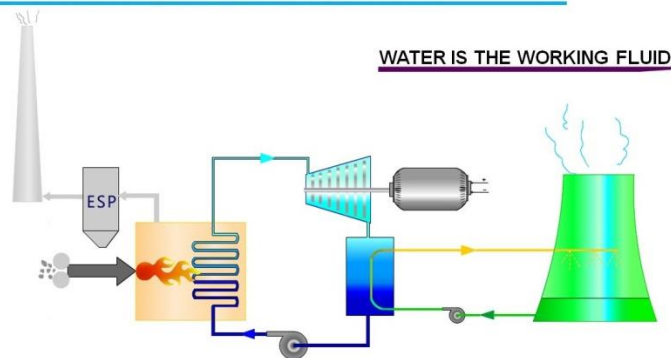


# 1

## INTRODUCTION TO THERMAL POWER PLANT

### THERMAL POWER PLANT



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- 1.2 Working of Steam Power Plant
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- 1.4 General Layout of Thermal Power Plant
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## 1.1 Introduction

The availability of electrical energy and its per capita consumption is regarded as index of national standard of living in the present day civilization and for development of any country, energy is the basic input.

Next to the food, fuel and power are the most important items on which national standard life depends. That's why once the food requirement is fulfilled; next task for any country is to increase the power generation. The production of food also increases with increases of power generation. Therefore, the increase in power potential of a nation is considered most important among all.

The energy in the form of electricity is most desired as it is easy to transport, easy to control, clean in its surroundings and can be easily converted in heat or work as per requirements. If we see the data of last ten years, we can realize that consumption of power increases continuously, not only in India but worldwide and it will increase with development of industries and the improvement of living standard. As the coal is easily available in India, large percentage of electricity is developed by thermal power plant in which coal is used as fuel.

## 1.2 Working of Steam Power Plant

Steam power plant basically works on the Rankine cycle in which steam and water is used as working fluid. In Rankine cycle high pressure and temperature steam is generated in the boiler by burning of fuel. That high pressure and temperature steam is then expanded in the turbine to produce power which in turn used to drive the generator to produce electricity. After the expansion of steam low pressure and temperature steam is condensed in the condenser and the condensate is fed back to the boiler with the help of the feed water pump and cycle is repeated.

## 1.3 Rankine Cycle

The main components of cycle are boiler, turbine, condenser and feed pump. The cycle consists of following four processes:

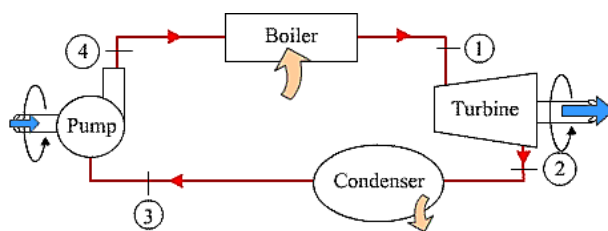


Fig. 1.1 Schematic diagram of Rankine cycle

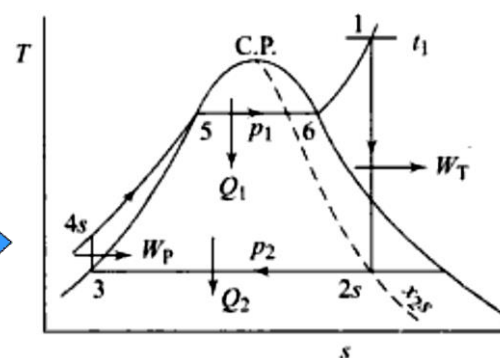


Fig. 1.2 T-S diagram of Rankine cycle

**Process 1-2 isentropic expansion:** Steam at high pressure and temperature is expanded in turbine isentropically. Pressure of the steam is decreases from  $P_1$  to  $P_2$ . During the process work is done by the turbine.

**Process 2-3 constant pressure heat rejection:** exhaust steam from the turbine is condensed at constant pressure in the condenser so steam is condensed into water. During the process latent heat of steam is rejected to cooling water.

**Process 3-4 isentropic compression:** Condensate from the condenser is pumped back to the boiler. During with work is done on the water by the pump

**Process 4-1 constant pressure heat addition:** in the boiler heat is supplied at constant pressure by burning of the fuel.

## 1.4 General Layout of Thermal Power Plant

The general layout of the thermal power plant consists of mainly 4 circuits as shown in figure 1.3. The four main circuits are:

- 1) Coal and ash circuit
- 2) Air and gas circuit
- 3) Feed water and steam flow circuit
- 4) Cooling water circuit

### 1.4.1 Coal and ash circuit

Coal from the coal storage is fed to the boiler through coal handling system to generate the steam. Ash produced due to combustion of coal is removed and dump into ash sump through ash handling system.

### 1.4.2 Air and gas circuit

Air from the atmosphere is supplied to the boiler either through F.D. or I.D. fan or by using both. The dust from the air is removed with the help of air filter. Air preheater is used to utilize the heat of exhaust gases which increase the efficiency of the plant. To remove fly ash from the gases electrostatic precipitator is used. Exhaust gases from the boiler is discharge to the atmosphere through chimney.

### 1.4.3 Feed water and steam flow circuit

High pressure and high temperature steam is generated in the boiler by burning of the fuel. That high pressure and temperature steam is then expanded in the turbine to produce mechanical work which in turn is used to drive generator to produce electrical power. The steam coming out from the turbine is condensed in the condenser and then fed back to the boiler with the help of feed pump. The condensate may be heated in feed water heater using the steam tapped from the different points of the turbine.

Some of the steam and water may be lost due to leakage through different components. To compensate the loss, make up water is supplied to the boiler through feed water treatment plant to remove the impurities.

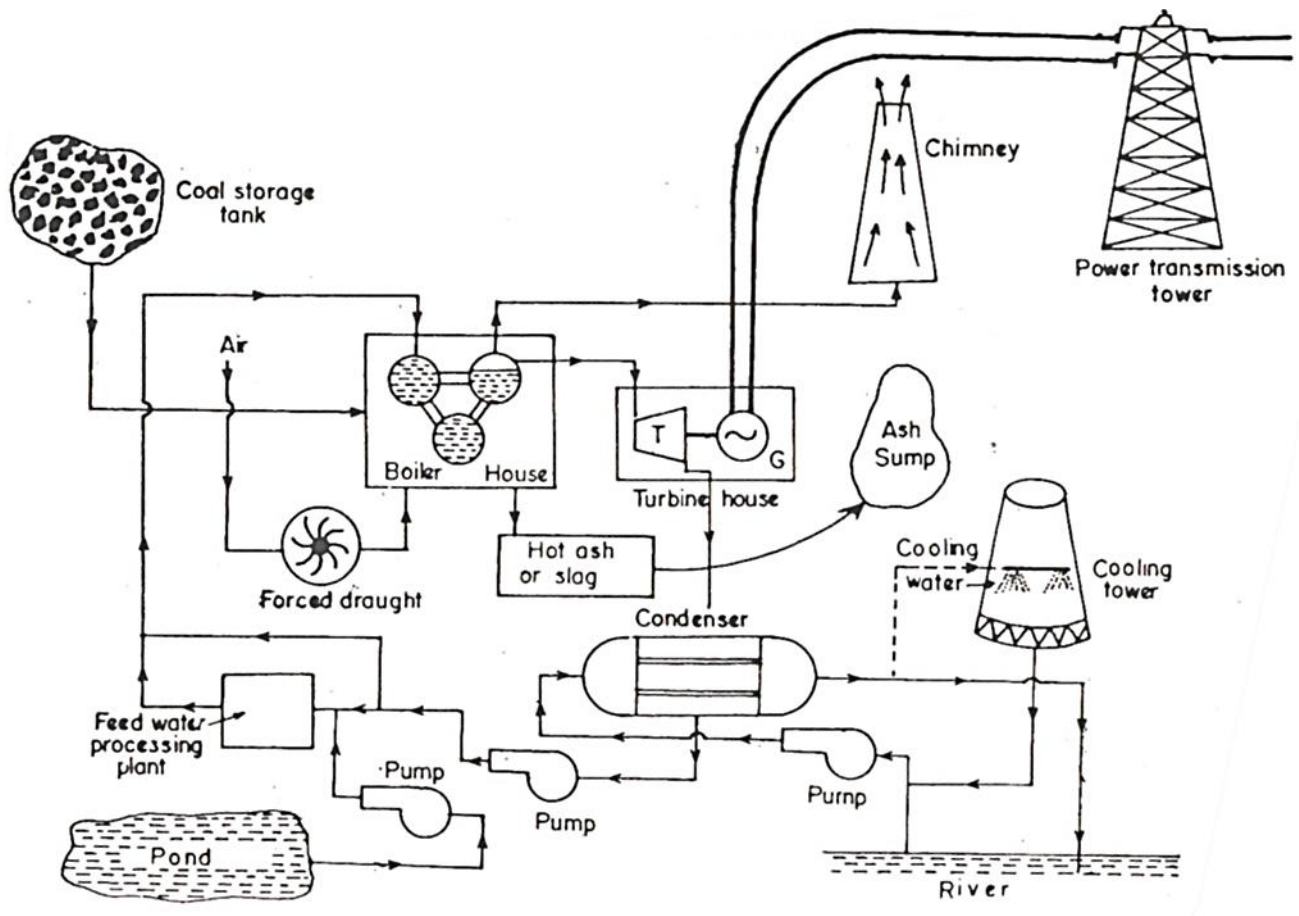


Fig. 1.3 General layout of thermal power plant

#### 1.4.4 Cooling water circuit

The considerable amount of cooling water is required to condense the steam in condenser. It is taken either from lake, river or sea. If adequate water is available throughout the year, then cooling water is taken from the upstream of the river, passed through the condenser and discharge to downstream of the river.

If adequate water is not available, then hot water from the condenser is cooled in the cooling tower and cold water from the cooling tower is passed through the condenser.

➤ The different types of system and components of the thermal power plant:

- |                         |                               |
|-------------------------|-------------------------------|
| 1. Coal handling system | 5. I.D. fan                   |
| 2. Ash handling system  | 6. Electrostatic precipitator |
| 3. Air preheater        | 7. Boiler                     |
| 4. F.D. fan             | 8. Steam turbine              |

- |               |                                    |
|---------------|------------------------------------|
| 9. generator  | 12. Feed water treatment plant     |
| 10. Condenser | 13. Cooling water circulating pump |
| 11. Feed pump | 14. Cooling tower                  |

## 1.5 Site Selection of Thermal Power Plant

The following factors should be considered while selecting the site for a steam power station

### 1.5.1 Availability of Coal:

The major source of energy which is available in India for thermal power plant is coal. Therefore, it is necessary to concentrate for the best use of coal for power generation.

For the large capacity power plant, the huge amount of coal is required. Therefore, it is necessary to install such power plant near the coal mines. In this case, the electricity must be transported to the long distances, so, location of the plant is such that it will give minimum cost considering the coal transportation and power transmission.

### 1.5.2 Ash Disposal Facilities:

The ash removal problem has become more serious particularly in India, because Indian coal contains large percentage of ash. The removal of ash is more difficult than coal handling because it comes out from the boiler in hot condition and it is highly corrosive and it also contains poisonous gases.

Ash can be easily disposed off to river, sea or lake if such facilities are available. But in present day the ash from the power plant is used for many industrial processes, so it is better to utilize the ash for such process.

### 1.5.3 Space Requirement:

Space is required not only for construction of the plant but it also required for coal storage, ash disposal, staff colony and market facilities. To reduce the initial cost of the plant, land should be available at low cost.

### 1.5.4 Nature of Land:

The selected should have good bearing capacity to withstand the dead load of the plant and the forces transmitted to foundation due to operation of the machinery.

### 1.5.5 Availability of Water:

The large quantity of water is required for condenser, for disposal of ash, and as feed water to boiler and drinking water for the working staff. Large quantity of ash is also required for ash disposal if hydraulic system is used. Therefore, it is necessary to install the plant near the water source.

### 1.5.6 Transport Facilities:

Transportation facilities should be available for transportation of coal as well as transportation of heavy machinery.

**1.5.7 Availability of Labour:**

Cheap labour should be available at the proposed site as enough labour is required for construction of the plant.

**1.5.8 Public Problem:**

The proposed should be far away from the town to avoid the nuisance from smoke, fly ash and heat discharged from the power plant.

**1.5.9 Size of the Plant:**

In small power plant cost of transportation of coal and water is insignificant compare to transmission of electricity. Therefore small plant can be located away from the coal mines to minimize the total cost of power generation. Similarly large size plant should be located near the coal mines to minimize the coal transportation cost.

**1.5.10 Future Extensions:**

Space should be available for future expansion of the plant.

**1.6 Things to Think About**

- List the share of electricity generated in India and USA by different types of power plants.
- Compare the per capita energy consumption of India with west and USA.
- What is the effect of climate (winter and summer) on efficiency of power plant?
- What are the future sources of energy for mankind?

**Assignment**

1. Draw general layout of a thermal power plant and explain the working of different circuits.
2. Name factors to be considered for selection of site for thermal power station.
3. Select power plant and its location in Gujarat with its justification