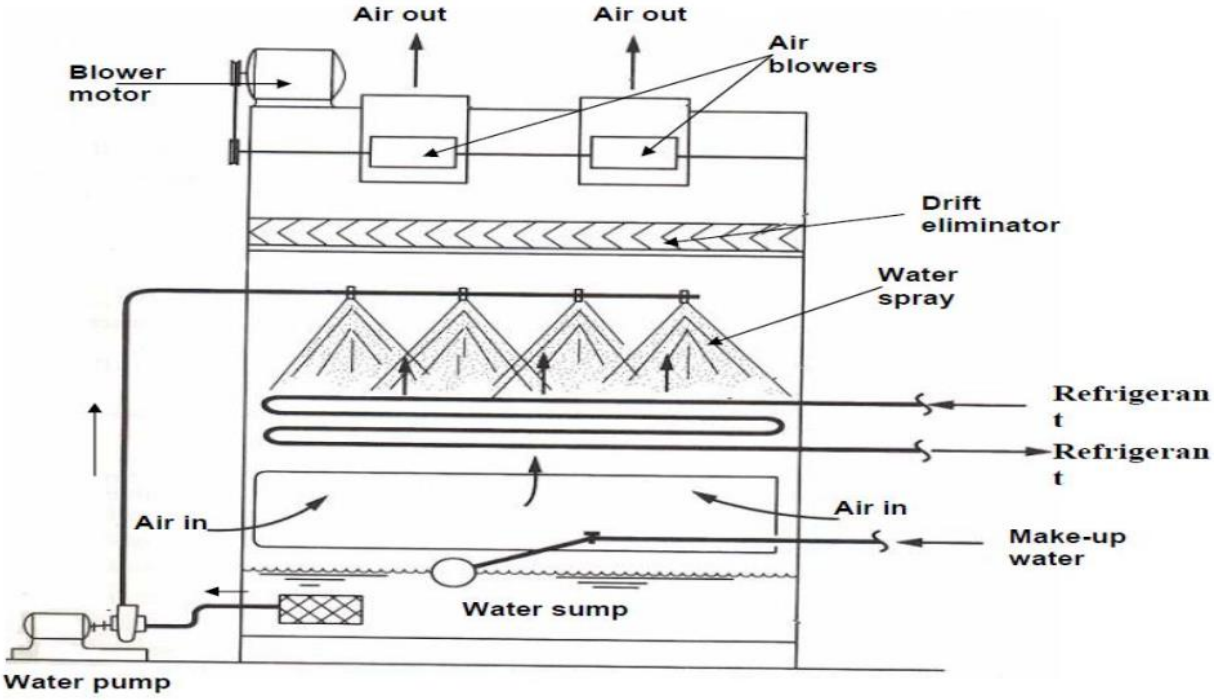
EVAPORATIVE CONDENSERS:

In evaporative condensers, both air and water are used to extract heat from the condensing refrigerant. Figure below shows the schematic of an evaporative condenser. Evaporative condensers combine the features of a cooling tower and water-cooled condenser in a single unit. In these condensers, the water is sprayed from top part on a bank of tubes carrying the refrigerant and air is induced upwards. There is a thin water film around the condenser tubes from which evaporative cooling takes place. The heat transfer coefficient for evaporative cooling is very large. Hence, the refrigeration system can be operated at low condensing temperatures (about 11 to 13 K above the wet bulb temperature of air). The water spray countercurrent to the airflow acts as cooling tower. The role of air is primarily to increase the rate of evaporation of water. The required air flow rates are in the range of 350 to 500 m^3 /h per TR of refrigeration capacity.



Schematic of an evaporative condenser

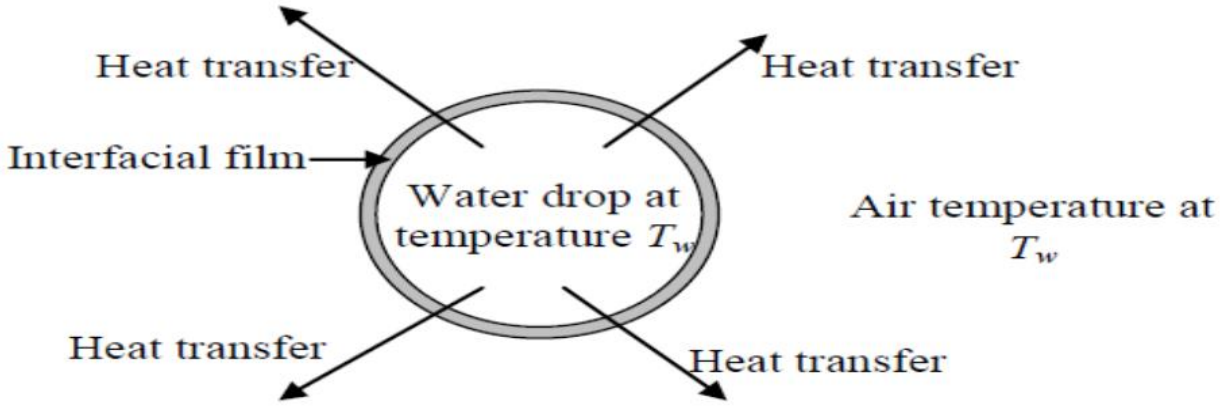
Evaporative condensers are used in medium to large capacity systems. These are normally cheaper compared to water cooled condensers, which require a separate cooling tower. Evaporative condensers are used in places where water is scarce. Since water is used in a closed loop, only a small part of the water evaporates. Make-up water is supplied to take care of the evaporative loss. The water consumption is typically very low, about 5 percent of an equivalent water cooled condenser with a cooling tower. However, since condenser has to be kept outside, this type of condenser requires a longer length of refrigerant tubing, which calls for larger refrigerant inventory and higher pressure drops. Since the condenser is kept outside, to prevent the water from freezing, when outside temperatures are very low, a

heater is placed in the water tank. When outside temperatures are very low it is possible to switch-off the water pump and run only the blowers, so that the condenser acts as an air cooled condenser.

Another simple form of condenser used normally in older type cold storages is called as atmospheric condenser. The principle of the atmospheric condenser is similar to evaporative condenser, with a difference that the air flow over the condenser takes place by natural means as no fans or blowers are used. A spray system sprays water over condenser tubes. Heat transfer outside the tubes takes by both sensible cooling and evaporation, as a result the external heat transfer coefficient is relatively large. The condenser pipes are normally large, and they can be either horizontal or vertical. Though these condensers are effective and economical they are being replaced with other types of condensers due to the problems such as algae formation on condenser tubes, uncertainity due to external air circulation etc.

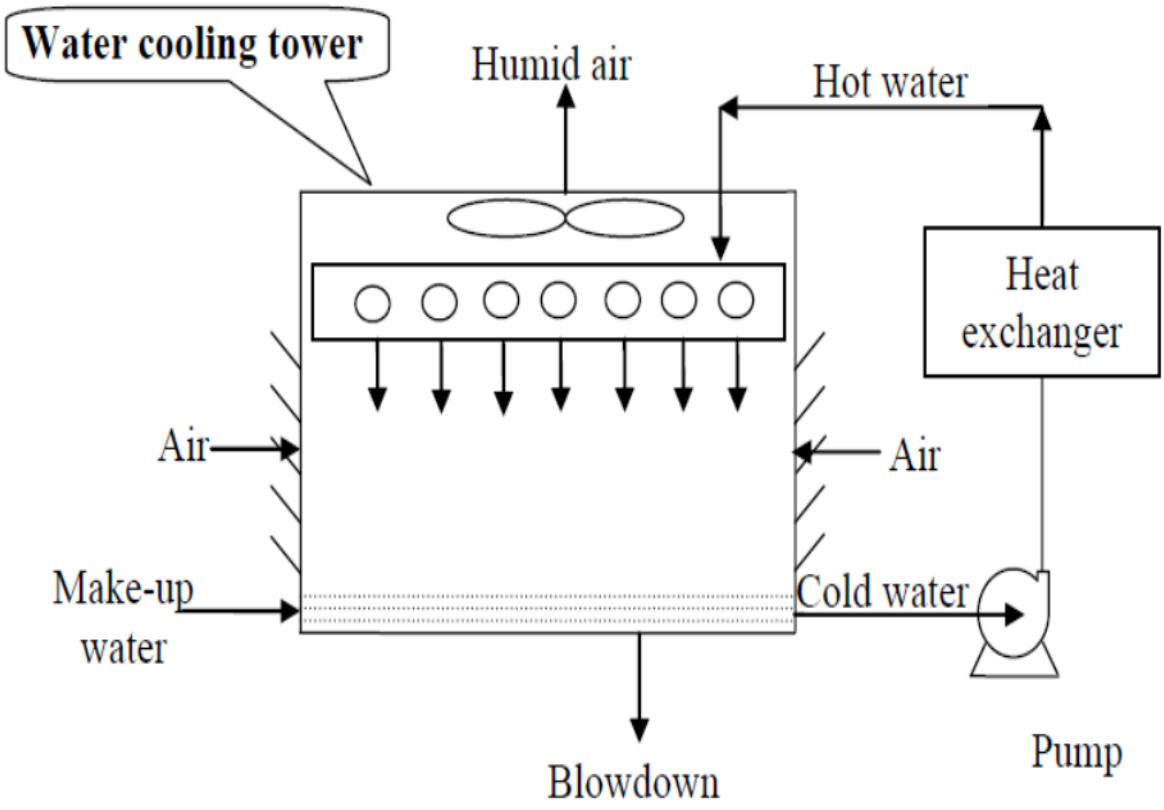
COOLING TOWER PRINCIPLE AND OPERATION

A cooling tower is a special type of heat exchanger in which the warm water and the air are brought in direct contact for '***evaporative cooling'***. It provides a very good contact of air and water in terms of the contact area and mass transfer co-efficient of water vapor while keeping air pressure drop low. Enthalpy of air is lower than enthalpy of water. Sensible heat and latent heat transfer take place from water drop to surrounding air. Schematic of heat transfer from water drop to surrounding air is presented in Figure below



Schematic of heat transfer from water drop to surrounding air.

Thus, cooling is accomplished by sensible heat transfer from water to air and evaporation of a small portion of water. A generalized cooling tower system is shown in Figure below . The hot water which is coming from heat exchanger is sprayed at the top of the cooling tower. Air enters through the louvers at the two opposite walls of the cooling tower. During cooling process of water, around 2% water is evaporated. Make water is used to compensate the water loss due to evaporation. Blowdown is there to drain a part of water containing solid deposit. The exit cold water from the cooling tower is used in the heat exchanger or other unit operation.



Generalized cooling tower system.

Factors govern the operation of cooling tower

i. The dry-bulb and wet-bulb temperatures of air

ii. Temperature of warm water

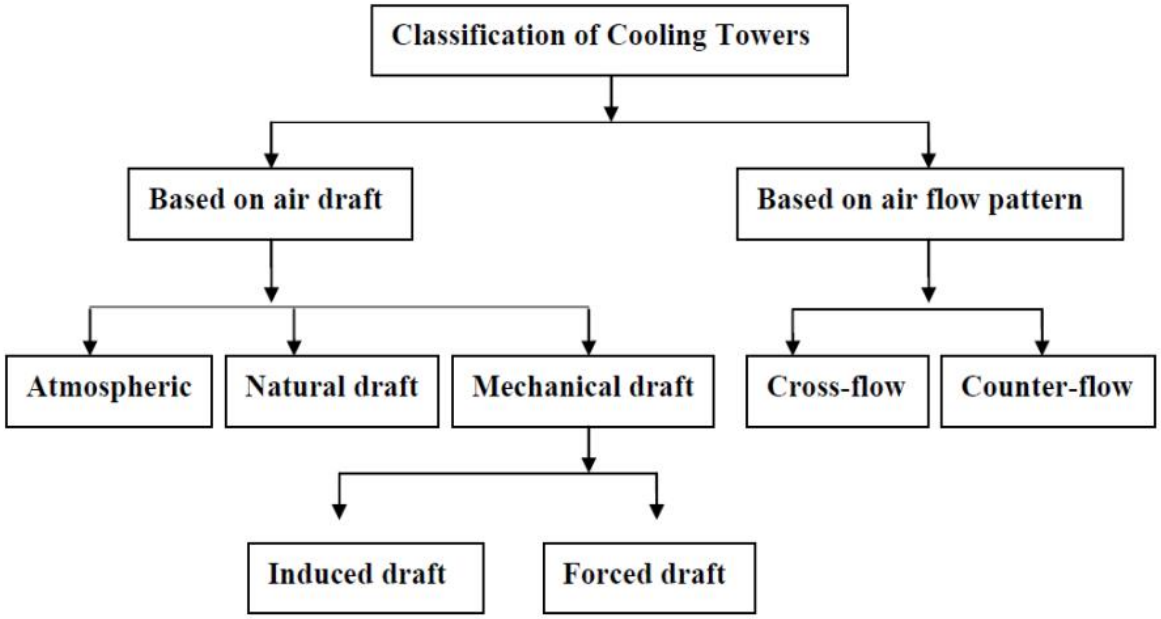
iii. The efficiency of contact between air and water in terms of volumetric mass transfer coefficient ( ) a k y/

iv. Contact time between air and water

v. The uniformity of the distribution of the phases within the tower

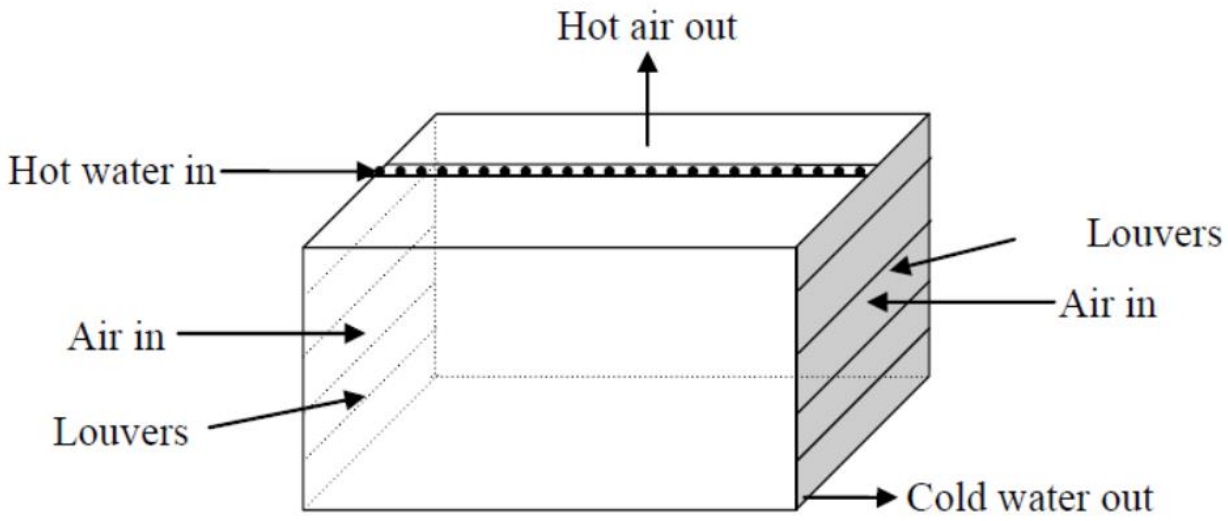
vi. Air pressure drop

vii. Desired temperature of cooled water



Atmospheric Towers

It is a big rectangular chamber with two opposite 'louvered' walls. Tower is packed with a suitable 'tower fill'. Atmospheric air enters the tower through louvers driven by its own velocity. Direction and velocity of wind greatly influence its performance. Figure below shows the schematic of the atmospheric cooling tower.



Schematic of atmospheric cooling tower.

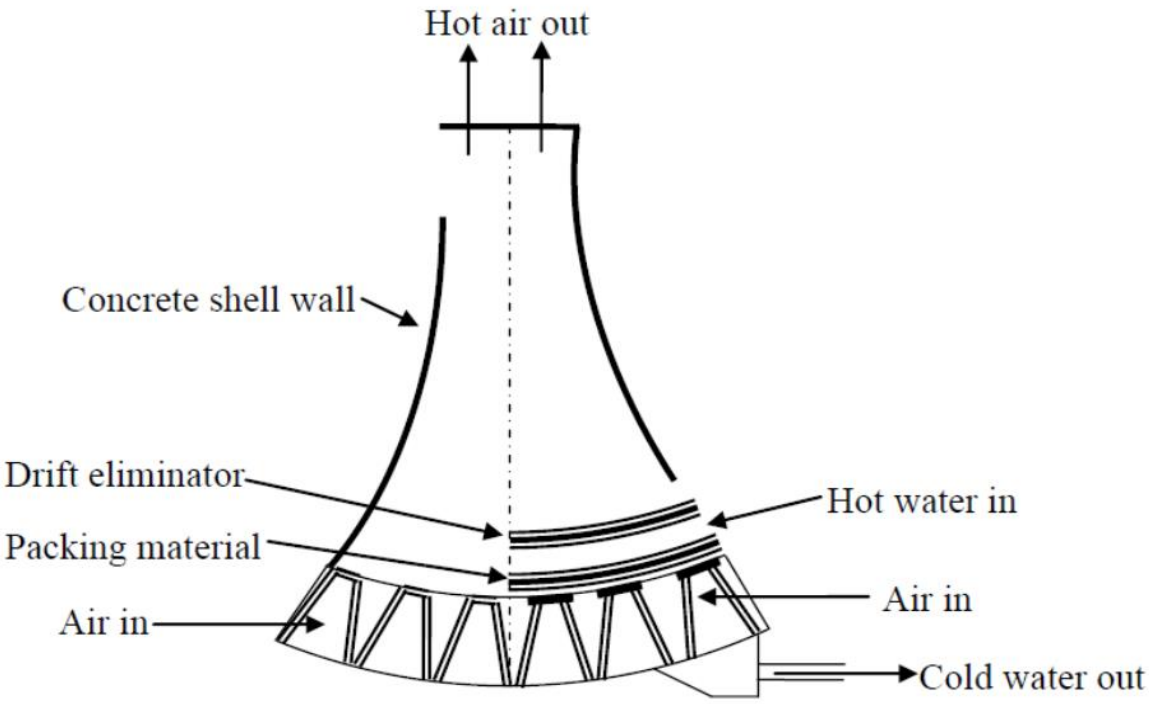
Natural Draft Towers

A natural draft cooling tower has a large reinforced concrete shell of hyperbolic shape (also called 'hyperbolic tower'). Natural flow of air occurs through the tower; hence it is called natural draft . ***Factors responsible for creating natural draft***

(a) A rise in temperature and humidity of air in the column reduces its density

(b) Wind velocity at the tower bottom

Fan is used to enhance the air flow rate in fan assisted natural draft tower. The typical diameter of tower is 150 m and capacity is 5,00,000 gallon/minute.



Schematic of natural draft tower.

HEAT PUMPS

Heat flows naturally from a higher to a lower temperature. Heat pumps reverse this natural flow, extracting heat energy from a cool source, such as the ground, and delivering it to a hot system, such as a building's heating system. In the same way that a fridge uses refrigerant to extract heat from the inside, keeping your food cool, a heat pump extracts heat from a range for sources, and uses it to heat your home and hot water An ideal heat source for a heat pump has a high stable temperature during the heating season. Ground source, water source and air source are common in the domestic setting.

The gas in the refrigeration circuit inside the heat pump has an extremely low boiling temperature. So when the liquid comes in from the garden circuit, that liquid transfers its heat to the colder liquid refrigerant in the evaporator. This causes the refrigerant to turn to vapour and passes upwards to the compressor. Electricity is used to drive the compressor . It squashes the vapour and this increases its temperature, as increasing the pressure raises the temperature. The vapour then moves onwards to the condenser heat exchanger. Water coming from the building's heat distribution system passes up the other side of the heat exchanger and this water absorbs the heat from the refrigerant coming from the compressor. The refrigerant condenses back to liquid form like steam on a window It passes through an extremely small opening in the throttling device and undergoes a large drop in pressure with an associated drop in temperature. This cold liquid is let into the bottom of the evaporator heat exchanger where the whole process is repeated. The key to any heat pump is that the energy required to concentrate (make it useful) is less than the energy required to provide the heat directly.

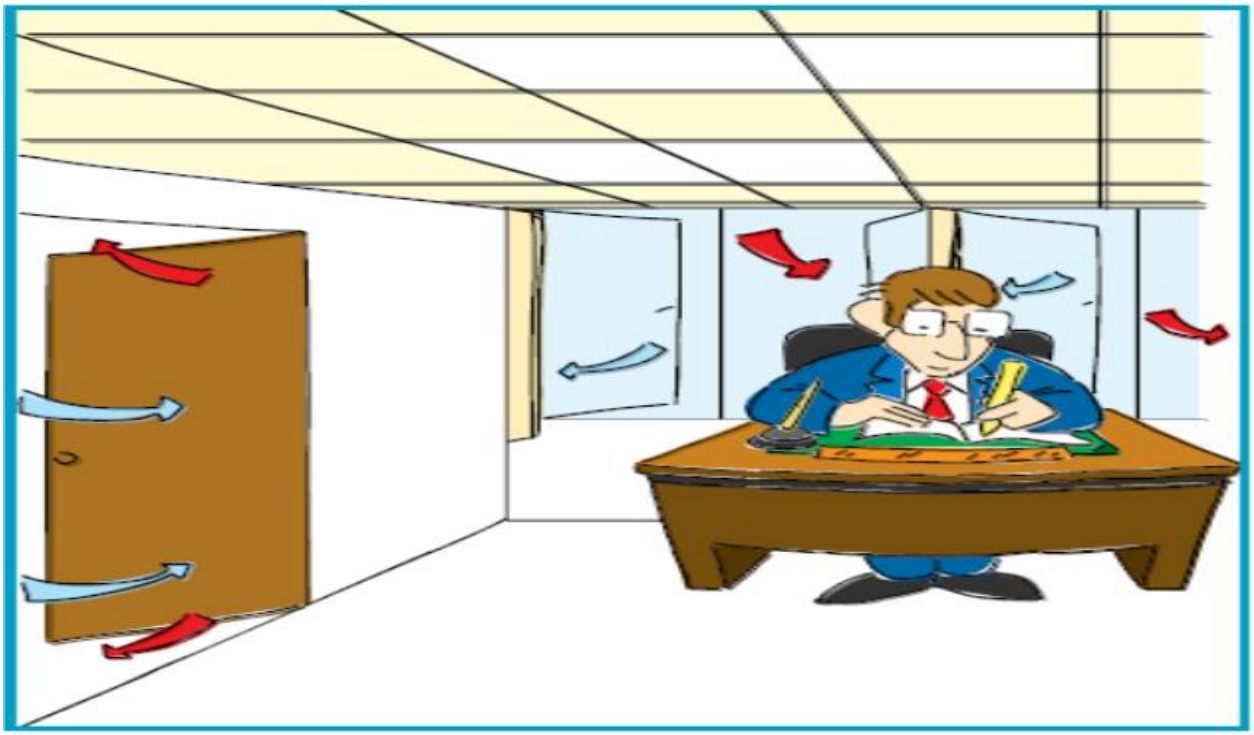
AIR BLOWING

Air blowing of natural gas and/or steam lines is a service that uses compressed oil free air. A quick opening valve is used to rapidly release the pressure to atmosphere. High and Low set-points are determined by the system being cleaned. CCT can also provide a pneumatic target inserter to eliminate the use of a manual target bar. Targets can be made out of any metal desired and in any length to accommodate different line sizes. Air Blows have been accepted across the country as a safe alternative to using natural gas to clean fuel supply lines to CTG's and Boilers. Air Blows on steam lines have the economic impact of no water consumption and fuel cost.

VENTILATION

Ventilation is the process of supplying and removing air by natural or mechanical means to and from a building. The design of a building's ventilation system should meet the minimum requirements of the Building (Ventilating Systems) Regulations.

"Natural ventilation" covers uncontrolled inward air leakage through cracks, windows, doorways and vents (infiltration) as well as air leaving a room (exfiltration) through the same routes. Natural ventilation is strongly affected by weather conditions and is often unreliable.



Natural Ventilation

Mechanical or forced ventilation is provided by air movers or fans in the wall, roof or air-conditioning system of a building. It promotes the supply or exhaust air flow in a controllable manner

Mechanical Ventilation

Purposes of Ventilation

Ventilation in a building serves to provide fresh and clean air, to maintain a thermally comfortable work environment, and to remove or dilute airborne contaminants in order to prevent their accumulation in the air. Air-conditioning is a common type of ventilation system in modern office buildings. It draws in outside air and after filtration, heating or cooling and humidification, circulates it throughout the building. A small portion of the return air is expelled to the outside environment to control the level of indoor air contaminants. The efficiency of a ventilation system can be evaluated through investigation of environmental factors such as the quality of supply air, the thermal comfort conditions of the occupied space and the level of airborne contaminants therein.