. Coal and ash handling plant.
2. Steam generating plant.
3. Steam turbine.
4. Alternator.
5. feed water.
6. Cooling Arrangment.

(1) Coal and Ash handling plant :-

Site selection criteria for Thermal power plant.

→ Water supply :- The availability of a sufficent amount of water for the plant to operate.

→ Topography :- The topography and geology of the site, including the slope and land characteristics.

→ Storage capacity :- The capacity of the water storage reservoir.

→ Accessibility :- How accessible the site is for transporting equipment.

→ Distance to load center: How far the site is from the load centers.

→ Environmental impact: The potential environmental impact of the plant on the local area.

→ Any technical and regulatory requirements that must be met.

→ The cost of the transmission that will connect the plant to the grid.

→ Availability of coal for site selection for steam power plant.

Coal and Ash handling plant:

(a) The coal (fuel) is transported to the power station by road or rail is stored in the coal storage plant.

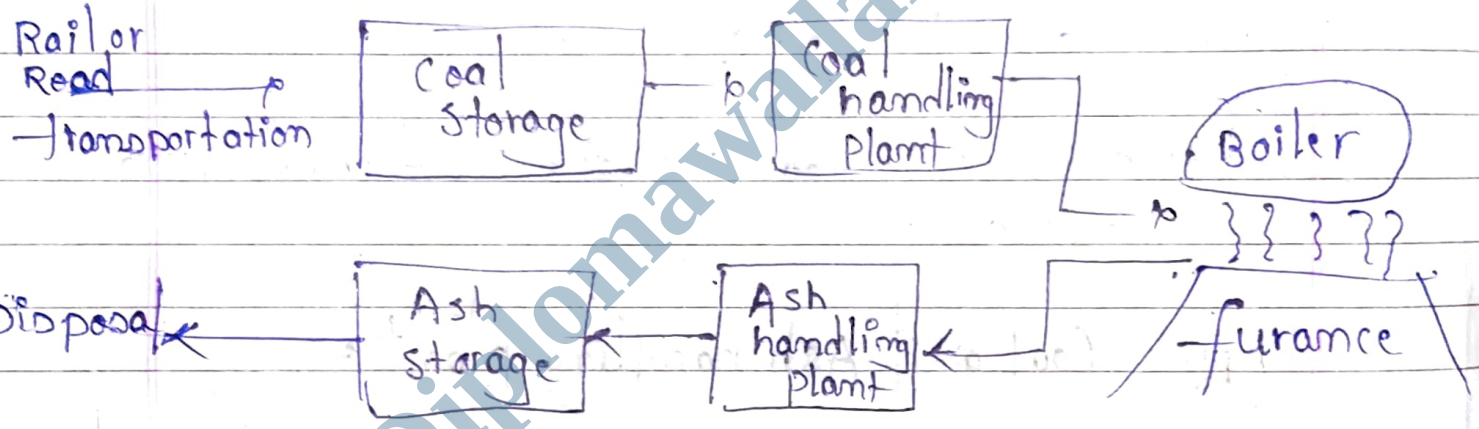
⇒ The storage of coal is generally done for protection against coal strike, failure for transportation system and general coal shortage.

⇒ From the coal storage plant, coal is supplied to the coal handling plant where it is pulverised (ie crused into small pieces) to get proper burning of coal. So coal buring Efficiency is increase.

⇒ The crused coal is feed to the boiler furance by conveyer belt.

⇒ After complete burning of coal ash is produced and this ash is removed to ash handling plant and then delivered to the ash storage plant for disposal.

The removal of ash from the boiler furnace is ~~nesa~~ necessary for proper burning of coal.



Super heater :-

The steam is produced in the boiler is use so it is further heated by the help of ~~spe~~ super heater where as steam temperature increase above the boiling point of steam by the fule gas on their way to chimney. Generally there are two function of ~~sp~~ super heater.

⇒ It increase the overall efficiency of thermal power plant by utilising the flue gas as shown in previous Example.

⇒ In the absence of superheater to much condensation of stem is turbine which may lead to blade corrosion so by using superheater heater blade corrosion is avoided.

NOTE :-

⇒ The superheated steam from the superheator is feed to steam turbine through the main valve.

⇒ The pH of water which is feed into boiler is 8.5 to 9.5. because pH value less than 7 is (acidic) which cause corrosion of boiler and more than 7 (basic) cause scalling effect (Maxm superheating 550°C).

ECONOMIZER :-

⇒ An economizer is basically a feed water heater ie. it feed water to boiler. It takes heat from flue gases for heating the water.

⇒ The feed water is feed to Economizer before suppling to the boiler.

⇒ An economizer takes heat from the fluek gases to increase the temperature of feed water.

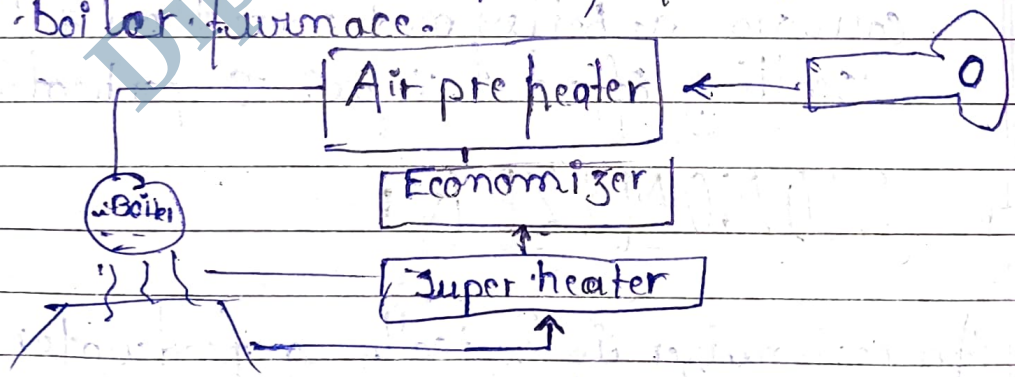
Air pre heater :-

⇒ An Air preheater increases the temp of air supplied for coal burning by heat of fule gases.

⇒ Air is drawn from the atmosphere by forced draught fan and this air is passed through air preheater before supplying the boiler furnace.

Basic function of Air preheater :-

⇒ Increase thermal Efficiency of the system.
⇒ Increase the steam capacity per square meter of boiler furnace.



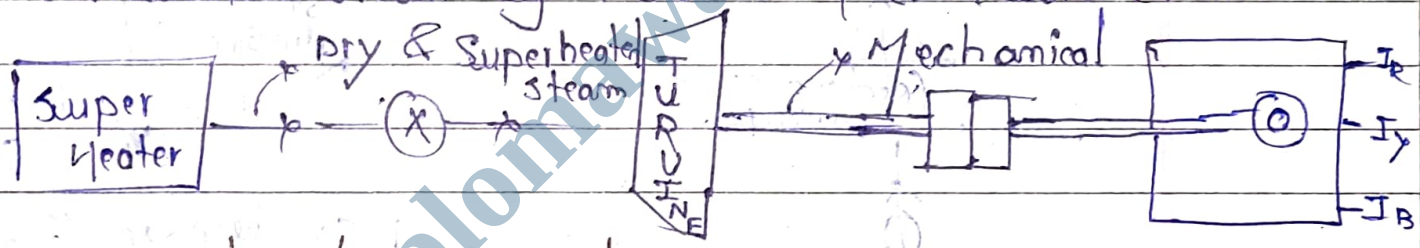
Note :- In thermal power plant electrostatic preciperator is used to remove dust from fule gases. It is intalled between Air pre heater and induced fan.

Steam turbine :-

=> The dry and superheated steam from the super heater is fed to the steam turbine through main valve.

=> The heat energy of stem while passing over the turbine them blades rotating hence, hot energy of steam is converted into mechanical energy.

=> After giving heat energy of to turbine the Steam exhausted to the condensor which condense the exhausted steam by means of cold water circulation



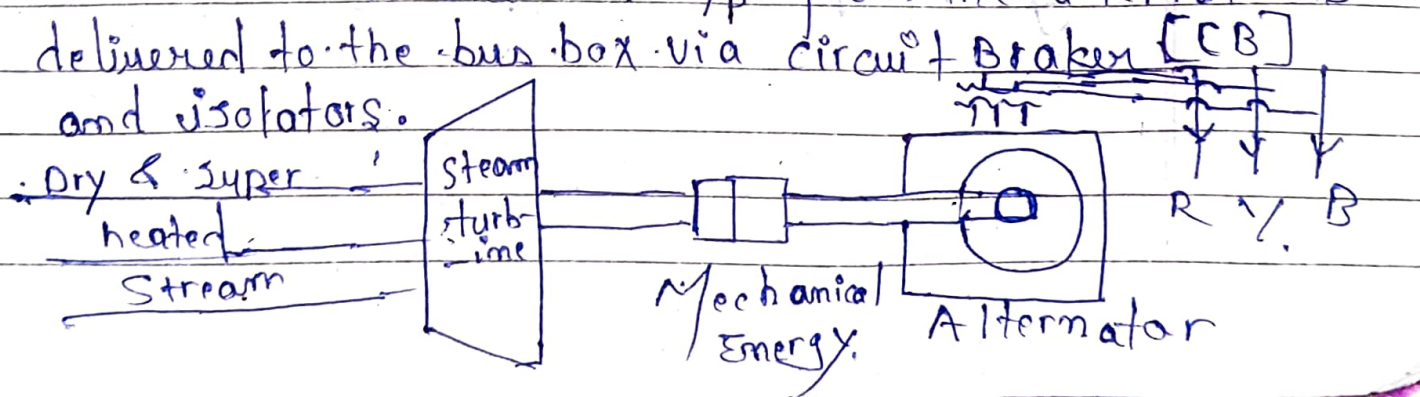
(6) Alternator / AC Generator :-

=> It gives AC electrical output.

=> The steam turbine is coupled to an Alternator.

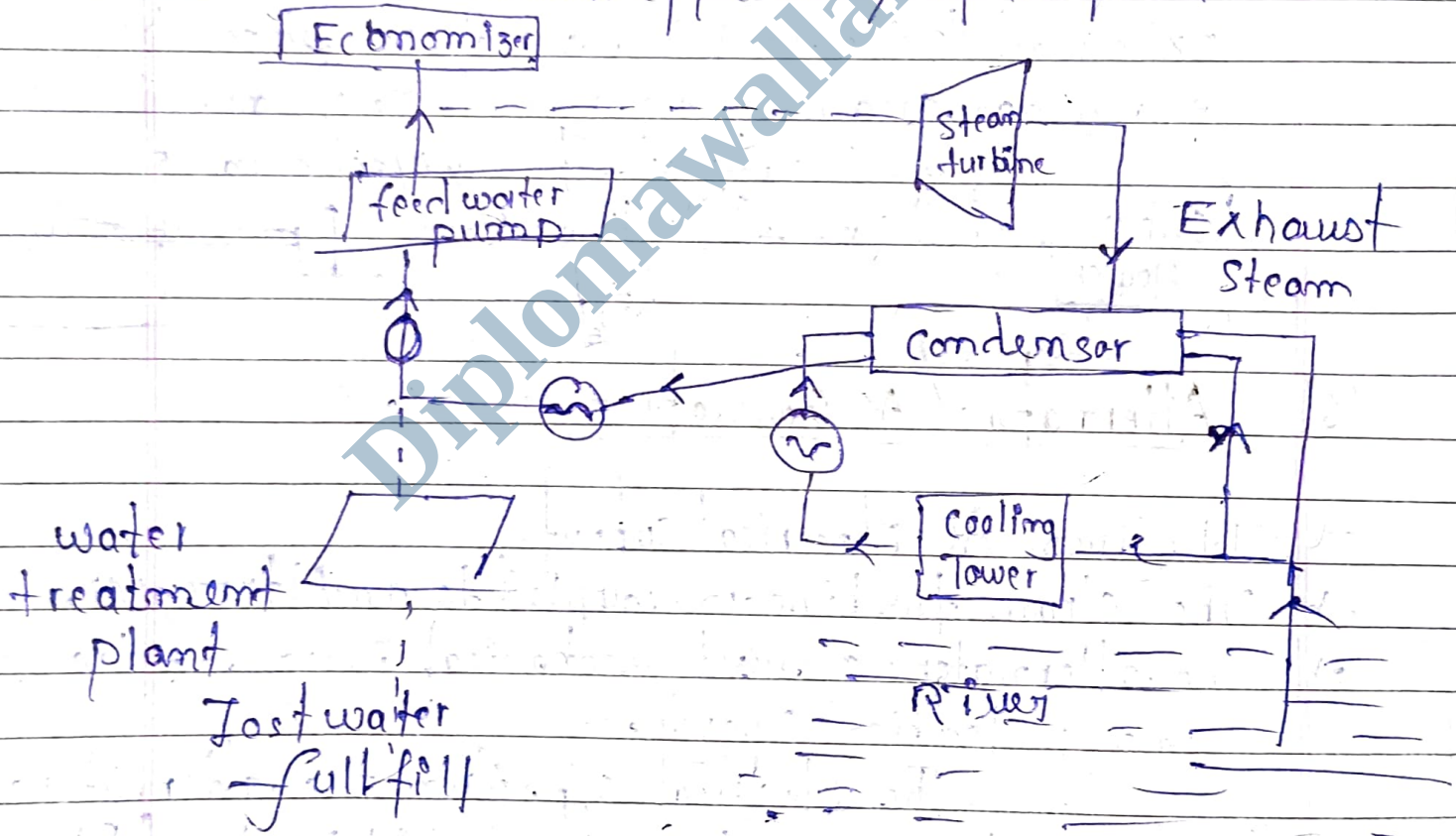
=> The alternator convert mechanical Energy of turbine into Electrical Energy.

The Electrical o/p from the alternator is delivered to the bus box via circuit Braker [CB] and isolators.



(7) Feed Water

- The condensate water in the condenser is used as feed water for boiler.
- Some water is may be lost in the cyclic process which is suitably compensate from the external water source.
- The feed water on it way to this boiler is heated by water heaters and economizer this increases the ~~effi~~ overall efficiency of the plant.



Cooling Arrangment :-

In order to realise of exhaust steam, this steam is condensed by means of condensor.

=> Water is drawn from natural sources of supply river, canal or lake and is circulated through the condensor.

=> The circulating water takes the heat or exhaust steam and become itself heat.

=> This hot water coming out from the condensor is discharge at a suitable location in the River.

=> If there is not availability of water from natural water source throughout the year then a cooling tower is used during the scarcity of wate in river hot water from the condensor is passed to the cooling tower, where it is cooled. The cold water from the cooling tower is reversed in the condensor.