

Generating Power Stations

Thermal Power Stations:-

Selection & Site for Thermal Power Stations (Steam Power Stations)

1) Supply & fuel:- The steam power station should be located near the coal mines so that transportation cost & fuel is minimum. However, if such a plant is to be installed at a place where coal is not available, then care should be taken that adequate facilities exist for the transportation of coal.

Availability of water:- As huge amount of water is required for the condenser, therefore such a plant should be located at the bank of river or near a canal to ensure the continuous supply of water.

Transportation facilities:- A modern steam power station often requires the transportation of material and machinery. Therefore adequate transportation facilities must exist. i.e. the plant should be adequate so that heavy equipment could be installed.

Nearness to load centres:- In order to reduce the transmission cost, the plant should be located near the centre of the load. This is particularly important if

d.c supply system is adopted. However, if a.c supply system is adopted, this factor becomes relatively less important. It is because a.c power can be transmitted at high voltages with consequent reduced transmission cost. therefore it is possible to install the plant away from the load centres. provided other conditions are favourable.

Distance from Populated area:-

As huge amount of coal is burnt in a steam power station, therefore, smoke and fumes pollute the surrounding area. this necessitates that the plant should be located at a considerable distance from the populated areas.

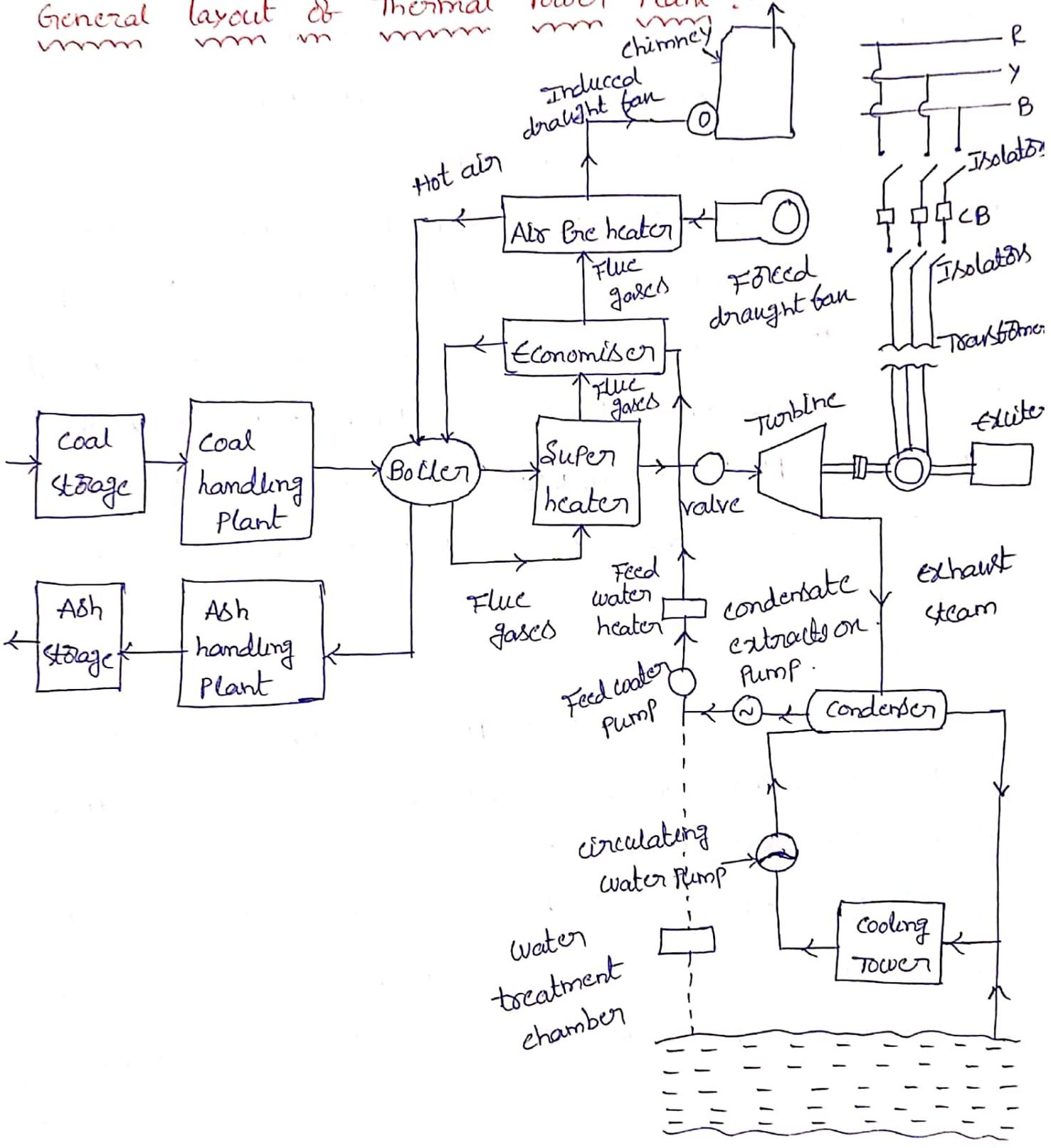
Advantages of Thermal Power Station:-

- 1) The fuel (coal) used is quite cheap.
- 2) Less initial cost as compared to other generating stations
- 3) It can be installed at any place irrespective of the existence of coal. The coal can be transported to the site of the plant by rail or road.
- 4) It requires less space as compared to the hydro. electric power station
- 5) The cost of generation is lesser than that of the diesel power station.

Dis advantages:-

- 1) It pollutes the atmosphere due to the production & large amount of smoke and fumes.
- 2) It is costlier in running cost as compared to hydroelectric plant.

General layout of Thermal Power Plant:-



Coal and ash handling Plant:-

The coal is transported to the power station by road or rail and is stored in the coal storage plant. Storage of coal is primarily a matter of protection against coal strikes, failures of transportation system and general coal shortages. From the coal storage plant, coal is delivered to the coal handling plant where it is pulverised (i.e. crushed into small pieces) in order to increase its surface exposure. The pulverised coal is fed to the boiler by belt conveyors. The coal is burnt in the boiler and the ash produced after the complete combustion of coal is removed to the ash handling plant and then delivered to the ash storage plant for disposal. The removal of the ash from the boiler furnace is necessary for proper burning of coal.

Steam Generating Plant:-

The steam generating plant consists of a boiler for the production of steam and other auxiliary equipment for the utilisation of flue gases.

Boiler:- The heat of combustion of coal in the boiler is utilised to convert water into steam at high temperature and pressure. The flue gases from the boiler make their journey through super heater, economiser, air-fue heater and finally exhausted to atmosphere through the chimney.

Super heater:-

The steam produced in the boiler is wet and is passed through a super heater where it is dried and super heated. (i.e steam temperature increased above that of boiling point of water) by the blue gases on their way to chimney. Super heating provides two principal benefits

- 1) The overall efficiency is increased.
- ii) Too much condensation in the last stages of turbine is avoided. The superheated steam from the superheater is fed to steam turbine through the main valve.

Economiser:- An economiser is essentially a feed water heater and derives heat from the blue gases for this purpose. The feed water is fed to the economiser before supplying to the boiler. The economiser extracts a part of heat of blue gases to increase the feed water temperature.

Air-Pre heater:-

An air pre heater increases the temperature of the air supplied for coal burning by delivering heat from blue gases. Air is drawn from the atmosphere by a forced draught fan and is passed through air pre heater before supplying to the boiler furnace. The air preheater extracts heat from blue gases and increases the temperature of air used for coal combustion. The benefits of air preheater

- 1) increased thermal efficiency
- 2) Increased steam capacity for same meter of boiler surface.

Steam turbine:-

The dry and superheated steam from the superheater is fed to the steam turbine through main valve. The heat energy of steam when passing over the blades of turbine is converted into mechanical energy, after giving heat energy to the turbine. The steam is exhausted to the condenser which condenses the exhausted steam by means of cold water circulation.

Alternator:- The steam turbine is coupled to an alternator. The alternator converts mechanical energy of turbine into electrical energy. The electrical output from the alternator is delivered to the bus bars through transformer, circuit breakers and isolators.

Feed water:-

The condensate from the condenser is used as feed water to the boiler. Some water may be lost in the cycle which is suitably made up from external source. The feed water on its way to the boiler is heated by water heaters and economiser. This helps in raising the overall efficiency of the plant.

Cooling arrangement:-

In order to improve the efficiency of the plant, the steam exhausted from the turbine is condensed by means of a condenser. Water is drawn from a natural

Source & Supply Such as a river, canal or lake and. (4)
is circulated through the condenser. The circulating water takes up the heat of the exhausted steam and itself becomes hot. This hot water coming out from the condenser is discharged at suitable location down the river. In case the availability of water from the source & supply is not assured throughout the year, cooling towers are used. During the scarcity of water in the river, hot water from the condenser is passed on to the cooling towers where it is cooled. The cold water from the cooling tower is reused in the condenser.

Equipment of Steam Power Station:-

- 1) Steam generating equipment
- 2) Condenser
- 3) Prime mover
- 4) Water treatment plant
- 5) Electrical equipment.

Steam generating equipment:-

This is an important part of steam power station. Such as boiler, boiler furnace, super heater, economiser, air pre heater and other heat reclaiming devices.

Boiler:- A boiler is closed vessel in which water is converted into steam. Boilers are classified into 2 types

- 1) water tube boilers
- 2) Fire tube boilers

In a water tube boiler, water flows through the tubes and the hot gases of combustion flow over these tubes. On the other hand in a fire tube boiler, the hot products of combustion pass through the tubes surrounded by water. Water tube boilers have a number of advantages over fire tube boilers viz. requires less space, smaller size of tubes and drum, high working pressure due to small drum, less liable to explosion etc..

Boiler furnace:-

A boiler furnace is a chamber in which fuel is burnt to liberate the heat energy. It provides support and enclosure for the combustion equipment. i.e burners. The boiler furnace walls are made of refractory materials such as fire clay, silica, kaolin etc..

Super heater:-

A super heater is a device which super heats the steam. Super heaters are mainly classified into 2 type.

- 1) Radiant super heater
- 2) Convection super heater.

The radiant superheater is placed in the furnace. b/w the water walls and receives heat from the burning fuel through radiation process. It has two main disadvantages firstly due to high furnace temperature, it may get

over heated and therefore requires careful design. (5)

Secondly the temperature of Superheater falls with increase in steam output. due to these limitations radiant Superheater is not finding favour these days.

convection Superheater is placed in the boiler tube bank and receives heat from blue gases entirely through the convection process. It has advantage that temperature of Superheat increases with the increase in steam output. For this reason, this type of Super heater is commonly used these days.

Air - Pre heater :-

These are classified into 2 types

- 1) Recuperative type
- 2) Regenerative type.

The recuperative type consists of a group of steel tubes. the blue gases are passed through the tubes while the air flows externally to the tubes. Thus heat of blue gases is transferred to air;

The regenerative type consists of slowly moving drum made of corrugated metal plates. the blue gases flow continuously on one side of the drum and air on the other side. this action permits the transference of heat of blue gases to the air being supplied to the furnace for coal combustion.

Condensers :-

These are classified into two types

- 1) Jet condenser
- 2) Surface condenser.

In a Jet condenser cooling water and exhausted steam are mixed together. therefore. the temperature of cooling water and condensate is the same when leaving the condenser.

Adv! low initial cost, less floor area required, less cooling water required

Dis adv! condensate is wasted and high power is required for pumping water.

In a Surface condenser there is no direct contact b/w cooling water and exhausted steam. It consists of bank of horizontal tubes enclosed in a cast iron shell.

Adv! Condensate can be used as feed water less pumping power required.

Dis adv! High initial cost, large floor area and high maintenance charges.

Turbines (Prime movers) :-

Turbines are two type

- 1) Impulse turbine
- 2) Reaction turbine.

In an impulse turbine the steam expands completely on the stationary nozzles. the pressure over the

moving blades remaining constants. In doing so, the steam attains a high velocity and impinges against the moving blades. (6)

In reaction turbine the steam is partially expanded in the stationary nozzles, the remaining expansion takes place during its flow over the moving blades. The result is that the momentum of the steam causes a reaction force on the moving blades which sets the rotor in motion.

Electrostatic Precipitator! -

An electrostatic Precipitator (ESP) is defined as a filtration device that is used to remove fine particles like smoke and fine dust from the flowing gas. It is the most commonly used device for air pollution control. They are used in thermal energy plants.

