Cooling water is supplied to the condenser for the condensation of steam. In this process the cooling water becomes hot. To cool this hot water coming out of the condenser the cooling towers and the cooling ponds are used so that the cooled water can be reutilized in the condenser again.

1. Cooling Towers

The cooling towers are very useful when there is scarcity of both the water and the land. It is an artificial device by which the hot water coming out of the condenser is cooled effectively. By using cooling towers the cooling water requirement is reduced and only makeup water is to be supplied. The principle of cooling the water is similar to that of the evaporative condenser. Some water about 1% goes into air in the form of water vapor by absorbing its latent heat of vaporization from the remaining water and thus causes the reduction in the water temperature. The cooling towers reduce the cooling water demand about 75 times but it is achieved at the expense of large capital, land, and operational costs. The types of cooling towers on the basis of the draught (method of air circulation) are:

(i) Natural draught cooling towers (ii) Mechanical draught cooling towers: (a) Forced draught cooling towers, and (b) Induced draught cooling towers.

(i) Natural Draught Cooling Towers

The schematic view of natural cooling tower is shown in Figure 1. The hot water from the condenser is pumped to a height of about 8 m to 12 m which enters the tower and then sprayed over the woodwork and trays. The water in the form of sprays meets the air entering from the bottom of the tower which is open to the atmosphere. Hot water gives up its heat to the air and gets cooled. The hot air along with some water vapor leaves the tower at top and the cooled water falls down in the form of rain and gets collected in the pond at the bottom of the tower. The cooled water from the pond is again supplied to the condenser. No fan is used in natural draught cooling towers. The bottom of the tower is kept open through which air enters into the tower. The airflow is maintained due to pressure difference caused by the difference in density between the hot air inside the tower and the outside atmospheric air.
The water vapors leaving the tower along with the air is prevented by using water eliminators. Still some loss of water will be there which will be compensated by adding fresh water called make up water. The reduction in temperature of the water is called range. The disadvantage of this type of tower is that to produce large natural draught the tower will be very high.

(ii) Mechanical Draught Cooling Towers In the mechanical draught cooling towers the air is circulated with the help of a mechanical device like a fan or a blower. Depending on the position of the fan or blower these are classified as forced draught or induced draught cooling towers. When the fan is installed at the bottom of the tower it is known as forced draught cooling tower as shown in Figure 2 (a). When the fan is installed at the top of the tower it is called induced draught cooling tower as shown in Figure 2 (b).
Hot water coming from the condenser enters the tower from its top and is sprayed through the nozzles. The sprayed water meets with the air going upwards. Eliminators are provided at the top to prevent the escaping of water droplets with air leaving from the top. Cooling towers are generally hyperbolic in shape and are made of steel, concrete, or timber. The induced draught cooling towers are generally used in large capacity power plants. In the case of forced draught tower power requirement is high and maintenance cost of the fan is high. The induced draught tower occupies less space as the fan drives are installed at the top of the tower. In the induced draught tower the air is drawn by the fan from all the sides of the tower through the openings at low velocity and thus the cooling effect is obtained across the entire cross section of the tower. Also it handles warm air, so there will be no freezing problems during winter season as in the case of forced draught cooling towers.

2. Cooling Ponds

It is the simplest method of removing heat from the hot water by discharging it through a pipeline into a large open pond exposed to the atmosphere. The water is cooled by blowing air over the surface of the pond and mixing with cold water of the pond. The heat from the hot water will be transferred to the air by evaporation and convection processes. The loss of water by evaporation and wind blowing over the cooling pond is about 2% to 3%. To reduce the area of
pond the water is sprayed into the air over the pond surface by water spray nozzles. For effective cooling these nozzles are fitted at a height of about 1 m to 2.5 m above the surface of water. Even after the use of spray nozzles the area required for cooling is large due to the evaporative cooling process. The factors which affect the dissipation of heat from the cooling pond are: area and depth of pond, temperature of water entering the pond, relative humidity, air velocity, atmospheric temperature and pressure, and solar radiation. The cooling ponds are classified into two categories, namely, non-directed flow type and directed flow type. The non-directed flow type cooling pond is shown in Figure 3 (a) and directed flow type is shown in Figure 3 (b).

![Fig. 3. Cooling Ponds](image)

In the case of non-directed flow type ponds, the hot water is discharged into the open pond. But in the case of directed flow type cooling ponds, the pond is divided into a number of channels by providing baffle plates which direct the flow of hot water. The cooling effect in directed flow cooling ponds will be more due to thorough mixing of hot and cold water streams. On the basis of spray nozzles arrangement, the cooling ponds may also be classified as single deck or double deck ponds. In a single deck cooling pond, the spray nozzles are arranged at the same elevation, whereas in double deck system the nozzles are arranged at different elevations. The double deck cooling ponds are more efficient than single deck system. The disadvantages of cooling ponds are: (i) Large area is required for cooling, for example, the surface area required in a cooling pond is about 30 times the size of cooling tower for the same duty, (ii) The loss of water due to air blow is large and it is unprotected against dust, and (iii) There is no control over the temperature of cooled water, and its cooling efficiency is low. The cooling ponds are suitable only for small capacity steam plants where land is easily and cheaply available.