A HOMEOWNERS HANDBOOK

AIR CONDITIONING

By Everett H. Rawlings

COOLING SYSTEMS

Cooling systems have become known as air conditioning. Specifically, air conditioning includes the maintenance of proper temperature, a balanced humidity, fresh air that is free of odors, clean air that is free of dust and a uniform pattern of air motion.

Thus just lowering the temperature in the conditioned space will not produce a comfortable environment unless the humidity is balanced and filtration is available to remove dust, pollen and odors. Also the movement of air must be introduced and exhausted from the conditioned space in such a way as to avoid discomfort to the occupants.

COOLING

The most common type of residential air conditioning is the electric powered compression system. There are four main components to any air conditioning or mechanical refrigeration system, regardless of whether it is a residential or commercial application. This includes household refrigerators, walk-in freezers and auto air conditioners. These four components are: 1. Compressor. 2. Condenser. 3. Metering device and 4. Evaporator.

A BRIEF HISTORY OF MECHANICAL REFRIGERATION SYSTEMS

In the 1830's in Apalachicola, Florida, Dr. John Gorrie created a system that forced air over buckets of ice suspended from the ceiling to lower the temperatures of hospital patients suffering from malaria and yellow fever. He is recognized today with a small museum in Apalachicola and his statue is located in the National Statuary Hall in Washington D.C.

Willis H. Carrier is generally recognized as the "father of air conditioning." In 1902 one year after graduating from Cornell University with a Masters in engineering the first system for controlling temperature and humidity in a building was in operation in a printing plant in Brooklyn, New York, thanks to Willis H. Carrier. Carrier was awarded a patent in 1906 for the "Apparatus for Treating Air." His was not the very first system for cooling, but his system was the first safe and successful one that was the forerunner to modern air conditioning. The coolant in his early systems was ammonia. Carrier's early systems were enormous and expensive.

As time went on office buildings, hotel dining and meeting rooms and theatres installed central comfort cooling systems. Since those early days of mechanical refrigeration the comfort of cooling is no longer considered a luxury but rather a necessity.

In 1927, General Electric introduced the first household refrigerator to be mass produced with a completely sealed refrigerating system. Called the "Monitor Top," for its distinctive top mounted round refrigerating unit which resembled the gun turret of the Civil War ironclad ship the Monitor. These refrigerators were known for their reliability and GE became as the industry leader for many years they produced literally millions, and refrigerators became household fixtures. One of the early innovations of the GE refrigerator was dual temperature control which enabled the combining of a separate refrigerator and freezer in one unit.

Chlorofluorocarbon (CFC) refrigerants were synthesized in 1930 by a team of engineers working at the General Motors Research Lab for the Frigidaire Division. Their product was trademarked as "Freon." CFCs are the first refrigerant to be nontoxic and nonflammable making it possible for refrigerators and air conditioners to be used with complete safety. In 1934 Albert Henne co-inventor of the CFC refrigerants, synthesized refrigerant **R-134a,** which is hailed in the 1980's as the best non-ozone-depleting replacement for CFCs. "Freon" and other proprietary branded CFCs were gradually being phased out because they were suspected of contributing to the thinning of earths protective ozone shield.

Because of the depression and then World War II central air conditioning systems for residences did not become common place until the 1960's, when mass produced systems became more affordable. After World War II, window units appeared; and by the 1950's the dripping box jutting out of bedroom windows became a common sight. Central A/C systems led to the residential building boom in the hot and humid South and desert Southwest. Las Vegas would not exist today if it were not for central air conditioning.

Today, most homes, many condos, department stores, restaurants, commercial buildings and even office buildings under five stories high are built with split system air source (air cooled) air conditioning systems. In larger homes and buildings two or more zones are installed. With a split system the condensing unit is/are installed outside the building or on the roof, and the air handler is/are installed inside the building.

In some situations, primarily because of a building design or interior space limitations, it may be more suitable to install what is referred to as a package unit. With a package unit all four main components of a central air conditioning system are all located in one cabinet. Thus an inside unit (air handler) is not required. The system's supply and return air are ducted to the package unit, which will be outside and most commonly on the roof of the building.

CONDENSING UNITS

Air conditioning and heat pump condensing units are located outside of the building and they may just seem to stop and start at will. Actually they are controlled by a wall- mounted thermostat inside the building. Condensing units are contained by a steel cabinet with a portion of aluminum or copper coils visible and protected by a wire enclosure, and almost always have an electric fan at the top of the unit. The basic purpose of a condensing unit is to extract heat from inside the building and deposit it outside. Heat pumps will provide heat in cool weather and cooling in hot weather. There is no visible difference between a straight cool system and a heat pump from the outside of the unit. A reversing valve and other components are what convert a straight cool A/C to a heat pump. In North America condensing units are sized for the cooling load rather than the heat mode.

The compressor which is inside the condensing unit draws the low pressure vapor or gas refrigerant after absorbing the heat from inside the building. It draws this low pressure gas through what is referred to as the "Suction Line". The suction line is the larger of the two lines (pipes) coming into the condensing unit cabinet. It then compresses and pressurizes the refrigerant and pushes it through the condensing unit coils, where the heat is released. The compressed refrigerant changes its state and becomes a high pressure liquid as it returns to the air handler through the smaller pipe called a "Liquid Line". Just the opposite happens in cold weather with a heat pump. Cold air is removed from inside the building and is absorbed by the refrigerant where it is passed through the compressor; then the cold air is released through the condensing unit coils. A reversing valve inside the cabinet causes the refrigerant to move in the opposite direction from the cooling mode.

Thus, in the cooling mode on a properly operating condensing unit, one should be able to feel a noticeable difference in the discharge air above the fan - usually 20 to 25 degrees Fahrenheit warmer than the surrounding air. Likewise when the condensing unit is operating in the heat mode the discharge air will be much cooler than the surrounding air on a properly operating system.

It is important to have the air conditioning system and condensing unit serviced at least once a year. Debris in the form of yard vegetation, animal hair, leaves or dirt accumulated on the coils can greatly reduce the efficiency of the system. An improperly charged refrigerant system may cause the unit to not perform its intended function. A malfunctioning or inoperative condensing unit fan may cause serious harm to the compressor.

COMPRESSORS

The compressor is the heart of a mechanical refrigeration system such as a residential air conditioning system. These are usually a welded type, hermetically sealed unit on residential air conditioners and are not field repairable. In central systems there are scroll compressors, rotary compressors, screw compressors and centrifugal compressors. Compressors come in various sizes for residential central comfort control systems. The smallest compressor is likely to be about 12,000 (BTU) British Thermal Units. Generally the largest residential compressor is 60,000 BTUs. Larger homes and buildings may require more than one zone or system. There are 12,000 BTUs per ton of air conditioning. As a very general rule of thumb one ton of air conditioning will cool 400 to 600 or so square feet of living space. When the compressor fails, the system is basically dead. Although it is possible to replace the compressor it may not be economically feasible due to the advancing age or efficiency of the system. By Federal mandate the newer systems today have at least a 13.0 Seasonal Energy Efficiency Ratio (SEER) with some units claimed to be as high as 20.0 SEER. Also, the newer systems generally come with at least a five year factory warranty on the compressor and some major brands even provide a ten year factory warranty. Interestingly enough the compressor on a residential refrigerator or a window air conditioner look very much like a standard residential air conditioning system although the latter is much larger in size.

Low pressure gas is drawn into the compressor from the inside (evaporator) unit through a refrigerant line referred to as the suction line. The compressor then compresses the low pressure gas and pushes it through the condensing unit coils where the now high pressure gas changes state and becomes a high pressure liquid. It then travels through to the indoor unit where it goes through a metering device, which then releases the pressure.

METERING DEVICES

The metering device is the part of the system that causes the pressure to drop as the refrigerant passes from the high pressure side to the low-pressure side. No heat is gained or lost as the refrigerant passes through the metering device, even though a significant reduction in temperature occurs because of the drop in pressure. By the lowering of the pressure through the metering device the refrigerant flashes to a gas state.

Metering devices come in several forms. The thermostatic expansion valve (TXV) is used in a majority of air conditioning systems including, most generally, in heat pump systems. An air conditioning system with a TXV valve is often more efficient than other designs that do not use one. Capillary tube systems are also in widespread use. These have no moving parts and are generally made of copper tubing.

EVAPORATOR

The refrigerant flows into the evaporator coil and as it flows through the coil it changes from a high pressure liquid to a low pressure vapor or gas. The evaporator is the reason we have a refrigeration system that works. As the pressure is released, and the state of the refrigerant as it flows through the evaporator coil changes, the temperature of the refrigerant drops. The temperature of the coil may be somewhere in the range of 40 degrees F. This now cold refrigerant is allowed to absorb heat from the conditioned space and this heat is transported by the copper refrigerant line (suction line) to the compressor where the cycle starts all over again. The suction line will feel cool or cold to the touch on a properly operating system as it enters the condensing unit.

CONDENSATION

When air is cooled by the evaporator, condensation occurs. The water that condenses out of the house air as it passes through the evaporator, runs down the coils and is collected in a drain pan. This moisture can amount to two gallons per hour on a hot humid day on a three ton system. Condensate contains fungus, algae and bacteria, and should be piped to a non-body contact area. The condensate drain line should contain a "U" shaped trap so that bacteria cannot be drawn back into the air that is circulated to the conditioned space.

CHECKING AN AIR CONDITIONING SYSTEM

The temperature differential (TD) between the return air and the supply air is generally considered acceptable in a range of 14-22 degrees Fahrenheit. Many variables can cause those numbers to fluctuate so anything within the range is probably acceptable and means the system is operating correctly. One can purchase a simple plug-in thermometer at do-it-yourself stores for performing this test.

Another simple test to determine if the system is performing properly would be to feel the suction line (the big pipe) at the condensing unit. It should feel cool or cold to the touch and will likely be sweating. If it does not feel cool there is likely a problem with the system. The liquid line (the smaller pipe) should feel about body temperature. If it feels hot then the system may be low on refrigerant or be malfunctioning in some way. When the system is operating the discharge air at the condensing unit should be noticeably warmer (20-25ºF) than the ambient air.

The average life expectancy of a residential air conditioning system in hotter regions of the United States is about 10-12 years although it not uncommon to see 15 year old systems operating satisfactorily. Older systems however, are not generally as efficient as newer ones because of the SEER (Seasonal Energy Efficiency Ratio.) By Federal Energy Code the minimum SEER on a system today is 13.0. Older models were not required to meet this higher standard. The SEER is determined by the formula SEER = BTUH divided by the Watts

HOW TO DETERMINE THE AGE AND SIZE OF THE AIR CONDITIONING SYSTEM

Generally the size (Tonnage) of the system can be found in the model number which is located on the manufacturers I.D plate of the condensing unit. For instance 024 along with other numbers used by the manufacturer to possibly denote the plant where the unit was manufactured - would likely indicate a two ton system i.e., 24,000 BTUH. There are 12,000 BTUH in one ton of A/C. The more common sizes to be found are 024, 030, 036, 042, 048, and 060. Thus a three ton system would most likely be found in a home in the range of 1500 to 1800 square feet of conditioned space.

The age of the system may be shown on the manufacturers I.D. label clearly shown as, "Date of Manufacture." Otherwise, it can usually be found in the serial number possibly in the form of 4207 in the middle four numbers in the case of "Rheem" and "Ruud"; 42 would indicate the week of manufacture and 07 would indicate 2007. Some manufactures use somewhat obscure forms of showing the age making it more difficult to determine accurately.