1.5.8 Vapor Absorption Chiller

How Vapor Absorption Chiller works?

The thermodynamic cycle of an absorption chiller is driven by a heat source; this heat is usually delivered to the chiller via steam, hot water, or combustion. Compared to electrically powered chillers, an absorption chiller has very low electrical power requirements – very rarely above 15 kW combined consumption for both the solution pump and the refrigerant pump.

Figure 31: Vapor Absorption Chiller

The single-effect absorption cycle uses water as the refrigerant and lithium bromide as the absorbent. It is the strong affinity that these two substances have for one another that makes the cycle work. The entire process occurs in almost a complete vacuum.

1. Solution Pump : A dilute lithium bromide solution (60% concentration) is collected in the bottom of the absorber shell. From here, a hermetic solution pump moves the solution through a shell and tube heat exchanger for preheating.
2. Generator : After exiting the heat exchanger, the dilute solution moves into the upper shell. The solution surrounds a bundle of tubes which carries either steam or hot water. The steam or hot water transfers heat into the pool of dilute lithium bromide solution. The solution boils, sending refrigerant vapor upward into the condenser and leaving behind concentrated lithium bromide. The concentrated lithium bromide solution moves down to the heat exchanger, where it is cooled by the weak solution being pumped up to the generator.
3. Condenser : The refrigerant vapor migrates through mist eliminators to the condenser tube bundle. The refrigerant vapor condenses on the tubes. The heat is removed by the cooling water which moves through the inside of the tubes. As the refrigerant condenses, it collects in a trough at the bottom of the condenser.
4. Evaporator : The refrigerant liquid moves from the condenser in the upper shell down to the evaporator in the lower shell and is sprayed over the evaporator tube bundle. Due to the extreme vacuum of the lower shell [6 mm Hg (0.8 kPa) absolute

pressure], the refrigerant liquid boils at approximately 39 °F (4 °C), creating the refrigerant effect. (This vacuum is created by hygroscopic action – the strong affinity lithium bromide has for water – in the Absorber directly below.)

5. Absorber : As the refrigerant vapor migrates to the absorber from the evaporator, the strong lithium bromide solution from the generator is sprayed over the top of the absorber tube bundle. The strong lithium bromide solution actually pulls the refrigerant vapor into solution, creating the extreme vacuum in the evaporator. The absorption of the refrigerant vapor into the lithium bromide solution also generates heat which is removed by the cooling water. Now the dilute lithium bromide solution collects in the bottom of the lower shell, where it flows down to the solution pump. The chilling cycle is now completed and the process begins once again.

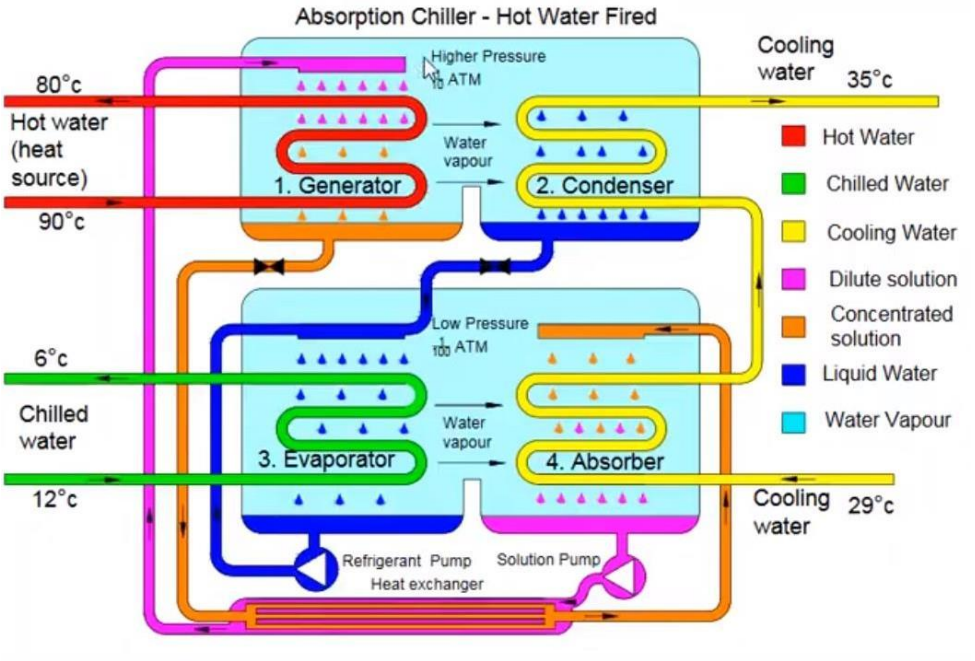

Figure 32: Vapor Absorption Chiller

Pros and Cons of Absorption Chiller:

The primary advantage of absorption chillers is lower electricity costs. Costs can be even further decreased if natural gas is available at a low price or if we can utilize a source of low grade heat that is otherwise wasted in a plant.

Two basic disadvantages of absorption chillers are their size - weight, as well as their requirement for larger cooling towers. Absorption chillers are larger and heavier compared to electric chillers of the same capacity.