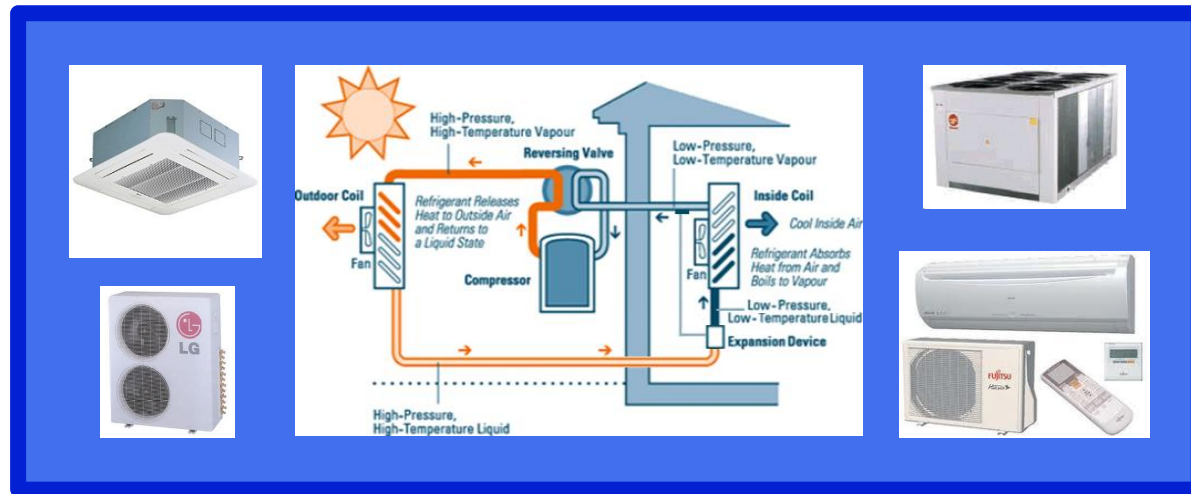


The Refrigeration Cycle (Air Conditioners)



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NRP

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NRP Training Information

www.nrp.com.au/training-available

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Siemens

aunz.siemens.com.au/enviro-climate-control_prod_bt

Course Topics

- Air conditioners - How do they work?
- What is Refrigerant
- Parts of an Air conditioner
- The Compressor
- The Condenser
- The Evaporator
- Reverse Cycle AC Units - Reversing Valve
- Refrigerant Leakage Detection
- Thermal Convection Process
- Temperature Control
- What's Next?

Air conditioners - How do they work?



Air conditioners and refrigerators work in the same way.

They are both made to transfer heat from inside the conditioned space to an area outside.

Instead of cooling just the small, insulated space inside the refrigerator, an air conditioner cools a room, a whole house or the entire floor of the building.

To make this possible they use special chemicals called refrigerants.



What is Refrigerant?

Refrigerants are chemicals that transfer heat energy easily during the change of state from a gas to a liquid and back again.



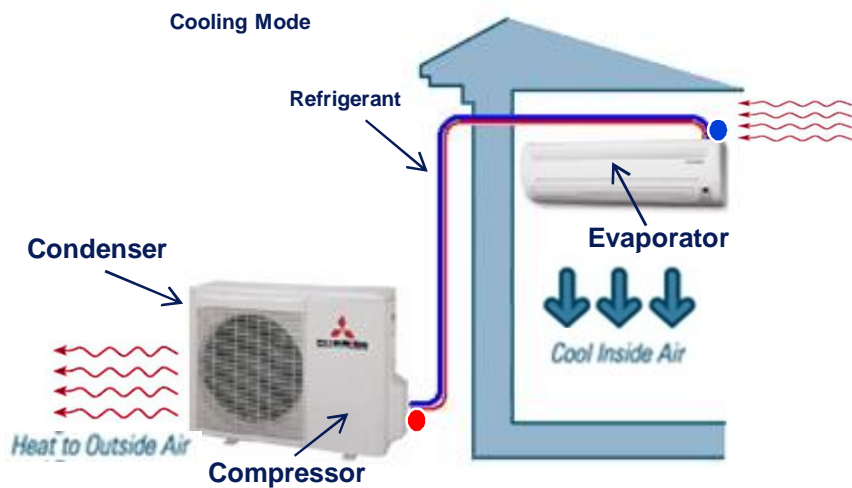
With a state change the following occurs:

“Change of State = Transfer of Heat Energy”

e.g. (Ice Melting, Solid to a Liquid **Absorbs** Heat Energy, Cools your Drink)

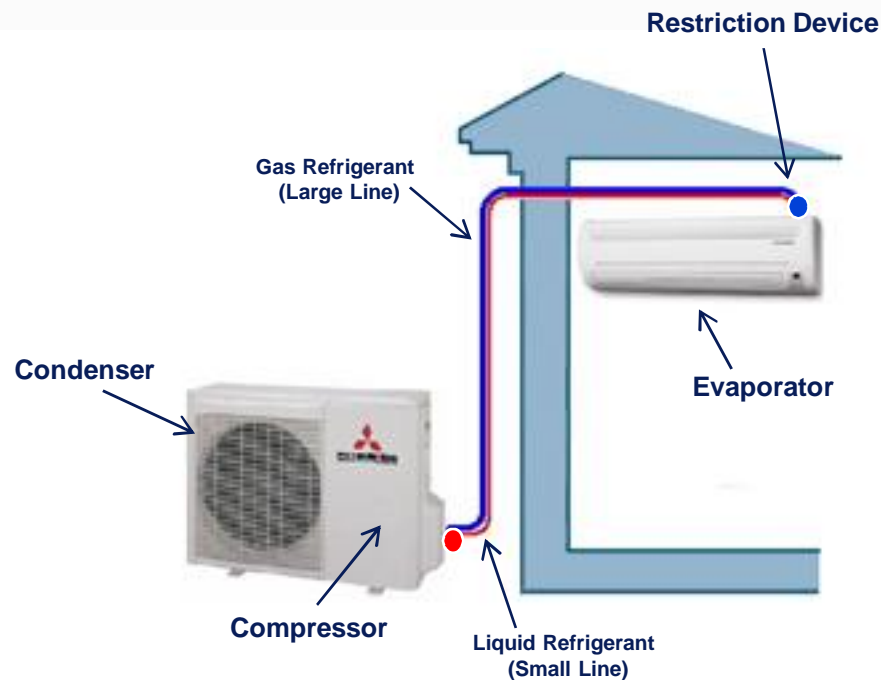
e.g. (Heat Energy **Absorbed** by Water via a Kettle, Liquid turns into Gas)

So by pumping refrigerant around and making it change state to absorb and reject heat energy we can transfer heat from air inside the building to air outside the building providing cooling.



Parts of an Air Conditioner

The best way to understand the refrigeration cycle is to look at the split air conditioning system of your home.



The machine has four main parts:

- Compressor (The Pump)
- Condenser (Coil that Turns Gas into Liquid)
- Restriction Device (Small Orifice, Tx Valve that Turns Liquid into a Liquid Vapour Mixture)
- Evaporator (Coil that Turns Liquid into Gas)

The Compressor and Condenser are usually located in the outdoor portion of the air conditioner.

The Evaporator and the Restriction Device are located in the indoor unit.

The larger line between the indoor and outdoor unit carries the refrigerant as a gas and the smaller line carries the refrigerant as a liquid.

The Compressor



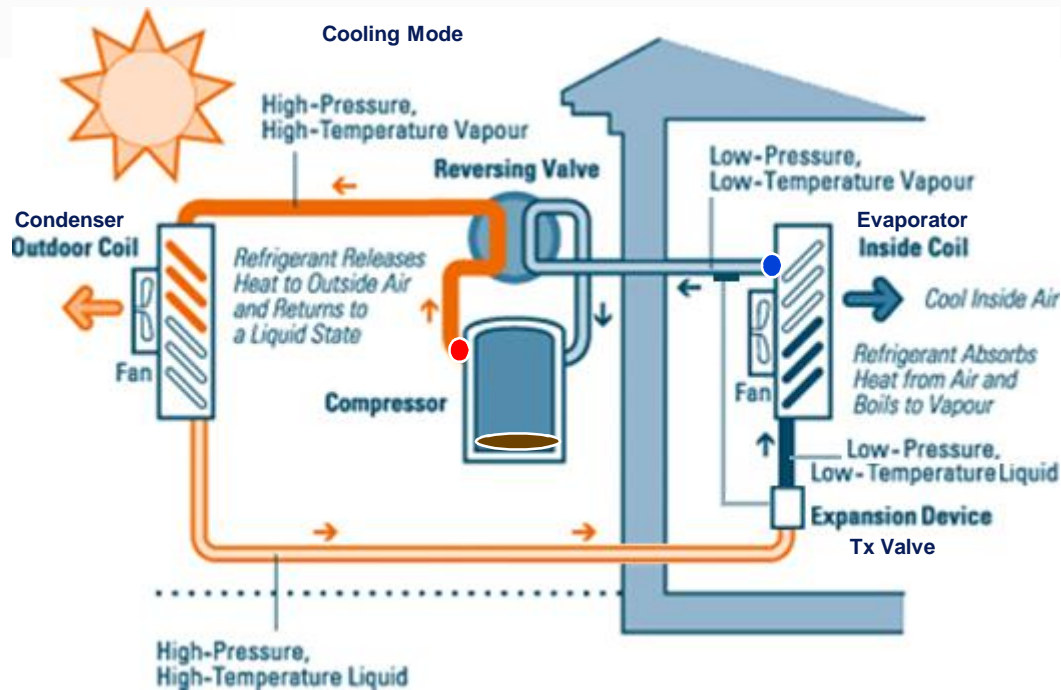
The compressor is essentially a gas pump that is used to circulate refrigerant around the system.

Refrigerant arrives at the compressor as a cool, low pressure gas on the suction line.

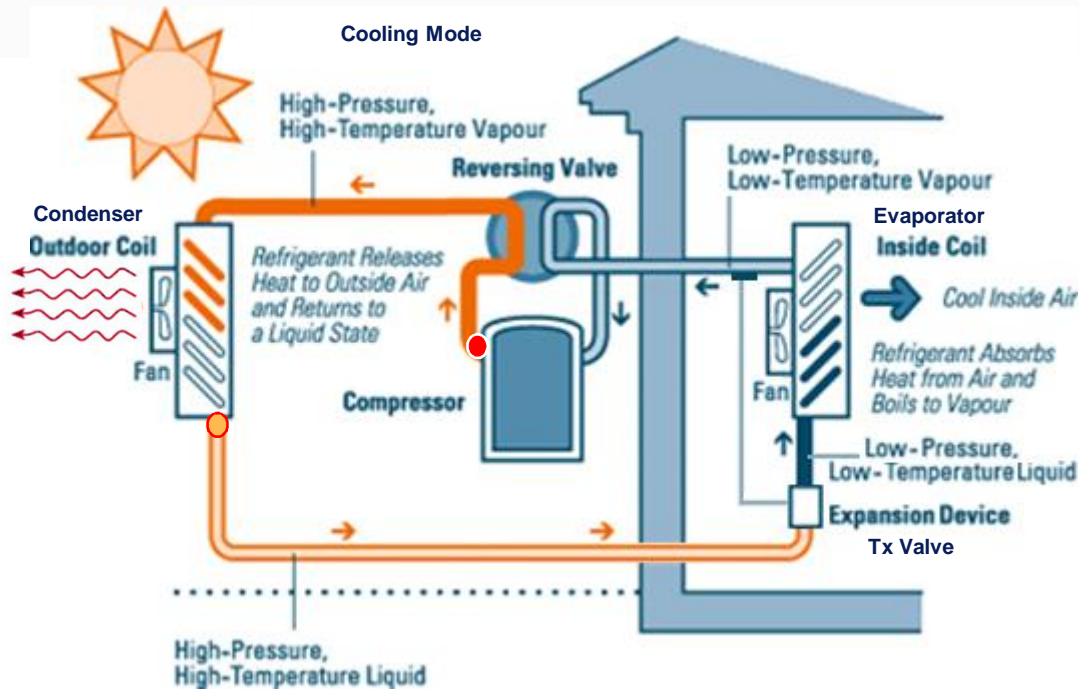
The compressor forces the refrigerant gas molecules closer together increasing the refrigerant temperature and pressure.

Compressors produce heat and are the biggest consumers of electrical energy in the refrigeration process.

The refrigerant leaves the compressor on the discharge line as a hot, high pressure gas and flows into the condenser.



The Condenser



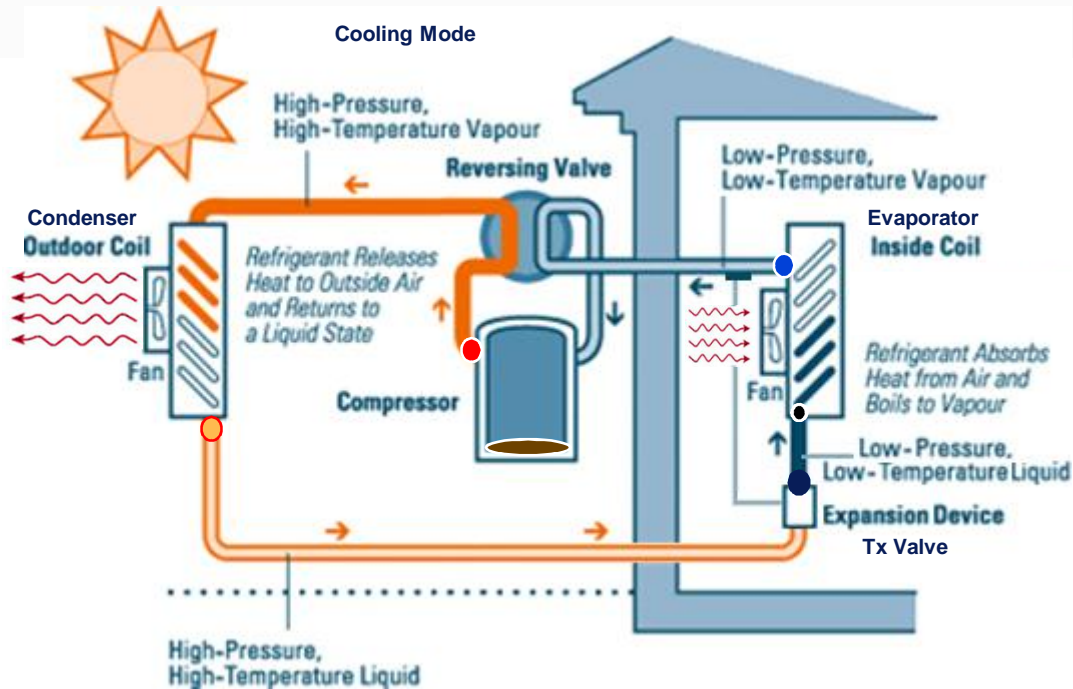
The condenser looks and acts like a car radiator. The condenser fan blows air through the condenser coil that is filled with hot refrigerant gas.

The refrigerant gas rejects heat energy into the outside air during the condensing process. This is why air coming off the outside condenser coil hot when in cooling mode.

This rejection of heat energy causes the refrigerant gas to change state from a gas to a liquid.

The refrigerant then leaves the condenser as a liquid at high temperature and high pressure.

The Evaporator



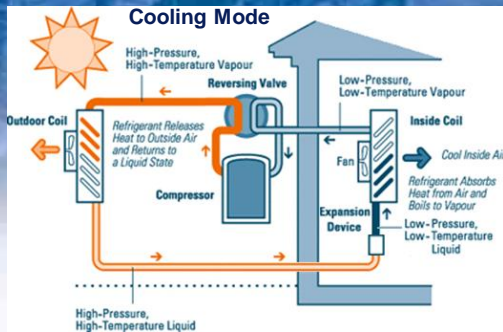
As the high pressure, high temperature liquid refrigerant is forced through the restriction device (Tx, Thermal expansion valve) it becomes a low pressure, low temperature liquid vapour mixture.

In the evaporator the refrigerant liquid absorbs heat energy from the rooms air making it change state from a liquid to gas. This process is also known as “boiling off” and cools the rooms air.

The Tx valve constantly adjusts the amount of refrigerant passing into the evaporator to ensure it is “boiled off” to a gas before returning to the compressor.

The refrigerant leaves the evaporator as a cool, low pressure gas flowing back into the compressor to begin the cycle again.

Reverse Cycle AC Units The Reversing Valve

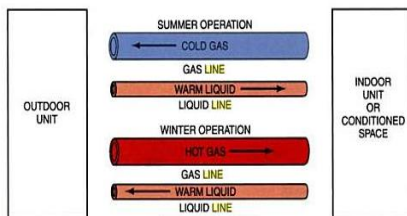
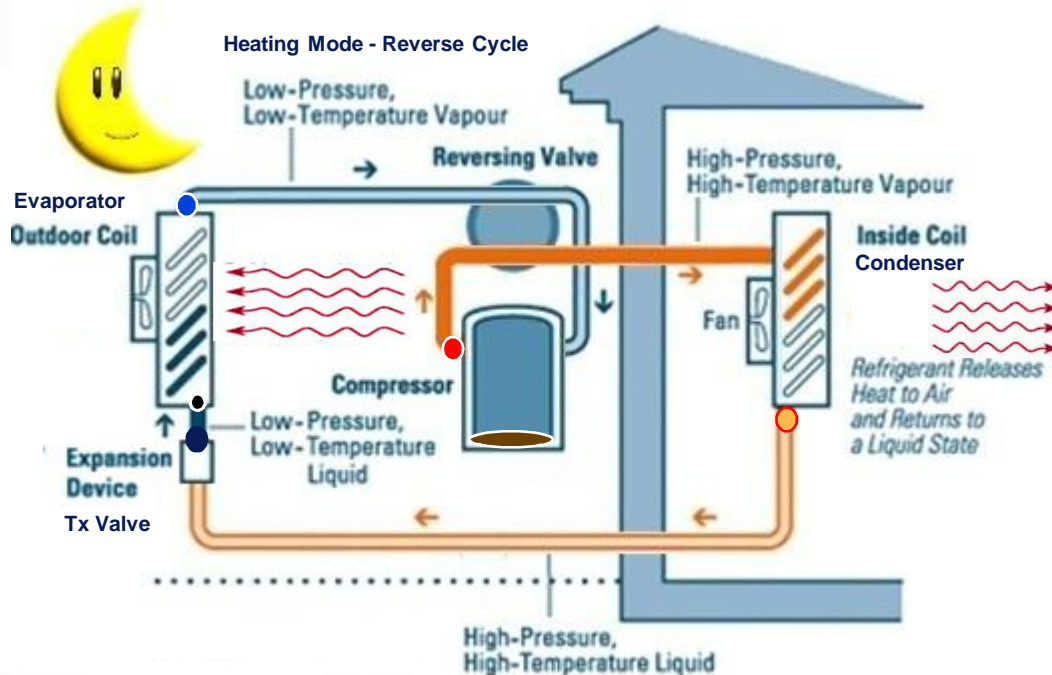


The reversing valve diverts the flow of refrigerant through the indoor and outdoor coils changing the direction of heat transfer. In effect the evaporator and condenser swap roles.

Due to the reversing valve the air conditioner can now be used to both heat and cool. This is where the term reverse cycle air conditioning comes from.

In the reverse cycle mode the reversing valve energises and refrigerant absorbs heat energy from the outside air and rejects it into the room as warm air. This is why when in heating mode the air coming off the outdoor coil is so cold.

Refrigerant lines carry a gas or liquid as before but in the opposite direction, with a change in the gas line temperature.



What Happens If Refrigerant Leaks?

Refrigerant can be colourless and odourless and is denser than air so an undetected leak can be fatal. Older refrigerants such as R22 are also harmful to the environment.

As per the AS/NZS (1677.2:1998) standard larger refrigerant based systems in enclosed areas must be monitored against leakage.

This requires the installation of Refrigerant Leakage Detectors and Audible and Visual indicators in the space to alert people of the danger. As NRP we can provide the Siemens range of refrigerant detectors as a solution.

Another sign of a possible leak is a loss of cooling or heating capacity of the system.

Leakage detection systems are purpose built, standalone products that can also be monitored via a Building Management System.



Refrigerant Gas Type	
2064	R 123
2065	R 125
2070	R 22
2077	R 134a
2078	R 404a
2083	R 407a

PolyGard® Refrigerant Gas Transmitter
ADT-D3 20XX with Infrared Sensor



PolyGard® Gas Controller MGC-04



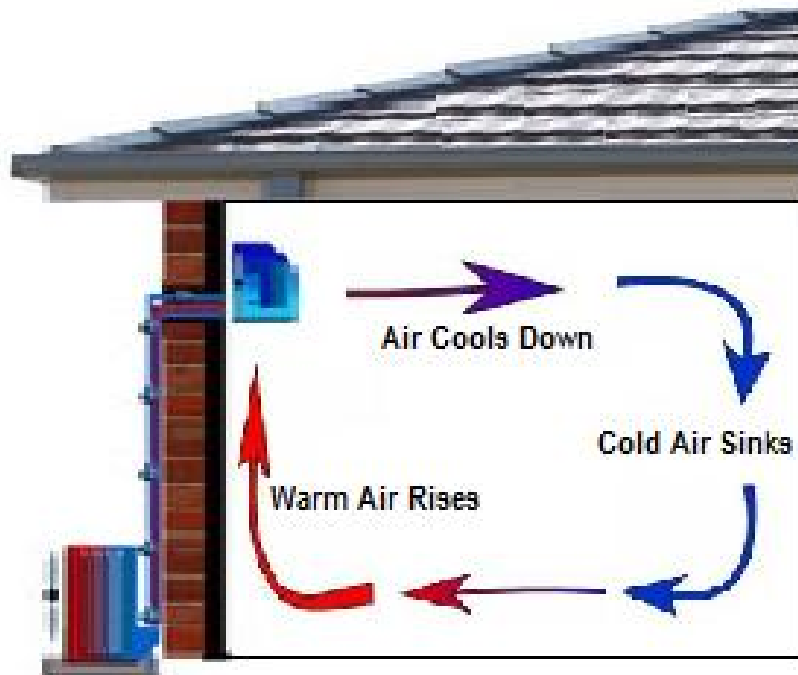
The Thermal Convection Cooling Process

The indoor fan circulates air inside the room across the evaporator coil to provide cool air to the room.

Hot air in the room is lighter and rises to the top of the room while the cold air settles to the bottom.

As it rises the hot air is drawn in across the evaporator by the fan and heat is again extracted from the air to cool it.

This convection process continues over and over again assisting the rooms air to reach an even and cooler temperature.



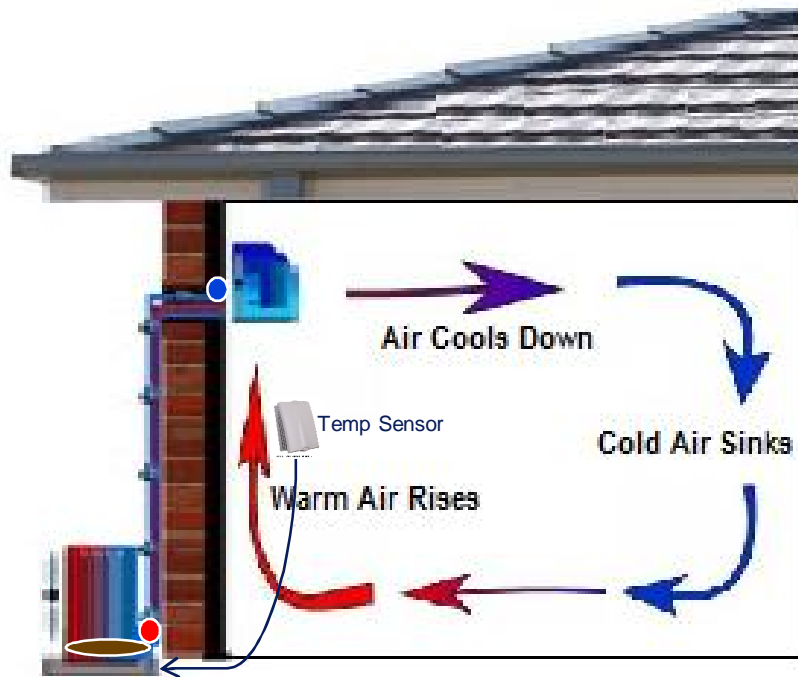
Temperature Control

When the AC unit is turned on the fan will continually circulate air through the room to assist the convection process.

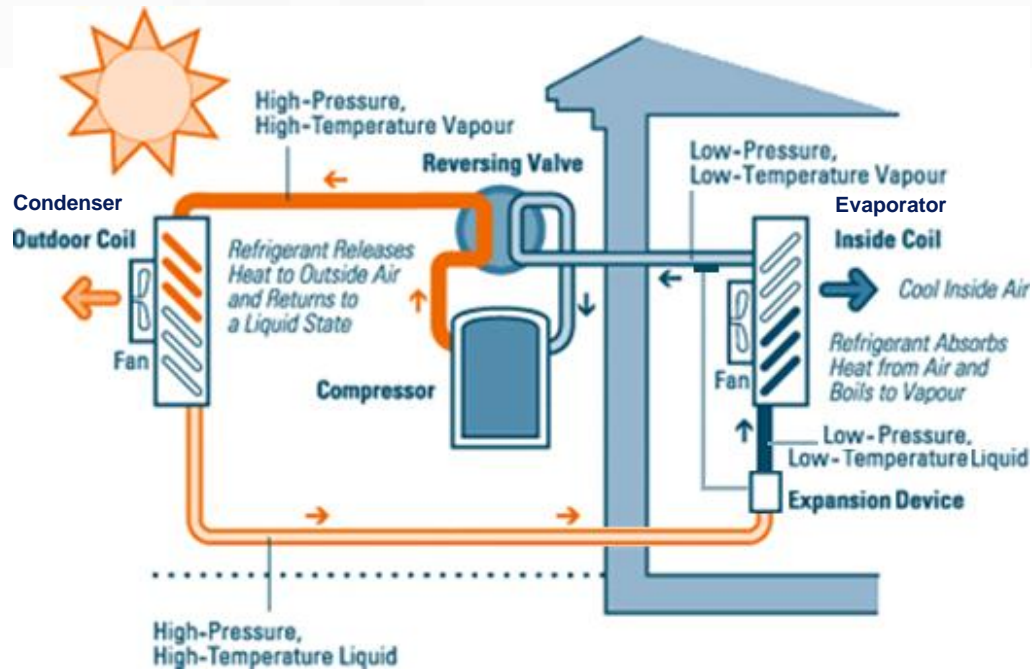
A temperature sensor in the room determines that cooling is required and turns on the compressor.

When the setpoint is reached, cooling is no longer required and the compressor is turned off.

If heating is required both the compressor and the reversing valve will be turned on or off as required and heat will be transferred into the room.



Key Points



- A change in state requires a transfer of heat energy.
- We transfer heat energy to and from the refrigerant by blowing air through the evaporator and condenser coils making the refrigerant change state.
- We move this heat energy between the indoor and outdoor coils by using the compressor to pump the refrigerant.
- In cooling mode heat energy is transferred from inside to outside air cooling the room.
- In reverse cycle mode heat energy is transferred from outside to inside air heating the room.
- Using Innotech controllers we can turn on and off the heating and cooling cycles to control room temperature.

What's next? "Introductory Controls"

In the next course you will learn how to use the Innotech product to control the refrigeration cycle and room temperature... Coming soon!



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