Condensing & Cooling System

BY

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Introduction

The juice concentration in evaporator and crystallization in pans are carried out under vacuum and for producing vacuum, special equipment has to be installed in sugar mills. In its simple form the equipment consists of ‘ Condensing & Cooling system’

Cold water is continuously pumped into the condenser, which condenses the vapour and water gets heated. The hot water from the condensers has to be reused for which special cooling system is installed involving atmospheric cooling by spray in ponds or surface cooling in towers.

Condenser

Condenser is a cylindrical closed vessel with a long pipe attached to the bottom open at t he lower end. The cylindrical body of the condenser is usually constructed of M.S. or S.S. plates b u t the conical bottom and throat of the condenser as well as tail pipe should preferably be made of C.I. or S.S. The condenser is a vessel with a barometric column extended into a well with water seal and is therefore installed on a special platform at a height of 11 m. above the well so as to maintain water column of 10 m. since the injection water has to flow by gravity from the condenser and the water column corresponding the perfect vacuum of 760 mm is 0.76 x 13.6 = 10.34 m. the density of mercury being 13.6.

Types of Condenser

Two major types of condensers are :

- Condenser with separate arrangement for air extraction
- Condenser with combined vapour and air extraction.

In the first type are—

- co-current condenser wherein the water and air flow are in the same direction.
- Counter current condenser in which air circulation is in opposite direction to water flow. Multijet condenser belongs to the class of cocurrent condensers which remove both vapours and air.

In a condenser the vapours entering, transfer heat to the cold injection water, the heat transmission depending on the temperature and quantity of water. Based on the h e a t balance the equation for arriving at the quantity of injection water is.

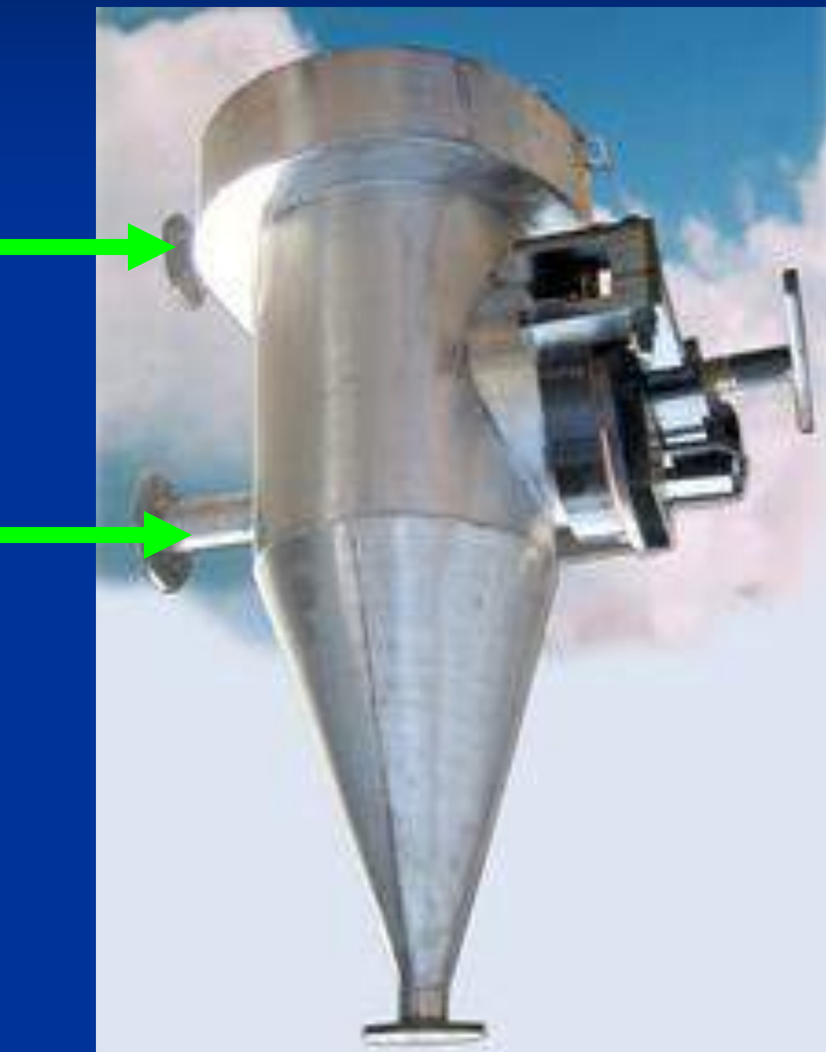
$W = (I-t2)/(t2 - t1)$ where W = Kg of injection water per Kg of vapour

I = heat of vapour in Kcal/kg

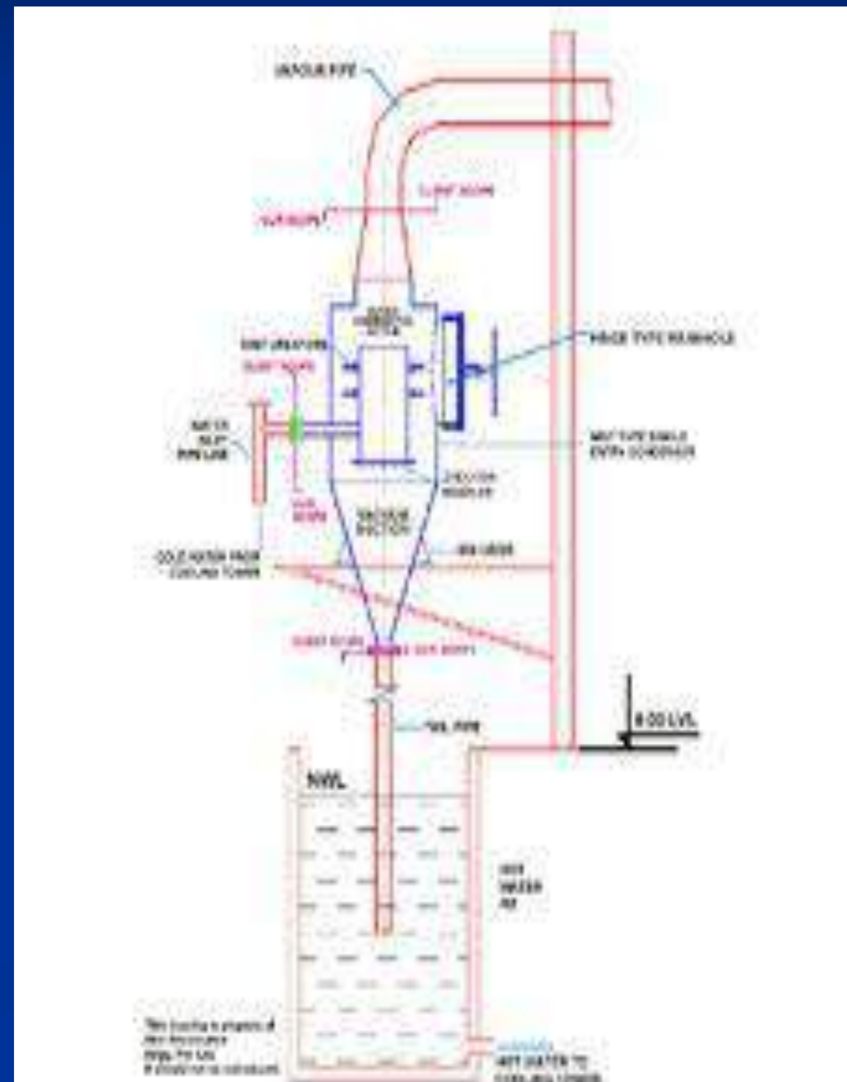
$t1$ = temperature of injection water in °C

$t2$ = temperature of condenser outlet water in °C. Under normal conditions the cooling water ratio to vapour condensed in around 50.

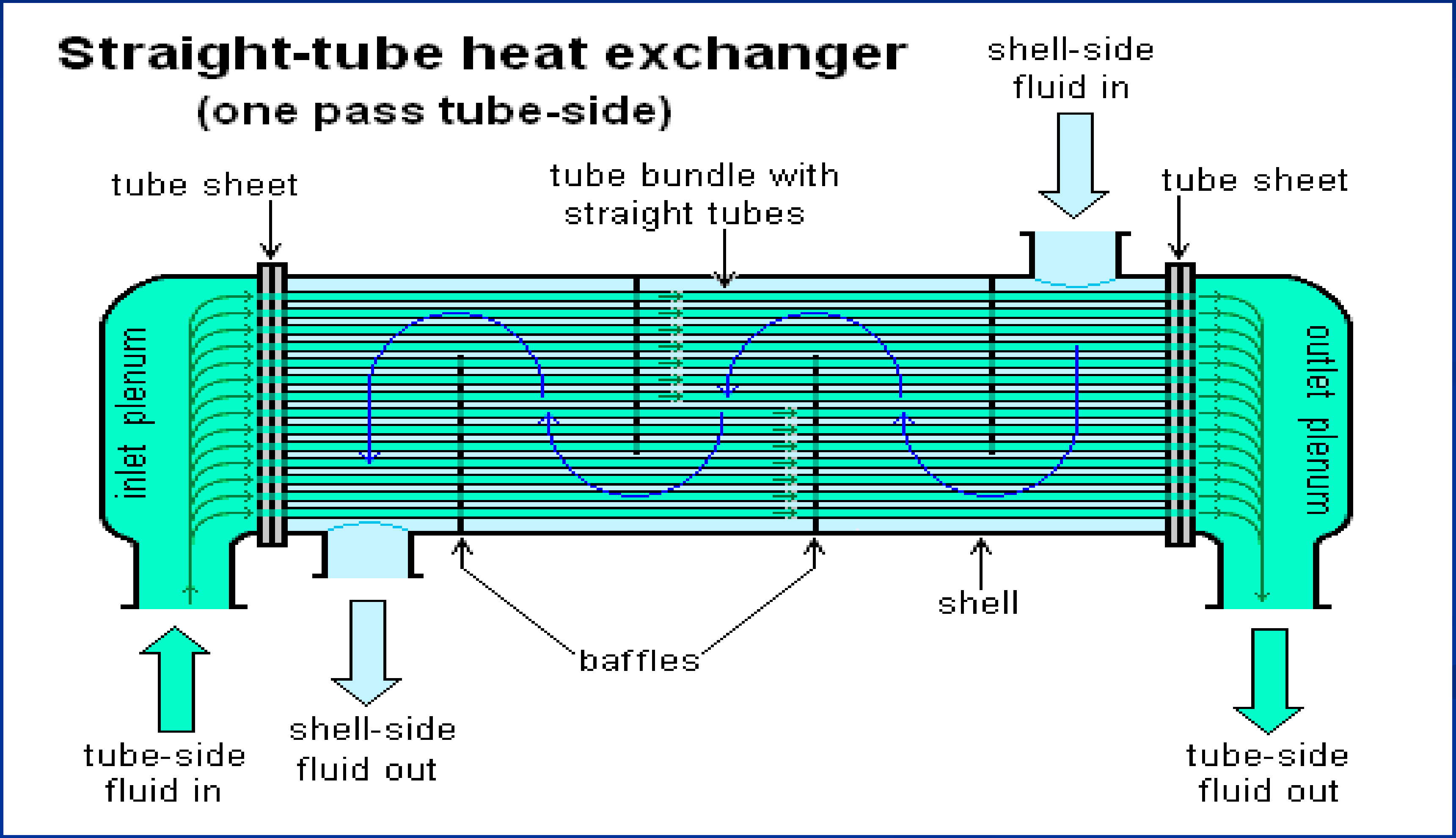
Multi Jet Double Entry Condenser



Multi Jet Single Entry Condenser



Surface Condenser



Cooling System

If the required quantity of water is not available from spring or river water (or from the sea, in the case of factories situated on the coast), it is necessary to resort to a cooling system to which the warm water leaving the condenser is pumped, and which cools it for re-use.

Types of cooling system

There are two principal types of cooling system:

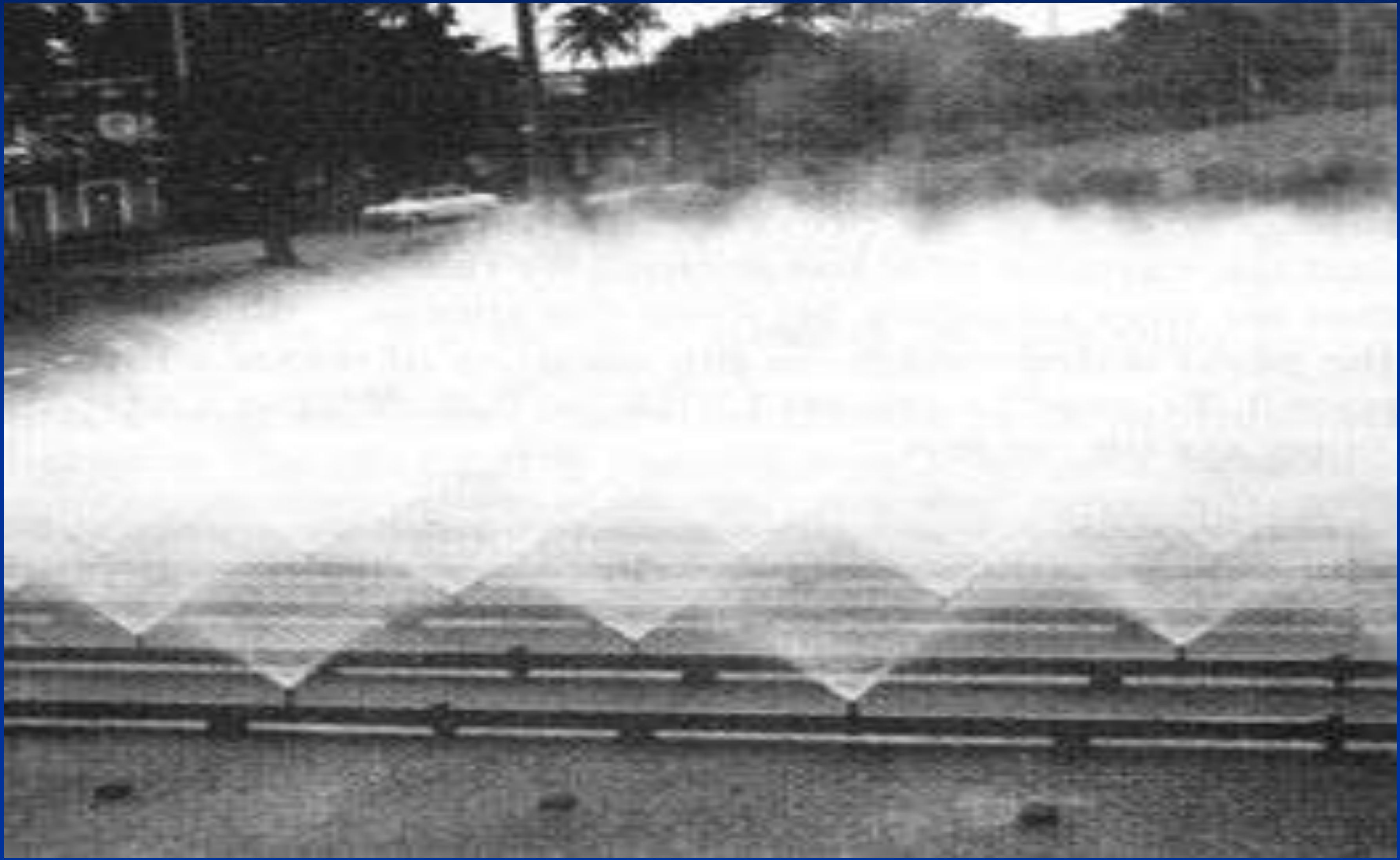
Natural draft Cooling System –

1. Spray pond.
2. Fan-less Jet Cooling Tower.

Mechanical draft Cooling System-

Mechanical draft towers utilize large fans to force or suck air through circulated water.

Spray Pond Cooling System



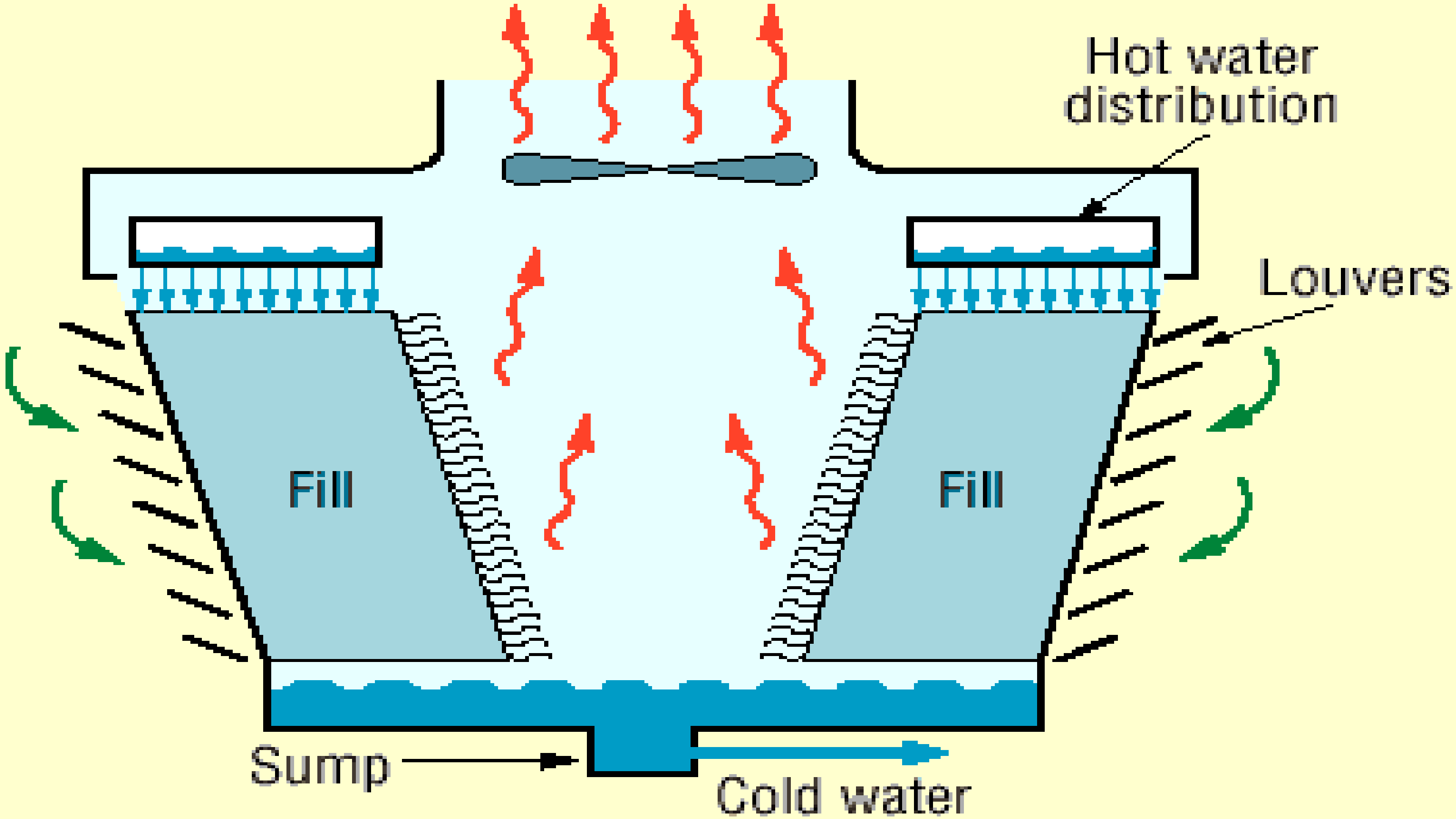
Fan-less Jet Cooling Tower

Mechanical draft towers

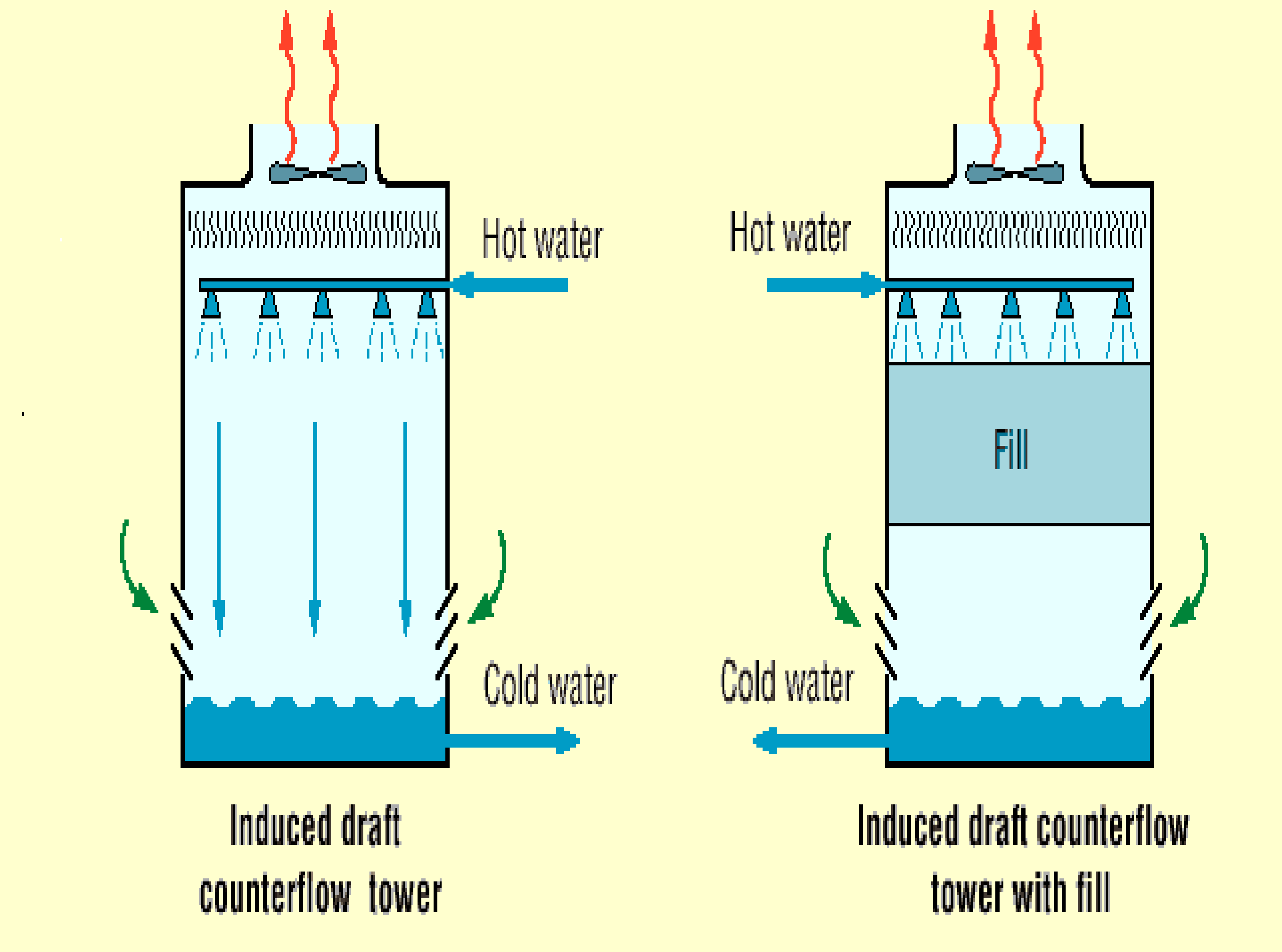
Mechanical draft towers are available in the following airflow arrangements:

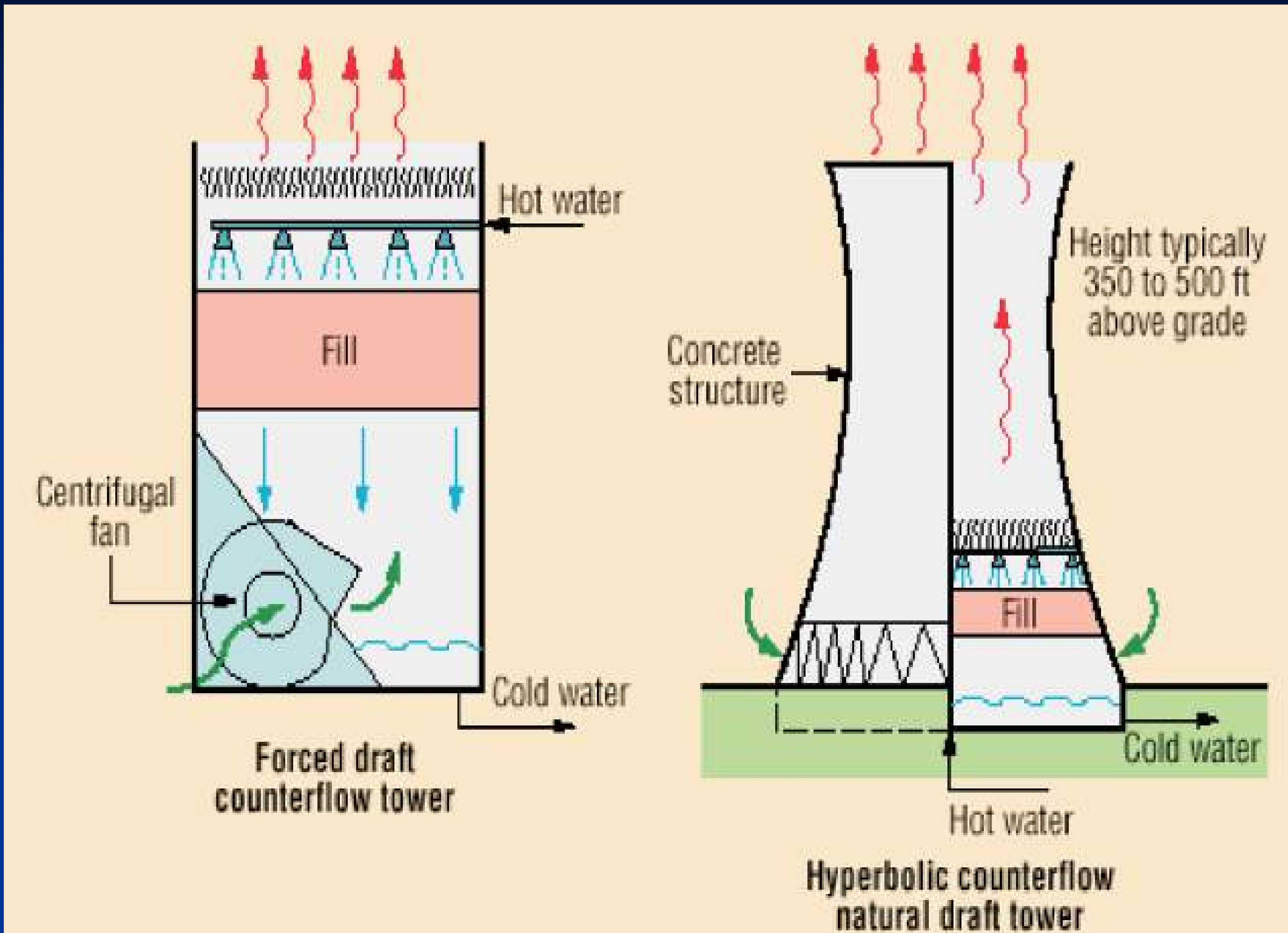
1. Counter flows induced draft.
2. Counter flow forced draft.
3. Cross flow induced draft.

- In the counter flow induced draft design, hot water enters at the top, while the air is introduced at the bottom and exits at the top. Both forced and induced draft fans are used.
- In cross flow induced draft towers, the water enters at the top and passes over the fill. The air, however, is introduced at the side either on one side (single-flow tower) or opposite sides (double-flow tower). An induced draft fan draws the air across the wetted fill and expels it through the top of the structure.

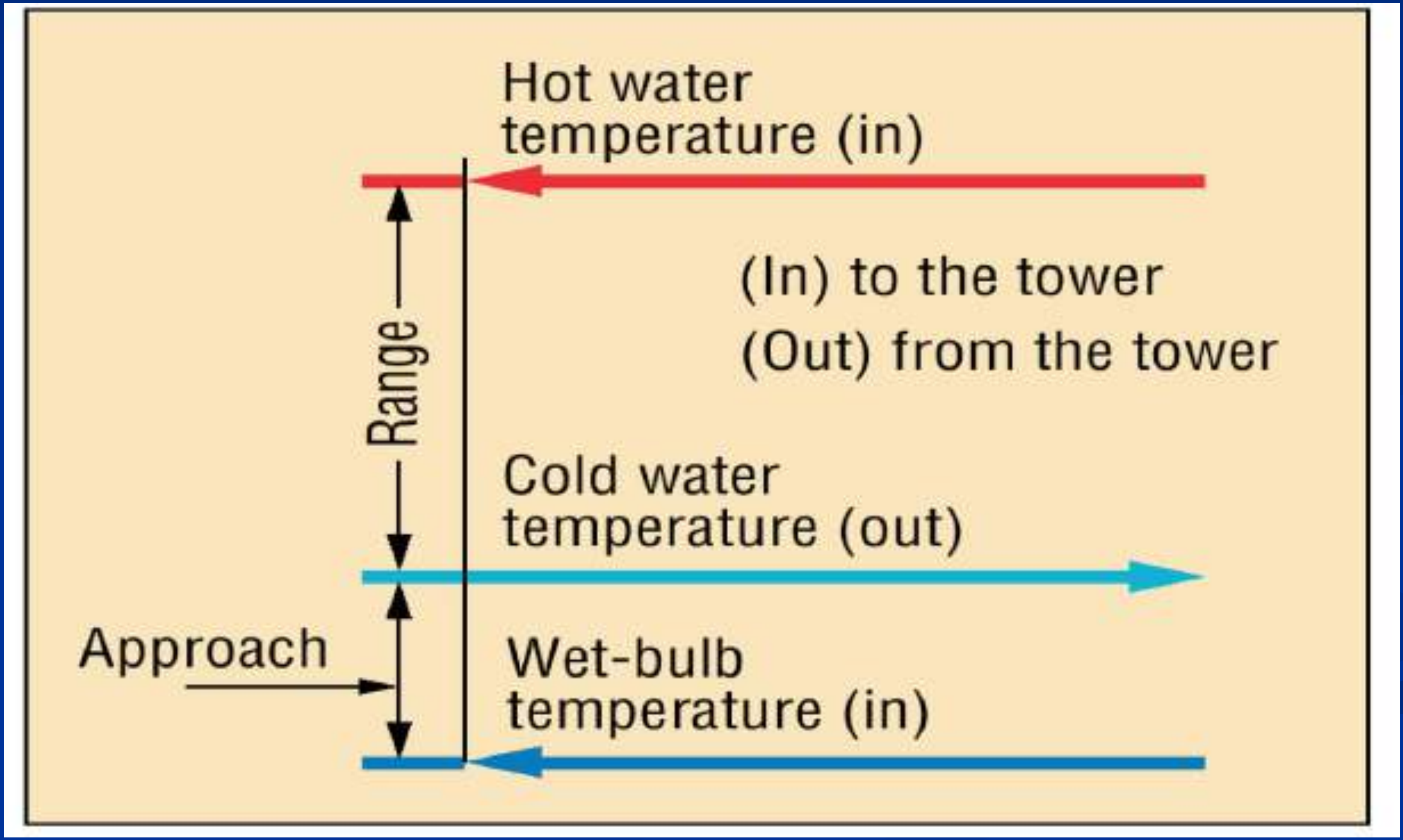


Induced draft, double-flow crossflow tower


Hot water
Cold water
Induced draft
counterflow tower
Hot water
Fill
Cold water
Induced draft counterflow
tower with fill


Hot water
Fill
Centrifugal
fan
Cold water
Forced draft
counterflow tower
Height typically
350 to 500 ft
above grade
Concrete
structure
Fill
Cold water
Hot water
Hyperbolic counterflow
natural draft tower

Cooling Tower Performance



The important parameters, from the point of determining the performance of cooling towers, are:

i) "Range" is the difference between the cooling tower water inlet and outlet temperature.

ii) "Approach" is the difference between the cooling tower outlet cold water temperature and ambient wet bulb temperature. Although, both range and approach should be monitored, the 'Approach' is a better indicator of cooling tower performance.

iii) Cooling tower effectiveness (in percentage) is the ratio of range, to the ideal range, i.e., difference between cooling water inlet temperature and ambient wet bulb temperature,

or in other words it is = Range / (Range + Approach).

iv) Cooling capacity is the heat rejected in kCal/hr, given as product of mass flow rate of water, specific heat and temperature difference.

v) Evaporation loss is the water quantity evaporated for cooling duty and, theoretically, for every 10,00,000 kCal heat rejected, evaporation quantity works out to 1.8 m3. An empirical relation used often is:

*Evaporation Loss (m3/hr) = 0.00085 x 1.8 x circulation rate (m3/hr) x (T1-T2)

T1-T2 = Temp. difference between inlet and outlet water.

Thank You