<u>A simple Refrigeration system explained.</u>

We have already discussed how energy can be neither created nor destroyed. Just moved around, from one thing to another, or have its 'state' changed from one type to another. Electrical energy to heat for example. Mechanical energy to electrical for another.

We also looked at how far more energy is involved in changing the state of a material, by adding heat energy to a liquid to change it into a gas or removing heat energy from a gas to change it into a liquid than is involved in changing that material's 'Sensible' temperature.

Understanding this basic principle, a law of physics, means that most of the principle of cooling and hence refrigeration is understood.

A liquid which is constrained in a tube is heated in a defined, closed space. It is heated using the objects and air surrounding those objects until it changes its state to become a gas. This gas is then directed through a tube to a compressor which reduces its volume (the amount of space the gas occupies). Compressing the gas means that the amount of energy in the gas, having nowhere else to go, causes the temperature of the gas to rise. Some of the energy required by the compressor to compress the gas also gets added, also in the form of heat. This is an unwelcome consequence in the system described but one that unfortunately is unavoidable.

The hot, compressed gas, now under high pressure is directed to a mechanical device called a condenser. The gas enters the condenser at a temperature far higher than the ambient air temperature in which the condenser is located. The relatively cooler ambient air is directed over the condenser tubes containing the hot compressed gas and because heat energy can only flow in one direction, that is from a hotter to a cooler material or medium then the hot gas is cooled down. The gas is cooled down to the point where it can no longer exist in the state of being a gas and thus condenses to become a liquid. This forces the gas to give up large amounts of latent heat which is given up to the ambient air passing through the condenser.

The liquid, known as a liquid refrigerant, is then directed, still under pressure, in its closed circuit tube system, back to the space to be cooled.

The refrigerant liquid is fed through a constricting device, often a thermostatically controlled valve but sometimes nothing more complicated than a constricted or narrowing of the pipe it is in, to a mechanical device called an evaporator. Also popularly known as a cooler or a unit cooler.

On the evaporator side of the constriction or controlling valve (thermostatic expansion valve) the constraining pressure on the liquid is released. Thus allowing the liquid to adopt its preferred state as a gas under the new pressure condition it has been led to. The liquid can only change back to a gas however by absorbing large amounts of energy from the nearest available source. This energy source is the air in the space to be cooled. The air itself in the space to be cooled having gained its heat energy from the objects in that space. Commonly perishable products such as food, plus the construction materials of the cooled space (cold room or freezer room), along with other sources such as occasionally through ambient air entering during door openings, from the skin and respiration of personnel that enter, from electrical lights and even electrically driven fans needed to move the air over the surfaces of the evaporator.

The refrigerant is thus circulated endlessly in a continuous cycle. The compressor also acting as the circulating pump. Heat energy is thus continuously removed from the space to be cooled, or refrigerated, and led to be expelled to ambient air, or, in some modern energy efficient systems, to be recovered as a heat source for other processes such as water heating.

To summarise.

Refrigerant, at a temperature whereby it can only exist in a liquid state when constrained in a closed pipe system at relatively high pressure, is fed into a stage of the closed pipe system which is at lower pressure. Thus causing the liquid refrigerant to evaporate into a gaseous state. In order to expand into a gaseous state the refrigerant must absorb heat energy and it achieves this by taking heat from air that is forced by fans through branches of tubes that form a mechanical device called an evaporator. Thus reducing the temperature of that air.

The low pressure gas continues in the pipe circuit where it is led to a compressor. The compressor compresses the gas so that it becomes far denser and thus occupying a smaller volume. As a result of compression the constant amount of heat the gas contains forces the temperature of the gas to rise.

Further, additional heat is added by the compressor due to the work of compression done by it. This is described as 'work heat' and is a result of both friction of the moving parts of the mechanical components of the compressor and, in some designs of compressor, some or all of the electrical energy used to drive the compressor and which is converted to heat energy.

The high pressure refrigerant gas, now denser and hotter than it was prior to compression, is fed to a condenser. Air at a lower temperature than the hot gas is forced through the condenser and over the gas which is fed through branches of tubes that form the condenser.

The process of cooling the refrigerant gas causes it to give up both the work heat energy that had been added by the compressor and also the Latent heat which has maintained the refrigerant in a gaseous state. The refrigerant gas thus condenses into its liquid state also under the same high pressure.

The high pressure refrigerant liquid continues in the circuit again to reach the lower pressure stage of the pipe circuit as described in the first paragraph above. And so the process continues as a constant uninterrupted flow of the refrigerant. A cycle which effectively absorbs heat energy from one part of the system, (the low pressure side) and then ejects that heat energy through another part of the system (the high pressure side).