Vapour Absorption Refrigeration System

The vapour absorption refrigeration system consists of:

- **Absorber**: Absorption of refrigerant vapour by a suitable absorbent or adsorbent, forming a strong or rich solution of the refrigerant in the absorbent/adsorbent.

- **Pump**: Pumping of the rich solution and raising its pressure to the pressure of the condenser.

- **Generator**: Distillation of the vapour from the rich solution leaving the poor solution for Recycling
The absorption chiller is a machine, which produces chilled water by using heat such as steam, hot water, gas, oil etc. Chilled water is produced based on the principle that liquid (i.e. refrigerant, which evaporates at a low temperature) absorbs heat from its surroundings when it evaporates. Pure water is used as refrigerant and lithium bromide solution is used as absorbent.

Heat for the vapour absorption refrigeration system can be provided by waste heat extracted from the process, diesel generator sets etc. In that case absorption systems require electricity for running pumps only. Depending on the temperature required and the power cost, it may even be economical to generate heat / steam to operate the absorption system.
Evaporator

The refrigerant (water) evaporates at around 4°C under a high vacuum condition of 754 mm Hg in the evaporator. Chilled water goes through heat exchanger tubes in the evaporator and transfers heat to the evaporated refrigerant.

The evaporated refrigerant (vapor) turns into liquid again, while the latent heat from this vaporization process cools the chilled water (in the diagram from 12 °C to 7 °C). The chilled water is then used for cooling purposes.

Absorber

In order to keep evaporating, the refrigerant vapor must be discharged from the evaporator and refrigerant (water) must be supplied. The refrigerant vapor is absorbed into lithium bromide solution, which is convenient to absorb the refrigerant vapor in the absorber. The heat generated in the absorption process is continuously removed from the system by cooling water. The absorption also maintains the vacuum inside the evaporator.
High Pressure Generator

As lithium bromide solution is diluted, the ability to absorb the refrigerant vapor reduces. In order to keep the absorption process going, the diluted lithium bromide solution must be concentrated again. An absorption chiller is provided with a solution concentrating system, called a generator. Heating media such as steam, hot water, gas or oil perform the function of concentrating solutions. The concentrated solution is returned to the absorber to absorb refrigerant vapor again.
Condenser

To complete the refrigeration cycle, and thereby ensuring the refrigeration takes place continuously, the following two functions are required:

1. To concentrate and liquefy the evaporated refrigerant vapor, which is generated in the high pressure generator.
2. To supply the condensed water to the evaporator as refrigerant (water)

For these two functions a condenser is installed.

Absorption refrigeration systems that use Li-Br-water as a refrigerant have a Coefficient of Performance (COP) in the range of 0.65 - 0.70 and can provide chilled water at 6.7 °C with a cooling water temperature of 30 °C. Systems capable of providing chilled water at 3 °C are also available. Ammonia based systems operate at above atmospheric pressures and are capable of low temperature operation (below 0°C). Absorption machines are available with capacities in the range of 10-1500 tons. Although the initial cost of an absorption system is higher than that of a compression system, operational costs are much lower if waste heat is used.

Evaporative cooling in vapor absorption refrigeration systems

There are occasions where air conditioning, which stipulates control of humidity of up to 50% for human comfort or for processes, can be replaced by a much cheaper and less energy intensive evaporative cooling.
The concept is very simple and is the same as that used in a cooling tower. Air is brought in close contact with water to cool it to a temperature close to the wet bulb temperature. The cool air can be used for comfort or process cooling. The disadvantage is that the air is rich in moisture. Nevertheless, it is an extremely efficient means of cooling at very low cost. Large commercial systems employ cellulose filled pads over which water is sprayed. The temperature can be controlled by controlling the airflow and the water circulation rate. The possibility of evaporative cooling is especially attractive for comfort cooling in dry regions. This principle is practiced in textile industries for certain processes.