



What is airconditioning?

Airconditioning is defined as a process which cools (or heats), cleans, circulates, freshens air and controls its moisture content simultaneously.

Most often airconditioning is about removing heat. Now that we have defined airconditioning let us get to know the nature of 'Heat'. There are two types of 'Heat': Sensible Heat and Latent Heat.

'Sensible Heat' is any heat that raises the temperature but not the moisture content of the substance. This is our regular and familiar every day heat. Because it raises the temperature it can be detected by the senses, and this in fact, is why it is called Sensible Heat.

'Latent Heat' is the tricky one. When we talk of Latent Heat we mean 'Latent Heat of Vaporisation'. It is that *heat required to transform a liquid to vapour*. Take water for example. Water can be heated to its boiling point of 100°C. If more heat is added at this point the temperature of the water does not increase. The water continues to boil and becomes steam. So where does all the heat go? Well, the heat goes into changing the water into steam. The latent heat of vaporisation in this instance is the heat required to change water from liquid at 100°C to vapour at the same temperature.

Latent heat plays an important part in Refrigeration and Airconditioning. It explains the principle of refrigeration and also is a component of **Heat Load**, of which we will learn more along the way. Human beings generate Latent Heat by way of moisture (perspiration) on their skin. This perspiration requires to be dried, therefore a change of its state from liquid to vapour



is required. Fresh air which is added into the air system, very often brings in plenty of moisture with it. Removal of this additional moisture also involves latent heat removal.

A portion of the airconditioning heat load is therefore in the form of latent heat. For example in an office 10% of the airconditioning heat load could be in the form of Latent Heat. This goes up to around 25% in a restaurant and around 33% in a movie theatre.

How is cooling made possible?

Now that we have discussed “Heat” let us talk about the principle at work in airconditioning. The core concept to understand is **Evaporation**. Remember how cold your skin felt when dabbed by liquid spirit at a doctor’s clinic before an injection? It felt cold because the spirit evaporated (changed from liquid state to the vapour state) very rapidly. And when it evaporated it needed heat to change its state. Where did this heat come from? It came from the liquid itself, and your skin, with which it was in contact.

* A refrigerant is a gas with special characteristics that make it suitable for Refrigeration. It is possible to liquefy it even in ambient temperatures when the pressure is raised. R-22 is the most commonly used refrigerant in airconditioning. Recent studies indicate that Refrigerants when leaked into the atmosphere cause damage to the **ozone layer**. By international consensus today’s refrigerants may be replaced by new ozone friendly refrigerants over the next three or four decades.

In the refrigeration cycle this principle is put to work by causing a liquid **Refrigerant*** to evaporate in a cooling coil (evaporator). This refrigerant is a specially chosen substance which has the property of evaporation at very low temperatures. (For example, the commonly used refrigerant, R-22, would start evaporating at -40°C even under normal atmospheric pressure). The cooling coil, in which the refrigerant evaporates, is in contact with the air (or water in chilled water systems) surrounding it, thereby cooling that as well. Once cooled, this air (or water) is then directed to the spaces which require cooling.

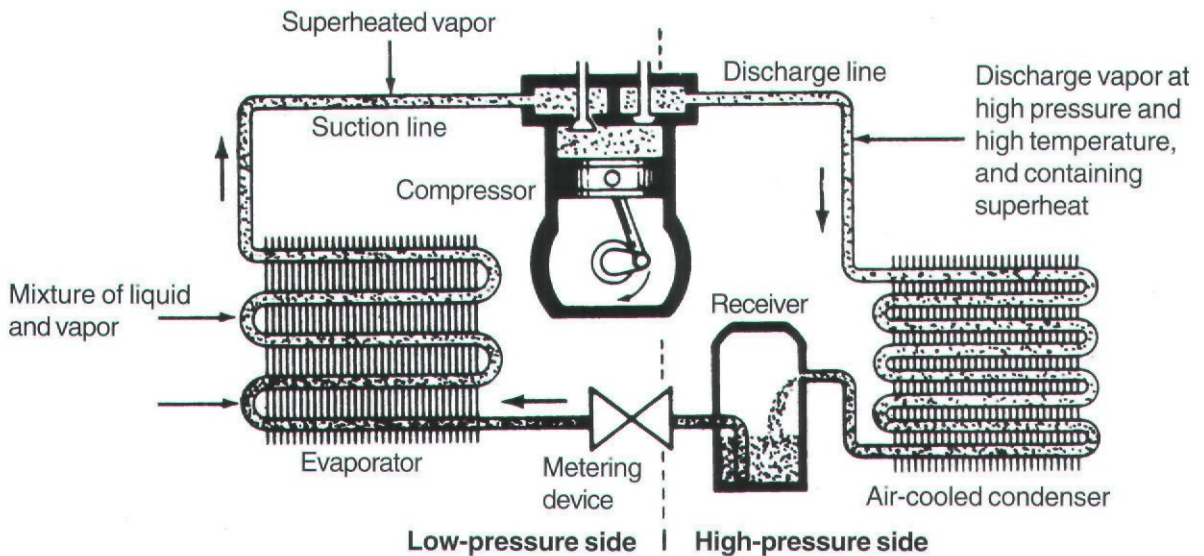


Fig. 1. The refrigeration cycle

Equipment used to produce cooling: Now that we have seen the process by which cooling takes place, and examined the nature of heat and humidity, let us briefly look at the main equipment used to produce the effects we require.

The Compressor: Under atmospheric temperature and pressure the refrigerant is in gaseous form. We learnt that the cooling takes place when liquids evaporate to become gas. Therefore we must first transform the refrigerant gas into the liquid form. Most gasses can be made into the liquid form by raising its pressure (and cooling it, which is handled by the condenser). The equipment that increases the pressure of the gas by compressing it, is called the Compressor.

The Condenser: During compression however the refrigerant becomes hot. This is because of two reasons:



- a) Because of the work done on it (remember how warm the hand pump became when pumping air into your bicycle tyres?) and
- b) Because the refrigerant is converted from gas to liquid releasing its latent heat

This heat has to be removed to enable the gas to condense into a liquid easily. The equipment that removes the heat is called the Condenser.

The Evaporator : From the condenser we now have the liquid refrigerant ready to go to work. This refrigerant can remove heat when it starts evaporating. The liquid refrigerant from the condenser is injected through a **metering device*** called the capillary or expansion valve into the cooling coil which is a bundle of tubes.

Inside the cooling coil the pressure is low, because of the metering/throttling device on one side and the compressor suction on the other side. In the low pressure, the liquid refrigerant starts evaporating rapidly. While evaporating it needs sensible heat to transform itself from the liquid to the gas state. So it soaks up heat from the surrounding tubes, and from the air, with which the tubes are in contact. This is what causes the cooling.

* A Metering Device (also called a throttling device) is either a capillary tube or an expansion valve. These devices allow a metered quantity of refrigerant to flow into the Evaporator. Too much refrigerant floods the evaporator and too little starves it of refrigerant. Only the right quantity of refrigerant introduced into the evaporator produces the best cooling.

End of cycle and beginning of the next one: Having done this, the refrigerant is back into the gaseous form. It is sucked into the compressor where it will be compressed again for the next refrigeration cycle.