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Science Rules

August 2016

This Cool Stuff outlines the rules of science which explain how a vapour compression refrigeration system works. If you know these, then understanding how a refrigeration system operates is simple!

The Rules

1. Heat only travels from hot to cold.

   Or from cold to even colder – it's all relative!

2. In order to boil or evaporate, a liquid must absorb heat.

   Boiling or evaporating is a change of state – from a liquid into a gas. It takes a lot of energy to change state.

3. In order to condense, a gas must lose (reject) heat.

   Condensing (or liquefying) is also a change of state – from a gas into a liquid. To do this the substance must lose a lot of heat.

4. The temperature at which a substance evaporates or condenses depends on pressure: the higher the pressure the higher the temperature.

   The temperature at which a substance changes state is called the saturation temperature (and sometimes the boiling point).

5. Different substances have different temperature / pressure relationships.

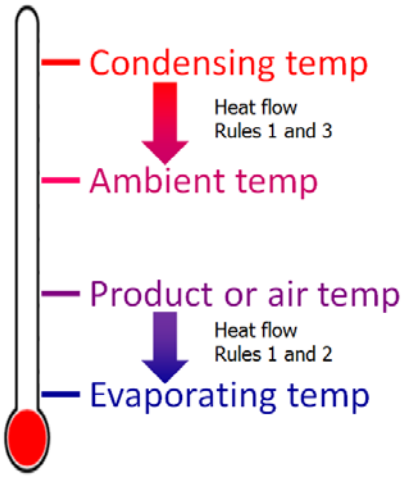
   Substances which make good refrigerants usually have saturation temperatures of about -40^{O}C at atmospheric pressure. Water has a saturation temperature of 100^{O}C at atmospheric pressure so is not an ideal refrigerant!

Applying the Rules

The required product temperature is lower than ambient (otherwise you don't need refrigeration!).

The refrigerant evaporates at a lower temperature than the product or air. So heat is removed, making the product or air cooler.

The refrigerant condenses above the ambient temperature, so that the heat absorbed when it evaporated is rejected into the air. This heat loss causes the refrigerant to condense.

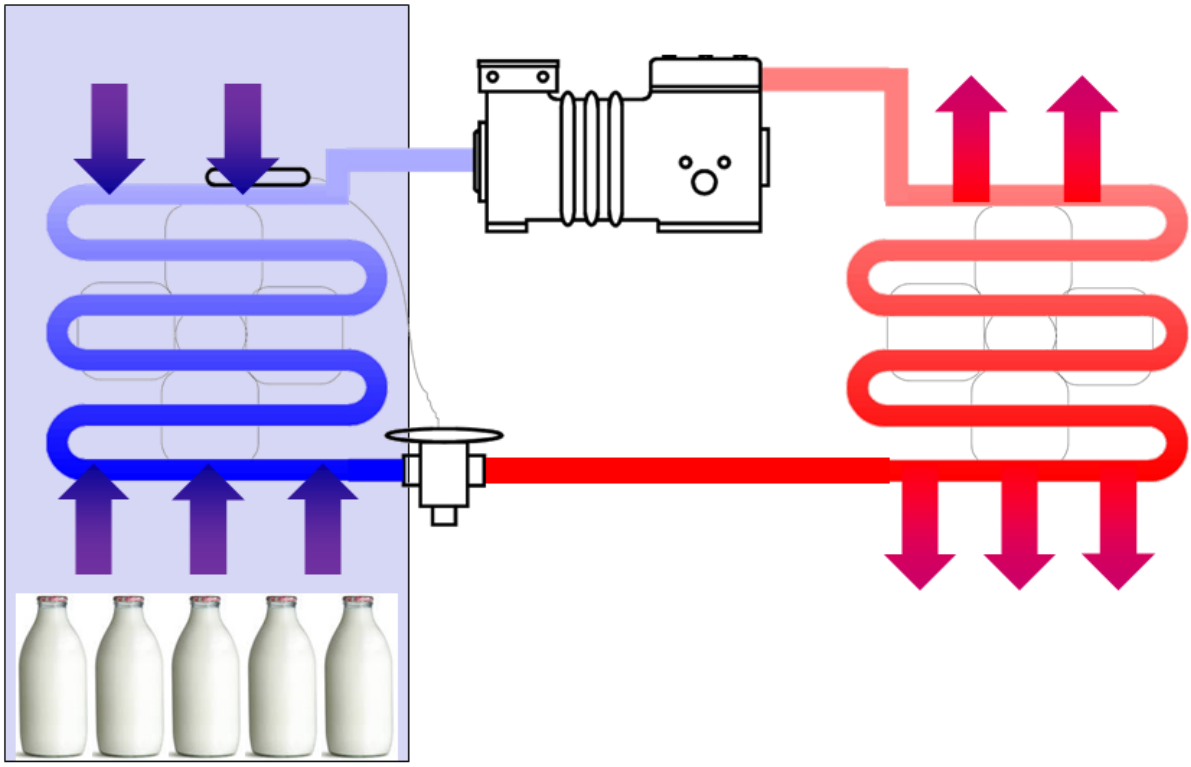


Cool Stuff from Cool Concerns

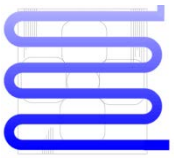
Vapour Compression Refrigeration / Air Conditioning System

Always remember – we make things colder by moving heat around, not by generating cold!

In the system we usually cool air (which then cools us or a product) and we reject heat to ambient air outside. The system works the same if it is cooling a liquid and / or rejecting heat to water.

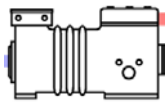


Evaporator



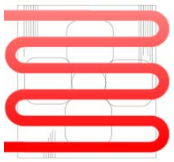
The refrigerant evaporates at a lower temperature than the air in the cooled space. The refrigerant absorbs heat from the air, so the air gets cooler.

Compressor



The refrigerant's pressure is increased by the compressor so that its saturation temperature is higher. It needs to be higher so that it can condense at a higher temperature than ambient air.

Condenser



The refrigerant is at high pressure & temperature entering the condenser so it condenses by rejecting heat to ambient air.

Expansion device

The expansion device drops the pressure of the refrigerant so that its saturation temperature is lower than the air temperature in the cooled space.