

# Thermal Power Plants

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# Contents

1	Introduction . . . . .	2
2	Working Components of a Thermal Power Plant . . . . .	3
2.1	Fuel Storage Facility . . . . .	3
2.2	Water Treatment Facility . . . . .	3
2.3	Boiler . . . . .	4
2.4	Turbine . . . . .	5

# 1 Introduction

Thermal Power Plants as the title infers is the place of mechanism which converts heat energy into electric power. In thermal power plants, the heat energy obtained from combustion of solid fuel (mostly coal) is used to convert water into steam, this steam is at high pressure and temperature. This steam is used to rotate the turbine blade which is connected to the generator. The generator converts the kinetic energy of the turbine impeller into electric energy.

Thermal power plants are the largest source of power in India. Thermal energy, which is used to convert heat into electricity is based on three types of heat sources.

1. Coal - More than 62 % demand is met by coal reserves. NTPC and other state level power generation companies are engaged in maintaining and operating thermal power plants.
2. Gas - Use Natural Gas.
3. Diesel

A structured thermal power plant is shown below. The diagram has been taken from Wikipedia.

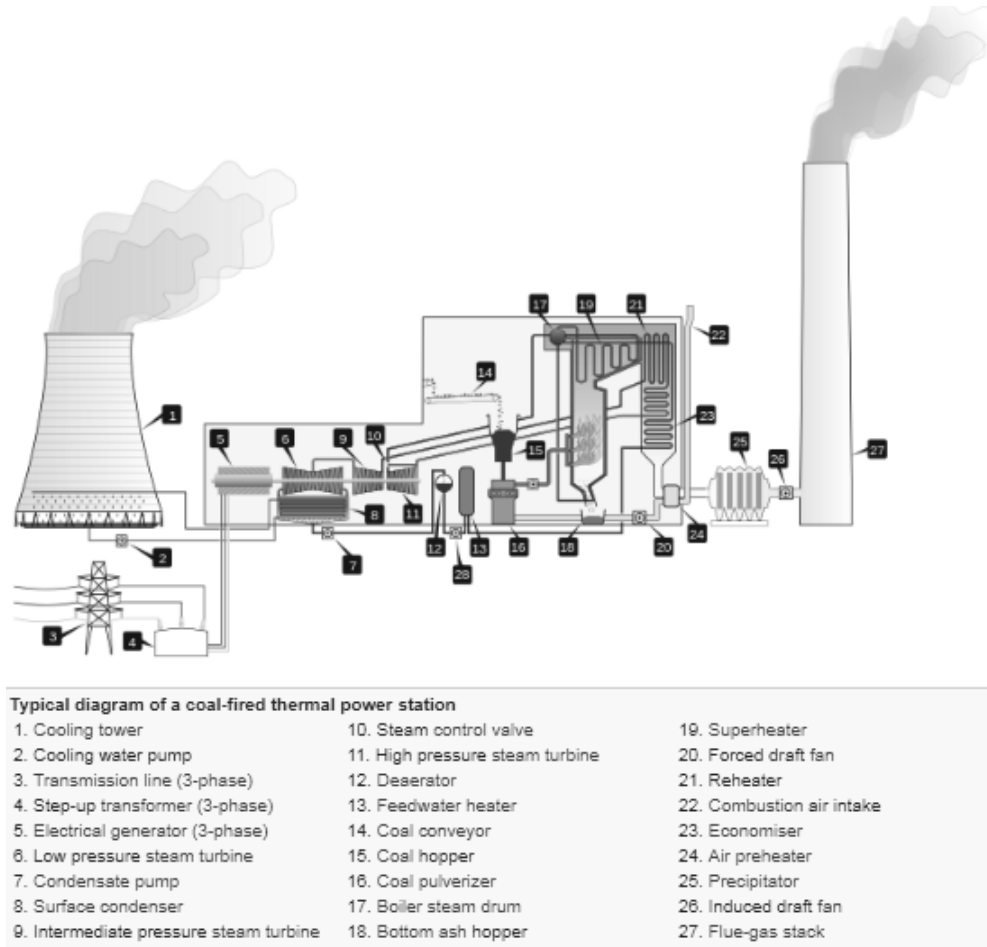


Figure 1: General structure of a Thermal Power Plant

## 2 Working Components of a Thermal Power Plant

The plant is a system, and a system needs harmonical contributions of some components. These components in their actual form are discussed below one by one. The workflow of a thermal power plant is in the following manner. Fuel (which has generally large particle size) is crushed down to smaller particle size. It is then combusted to generate heat. This heat is then transferred to running water which then turns to high pressure steam. Generally, gases from the boiler exhaust are at high temperature and if this heat is not utilized will lead to a large amount of losses resulting in reduced boiler efficiencies. So generally this waste heat is recovered by heating either air required for combustion or preheat water before sending it into a boiler. Gases are then allowed to pass through a dust collector or a bag filter to arrest dust particles so as to prevent air pollution before sending it to the atmosphere through a chimney.

### 2.1 Fuel Storage Facility

Fuel is an important resource. Any plant which depends extensively on fuel needs to store it somewhere from where it could be used later on when the supply of fuel from the mine is improper. This is where a fuel storage facility comes into picture.

In a thermal power plant, the first step in process of power generation is that the fuel is brought to breaker house with the help of belt conveyor, here light dust is separated with the help of rotary machine through the action of gravity. It further goes to the crusher where it is crushed to a size of about 50mm.

### 2.2 Water Treatment Facility

The water that has been converted to steam, is brought to the turbines under high pressure. This steam is used to rotate them. Normal water is taken from the river, and it contains a lot of dirt, suspended particulate matter (SPM), dissolved minerals and dissolved gases such as air etc. If the water fed to the boiler is not treated, it will reduce the life and efficiency of equipment by corroding the surfaces which may lead to overheating of pressure parts and explosions.

This particulate matter is separated out by adding *alum* into the water. Alum coagulates the dirt and increases its density. Then, due to gravity, this coagulated matter settles down in the water which is then removed from it.

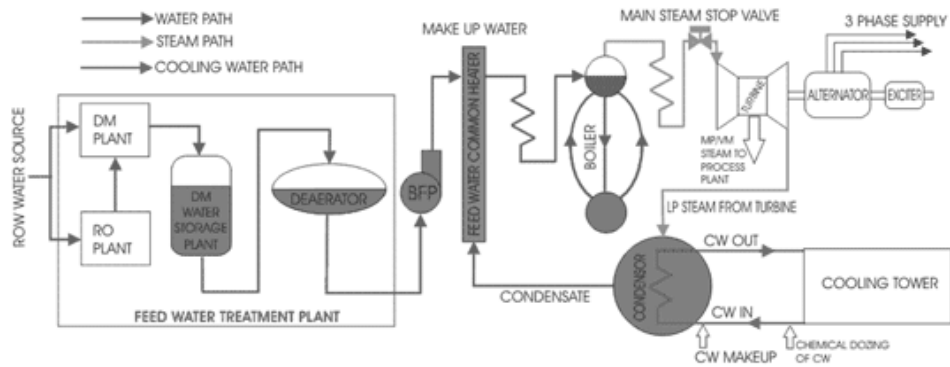


Figure 2: Water treatment

After gravity separation, water softening is done by ion exchange process. As the hardness comes through the carbonates and bicarbonates of sodium and magnesium, these salts are removed from water anion exchange and cation exchange process.

Water also contains dissolved oxygen and this leads to corrosion and fouling of boiler tubes and surfaces when it comes in their contact. So removing dissolved oxygen from water is done by adding oxygen scavengers and by using a Deaerator tank. Deaerator tank also acts as a feed water tank to store the feed water. On heating feed water in a deaerator tank decreases the solubility of air in water, thereby removing the dissolved air from the water.

## 2.3 Boiler

A boiler is a high pressure vessel used to generate high pressure steam at saturated temperatures. Water tube boiler consists of a furnace enclosed by the water tubes membrane. The crushed fuel from the crushers is fed into the boiler furnace over the grate. The hot air from the Forced Draft (FD) fan is mixed with the crushed fuel causing combustion of fuel.

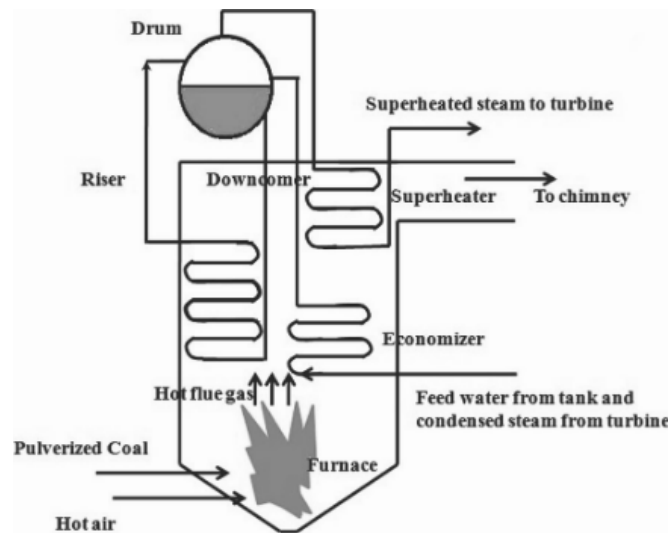


Figure 3: Boiler

Combustion of fuel generates a lot of radiation heat which is transferred to water in the membrane tubes. Flue gases generated during combustion travel at high velocity across the convection bank of tubes thereby heating water through convection heat transfer. Hot water is sent to a boiler drum at high pressure through the feed water pump. The boiler tubes which are in contact with low temperature acts as downcomers to circulate the water while the tubes which are in contact with high temperature acts as risers to carry steam. This leads to an effective circulation of water thereby preventing the tubes from getting overheated.

Steam leaving the boiler is at a saturated temperature and pressure but there are a lot of heat losses during its transportation to the turbines. So to increase the quality of steam, steam Superheater is installed in a radiative section of a boiler to increase its temperature and dryness fraction without increasing its pressure as well as to accommodate for the transportation temperature losses.

The exhaust gases leaving the boiler are generally at high temperature and this waste heat is extracted by installing an Economiser or Water Pre heaters to preheat the feed water to the

boiler and Air Pre-heaters to pre-heat the air coming from the Forced Draft Fan required for the combustion of fuel. Installing this equipment help to decrease the flue gas temperature thereby increasing the efficiency.

The flue gases leaving the boiler also contain some ash particles, so to reduce the air pollution, flue gases are allowed to pass through the Dust Collectors and Bag Filters to remove the ash particulates from the flue gases and are sometimes passed through the Wet Scrubbers to decrease the sulfur content from the gases.

The flue gases are drawn through this equipment using an Induced Draft (ID) Fan which is designed for a fixed capacity and head to prevent any back pressure. After the ID fan, flue gases are exhausted off into the atmosphere using a chimney.

## **2.4 Turbine**

A turbine is a mechanical device which converts the kinetic and pressure energy of steam into useful work. From the super-heater steam goes to the turbine where it expands and loses its kinetic and pressure energy and rotates the turbine blade which in turn rotates the turbine shaft connected to its blades. The shaft then rotates the generator which converts this kinetic energy into electrical energy.

# Bibliography

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