Contents

7 Air-conditioner/Heat Pump

There are some basic concepts that should be understood in order to understand how an air-conditioner or heat pump works:

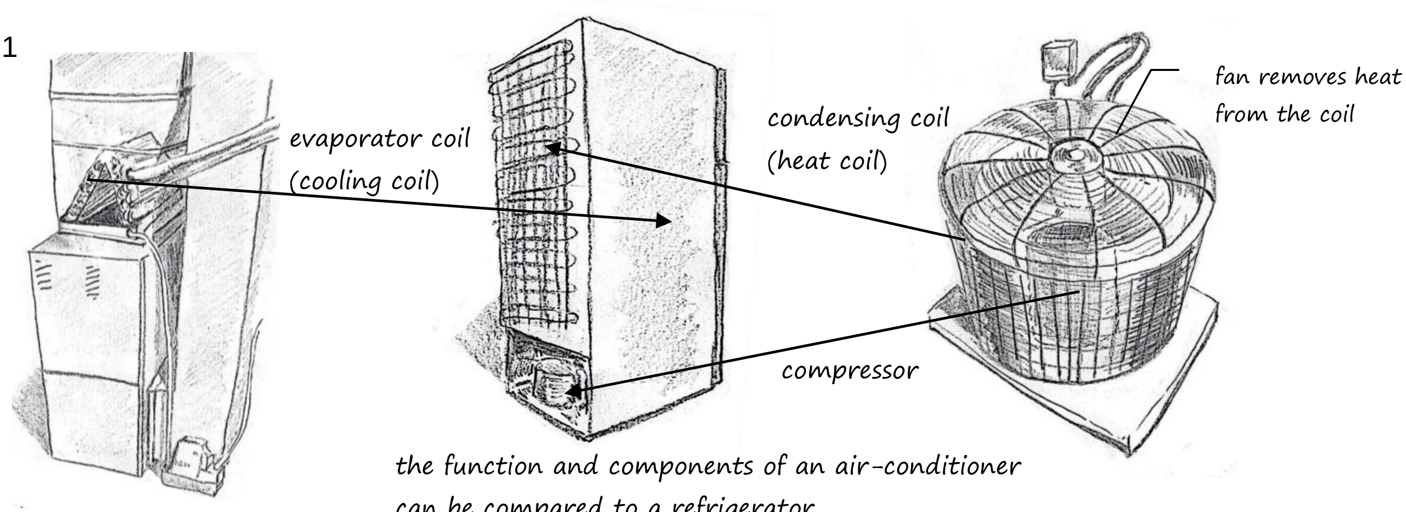
1. **There is no such thing as cold - only less heat.** Atoms that are very active will collide with each other creating heat energy. When heat is removed from the atoms they become less active therefore less heat energy is produced. We perceive that process as cooling.
2. Heat energy moves from a warm body to a cold (less warm) body. For example when our feet are in contact with a concrete floor our soles feel cold.

An air-conditioner removes heat (cools) from the house air.

A heat pump can both remove heat (cool) from the house air and add heat (warm) to the house air.

The measurement of cooling efficiency is the SEER (seasonal energy efficiency ratio). The SEER rating of a unit is the cooling output during a typical cooling-season divided by the total electric energy input during the same period. The higher the unit's SEER rating the more energy efficient it is

Fig. 7.1

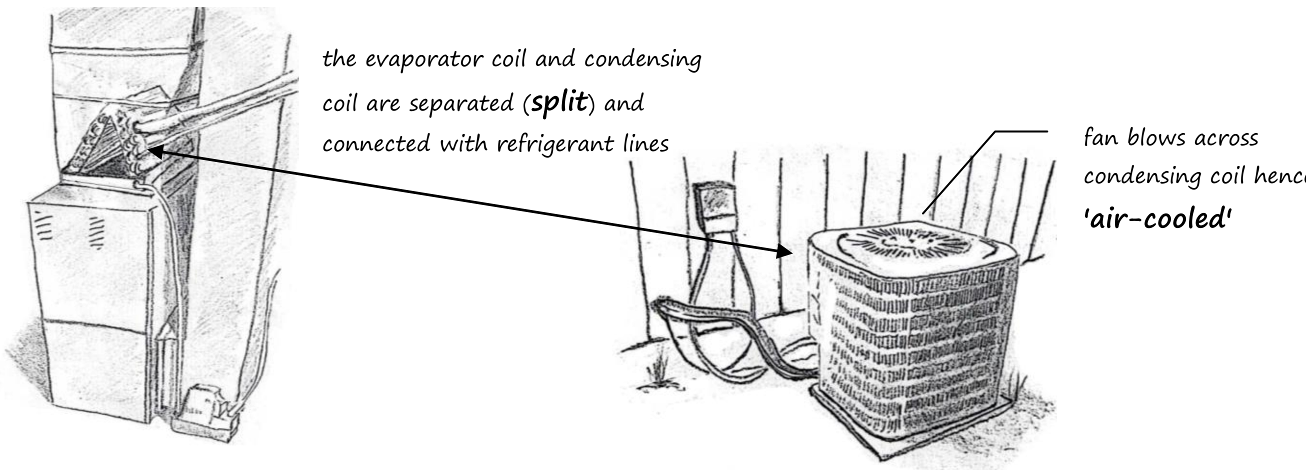


For older air-conditioners a SEER value of 8 to 10 is common. For newer units SEER 13 is considered a good value. However this does not guarantee an efficient unit

7.1 Description

Air Conditioner (air-cooled): The most common type of air conditioner is an **air-cooled split system**. which is located on the exterior of the house on the ground or mounted on the wall. It relies on the fan inside the cabinet to circulate air across the condensing coil to remove heat thus 'air-cooling'.

Fig. 7.2

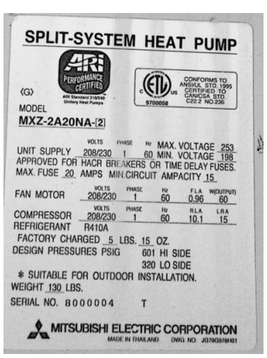


Heat Pump (air-cooled): A heat pump works under the same principal as an air-conditioner except it has the added feature of reversing the process to heat the house air. This is done with a special device called a reversing valve. During the cold season a heat pump will capture heat from the outside air to warm the house air. Of course as it gets colder outside there is less heat to capture therefore limiting its heating ability.

Generally when the temperature outside falls below freezing the heat pump will become less efficient and an auxiliary form of heat is required. Recent design improvements (high-efficiency) have made heat pumps efficient enough to provide heat for weather conditions as low as -20^{O}C.

Since a heat pump looks the same as an air-conditioner one way to determine the difference is to read the label. Another way is to test from the thermostat.

Fig. 7.3



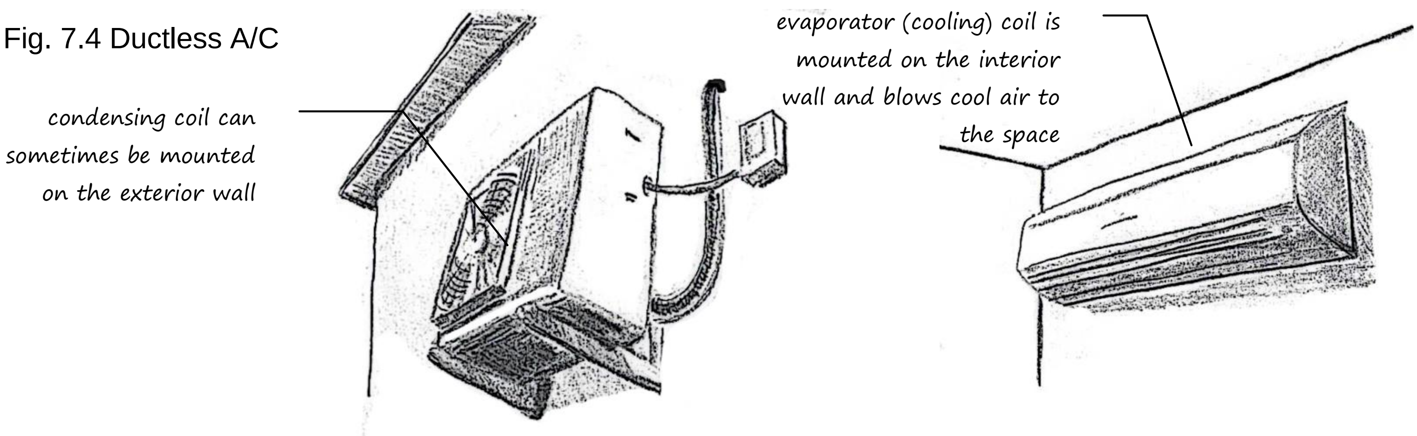
Air Conditioner/Heat Pump (water-cooled): Although less common this type of system relies on water to remove heat from the condensing coil. This requires a constant flow of water while the system is operating. It can be compared with turning a faucet on which is wasteful since this water cannot be reused but discarded into the waste drain.

Heat Pump (ground-source): Also called a *geothermal heat pump* this system provides both cooling and heating. The temperature in the ground below the frost line is constant at approximately 10-15 ^{O}C. The heat pump takes advantage of this constant temperature to remove or add heat through a piping loop system installed in the ground.

A ground source heat pump is very expensive to install but considered energy-efficient and has a low environmental (ecological) footprint.

Ductless Air-Conditioner: When a house does not have a forced air duct system we rely on a ductless air-conditioner to cool the house. This works like a regular air-conditioner except the cooling component (evaporator coil) is mounted on the inside wall of the second level hall area or the room intended to be cooled. When mounted in the hall and depending on the size of the house a single coil can provide adequate cooling to an entire house.

Fig. 7.4 Ductless A/C



Multi-Split Ductless: Sometimes a single evaporator coil is not adequate so we use two or more units which can be connected to a single compressor.

7.2 Cooling Capacity

British Thermal Units: The **British Thermal Unit** (**BTU**) is a traditional unit of energy equal to about 1055 jouls. It is the amount of energy needed to cool or heat one pound of water by one degree Fahrenheit.

In science, the joule unit (SI from French:*Système International d'Unités* translated as International System of Units) of energy, has largely replaced the BTU.

TONS: Often we refer to the cooling capacity in terms of TONS. This is equivalent to the amount of energy required to melt 1 TON of ice in one hour.

One TON capacity is equal to **12,000 BTUs** and generally can **accommodate 1000 sq-ft** of living space. We therefore have a way to estimate if an air-conditioner is adequately sized for the house. Of course this depends highly on the warm season temperatures and the age of the house.

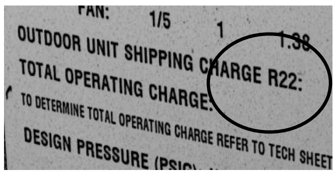
It is possible for an air-conditioner to be oversized (larger capacity than required). First we must understand that when an air-conditioner cools it also removes moisture from the air. Cool dry air is comfortable. An oversized unit might cool the air too quickly and not allow enough time to adequately remove the moisture in the air. The result is a cold damp environment which is not comfortable.

The **capacity can be found** on the model number of the **data plate** located on the condenser cabinet. A technical reference manual is required to interpret the model number.

Refrigerant: The refrigerant is what makes cooling (removal of heat) possible. The refrigerant is commonly referred to as Freon which is a trademark name also known as **HCFC-22**, or **R-22** . Freon is like carbon dioxide except many times more harmful to the environment. Over the years Freon has been improved to lessen the environmental impact.

Presently **R-410A**, a more environmentally friendly refrigerant, is in use for newer air-conditioners. It does not contribute to ozone depletion.

Fig. 7.4.1

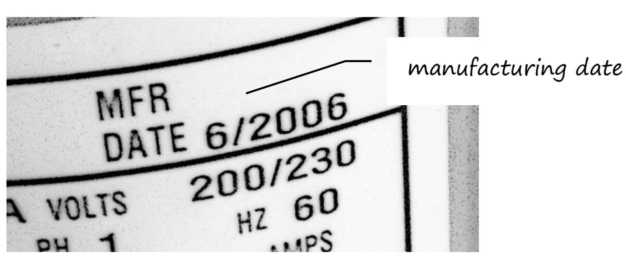


7.3 Age Life/ Expectancy

When it comes to air conditioners and heat pumps the **life expectancy** is typically measured by the **compressor** component. The compressor is essentially the heart of the system and once it fails we generally replace the entire system.

The **age can be found** on the serial number of the **data plate** located on the condenser cabinet. A technical reference manual is required to interpret the serial number. In many newer units a manufacturing date is given

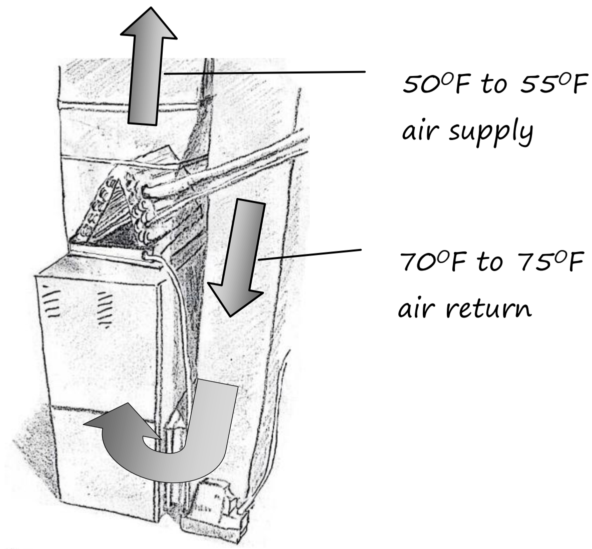
Fig. 7.5 A/C Data Plate



7.4 Cooling Performance

In order to determine if the system is performing adequately we can measure the difference between the supply air temperature and return air temperature. We can also measure the temperature across outdoor fan coil.

Fig. 7.6



7.5 Limitations

The following limitations may prevent proper or complete inspection of the system.

Cannot Test With Low Outdoor Temp: System is not tested if the outdoor temperature is below 10^{O}C (33^{O}F) since this puts undue stress on the compressor which may damage it.

Data Plate

The data plate provides the general information of the cooling system of which the following might used by the Home Inspector:

- Manufacturer
- Date of Manufacturing
- Cooling capacity
- Minimum and Maximum Electric Breaker size and type
- Voltage/Phase
- Refrigerant type
- Efficiency
- RLA – rated load amperage

The following provides some data plate conditions that may limit the information required by a Home Inspection.

Missing: Sometimes the data plate may have been removed or fallen off over time.

Not Legible: Usual due to wear and tear over time.

Incomplete: Relevant information may not be listed though this is unlikely.

Not Found: Sometimes located in a part of the unit where it is not visible or accessible.

Outdoor Coil Covered: To protect the unit often home owners will cover the outside coil during the off season so the air-conditioner should not be tested.

Restricted Access: A unit might be located in an area where it is not readily accessible i.e. on a roof. This will limit the inspection.

System Breaker Shut Off: The breaker (located in the electrical panel or a sub pane) must be in the on position at least 24 hrs prior to the air-conditioner being

System Inoperative: This usually implies the system did not respond when tested by the Home Inspector. It may also imply that components are missing.

Window A/C Units Not Tested: Generally these units are not tested as part on a regular Home Inspection

7.6 Recommendations/Observations

7.6.1 Air Conditioner

Condenser Coil/Fan/Compressor: This is the part of the air conditioner located on the outside of the house (air-cooled). It can be identified by the noisy fan and hot air it removes from the condensing coil.

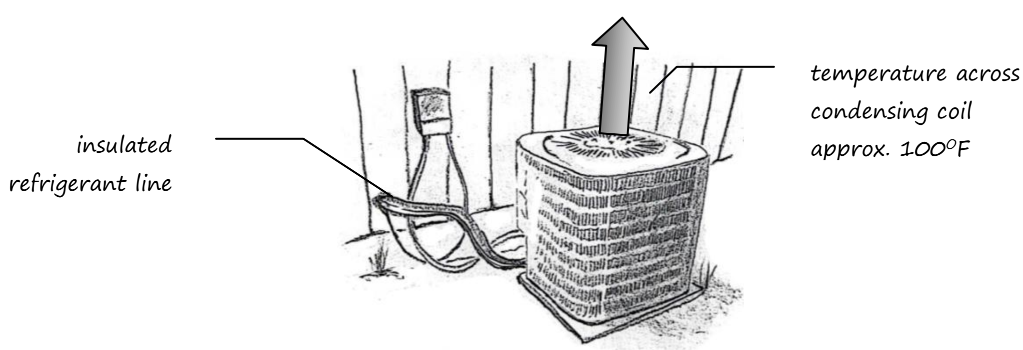
The condensing coil and fins require annual cleaning. The fan lubricant oil should topped annually.

The compressor located inside the cabinet is typically not visible or inaccessible except by removing

Refrigerant Lines: The refrigerant lines link the condenser coil (outside) with the evaporator coil (inside). The refrigerant (often called Freon) runs through the lines removing heat as it changes state - from a liquid to a gas.

The refrigerant lines should be properly supported and the larger line (cold) should be insulated. They should also be placed so that risk of damage is minimized.

Fig. 7.7

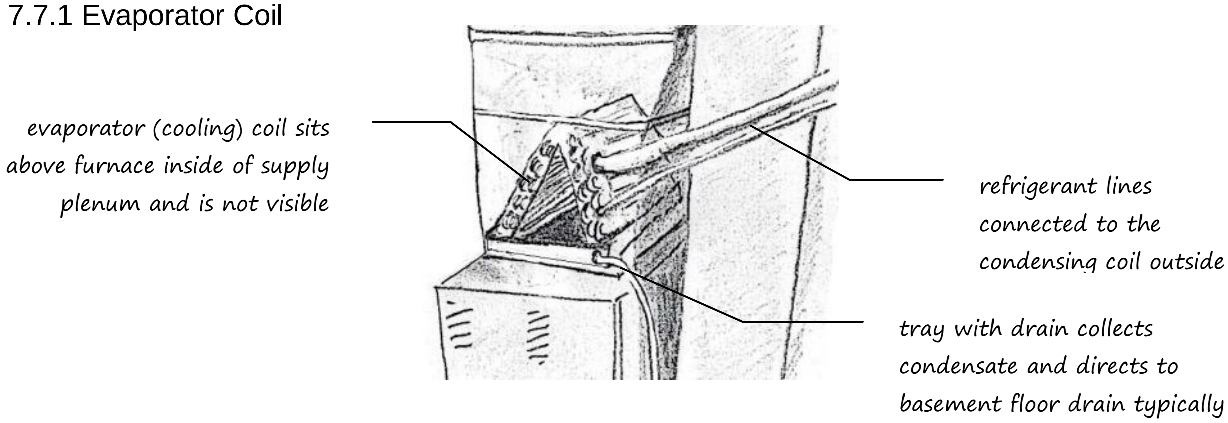


Evaporator (Indoor) Coil: Also called the **cooling coil** is located above the furnace cabinet (or air-handler) and typically not visible. It requires annual cleaning since dust from the house air can cling to the metal fins.

When there is poor heat transfer the coil can ice up and block the passage proper air flow.

The evaporator coil is where the temperature drop (15^{O}F to 20^{O}F) is measured with a thermometer. If the air temperature drop is inadequate the air conditioner should be professionally serviced.

Fig. 7.7.1 Evaporator Coil

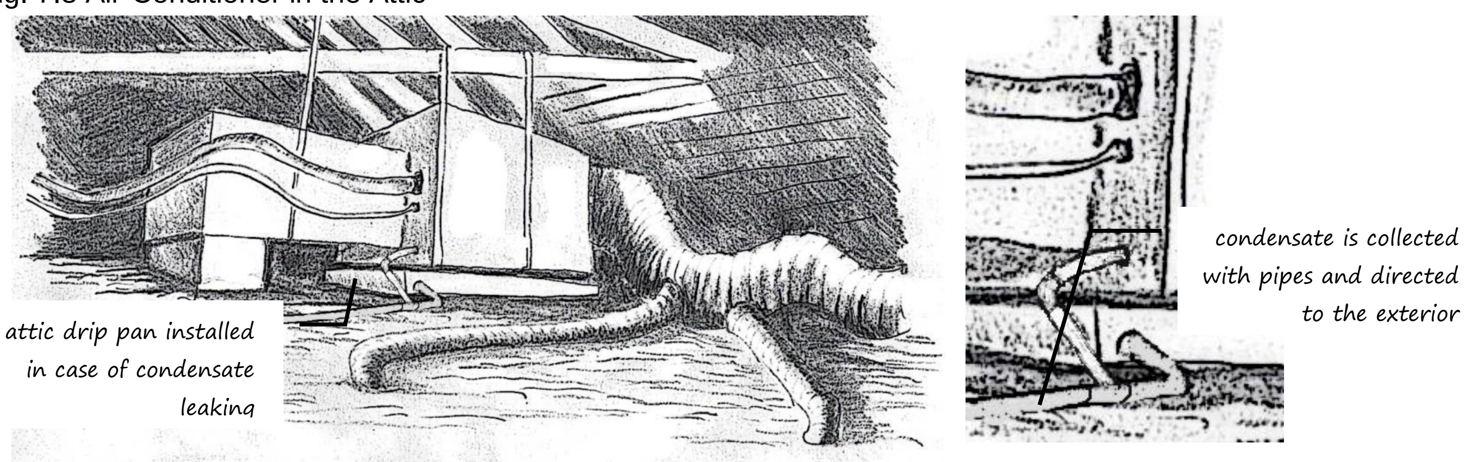


Condensate Drain/Pump: When we cool air (remove heat) the moisture in the air will condense into water. This water is collected by a tray that sits under the evaporator coil to a condensate drain. The drain is directed to the nearby floor drain. When no floor drain is present the condensate drain is directed into a condensate pump which discharges the water to a sink (usually a laundry sink).

Sometimes the condensate drain will be directed into a plumbing waste stack. This is a poor arrangement since sewer odours can migrate into the house air.

Attic Drip Pan: When the evaporator coil is located in the attic there is a risk of the condensate line failing. A pan is located underneath the cabinet to collect any water.

Fig. 7.8 Air-Conditioner in the Attic



Indoor Fan: Also called the **blower** this is what circulates air through the house. It is usually part of the furnace (bottom of cabinet) or can be a standalone air-handling unit.

Older blowers are belt driven and all newer units are equipped with direct driven units. High efficiency furnaces have blowers with a two-stage capability which means they can step up the intensity and blow air from low to high depending on the demand.

Noisy and dusty blowers require maintenance. The motor that drives the blower can be replaced if it fails.

Ductwork: In older homes the ducts tend to be smaller and not designed to distribute cool house air. Cold air is denser and more difficult to push through therefore less effective and efficient.

Attic Ductwork: Since the attic (roof space) is not a conditioned space (outside the building envelope) the ducts require proper insulation for better efficiency. This also applies to crawlspaces.

Thermostat: The thermostat should be located in the central part of the house where the house air is considered to be at an average temperature overall.

For heat pumps the thermostat must have the option of cooling and heating. Sometimes this is labeled as auxiliary heat or emergency heat.

7.6.2 Heat Pump

All the main components of an air-conditioner apply to a heat pump with the exception of the reversing valve. Since heat pumps can operate in both cooling and heating mode they tend to require more maintenance and repairs.

Reversing valve: This component is what makes the heat pump able to provide the duel function of cooling and heating. The proper function of the reversing valve can be determined by testing the system in both heating and cooling modes. One of the most common problems that can develop with a reversing valve is that is can get stuck. Replacement might be necessary.