Heat Pumps 101

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If you have been in this business for even just a few years, you've probably heard the expression, "Heat goes to cold." If you were to ask someone, "Where does heat go?" they would say heat rises…but that's not necessarily true. *Hot air rises,* ***but*** *heat goes to cold…* always.

Mother Nature hates an imbalance and whenever it exists, she does everything in her power to equalize or balance it. When your heating system delivers warmth to your house, it eventually leaves through the windows, roof and siding. Why does the heat leave? There is an imbalance between the temperature inside the house and the temperature outside. Heat goes to cold… always!

The same thing happens in the Summertime. When it is very hot outside and your house is cooler inside, the heat outside wants to go to the cooler indoor temperature. How do we typically make the indoor cooler? Most people would say the air conditioner makes the house cool, which is true, but how it does so eludes most people. We use an air conditioning system that removes heat from the indoors and sends it outside. That's because you can't *make* cold. Instead, to create a cooler atmosphere, you have to remove the heat, which is the basics of refrigeration. Whenever you feel cold, it is caused by a lack of heat.

Therefore, if we know that heat *wants* to go to cold, why is a "heat pump" called a heat pump? Why do we have to pump the heat when heat normally goes to cold? The reason is a heat pump, rather than creating heat, it simply *moves* heat. For example, a heat pump can move thermal energy from the cooler outdoor air into the warmer inside room. It pushes heat in a direction counter to its normal flow (cold to hot rather than hot to cold), hence, the word *pump*. A boiler or furnace burns fossil fuel to create heat. A heat pump simply uses an existing source of renewable energy like the heat that exists in the outdoor air. This can lead to reduced consumption of energy while at the same time providing comfort.

The definition of *refrigeration* is the process in which work is done to move heat from one location to another. It may also be defined as lowering the temperature of an enclosed space by removing heat from that space and transferring it elsewhere. Refrigeration uses *refrigerant* to move the heat as it changes state. For several years now, R410A has been the refrigerant used in the heat pump industry. However, that is about to change to new refrigerant called R32 that will be introduced by the end of 2024 (more on refrigerant changes in the next issue).

The properties of 410A allow the refrigerant to be a liquid well below freezing. It has a freezing point at -155°C (-247°F). It has a boiling point of -48.5°C (-55°F). As a liquid refrigerant, when it evaporates into a vapor, it is absorbing heat. When the refrigerant is in its vapor state, containing all that energy, and then condenses back into a liquid, it rejects or expels the heat it originally absorbed. That phase change contains a significant amount of energy.

For example, when you change the temperature of 1lb of water from 211°F to 212°F, it requires one BTU. When you change 1lb of 212°F water to 212°F vapor (steam), it takes 970 BTUs, which you "get back" when the vapor condenses back to its liquid state.

A heat pump incorporates the vapor-compression refrigeration cycle to move heat either away from an area where it's not wanted (cooling) or move heat into a space that needs it (heating). Due to the unique operating properties of R410A, an Air-to-Water or Air-to-Air heat pump has the ability to take heat (energy) out of the air that we would view as very cold but to the refrigerant is warm. This applies to the heating mode of the heat pump.

The cooling operation is identical to that of an air conditioner. Again, using refrigerant and the vapor-compression cycle, the cold liquid refrigerant flows through the air conditioning coil as room air blows across it. The heat from the air goes to the cold liquid refrigerant, thus leaving the air cooler than it was when it entered the coil. The absorbed heat "flashed" the cold liquid refrigerant into cool vapor, which then flows outside to the compressor. There, the cool vapor will be compressed (by the compressor) into a high temperature vapor.

The vapor, which is storing a lot of energy (the heat from the home we wanted to remove), is pumped through a condensing coil where a fan is blowing outside air across it. This outdoor air is hot relative to our comfort but much cooler than the temperature of the hot vapor refrigerant. The hot vapor transfers its energy/heat to the outside air thus completing the process of removing heat from the house and condenses back into a warm liquid.

Reversing Valve

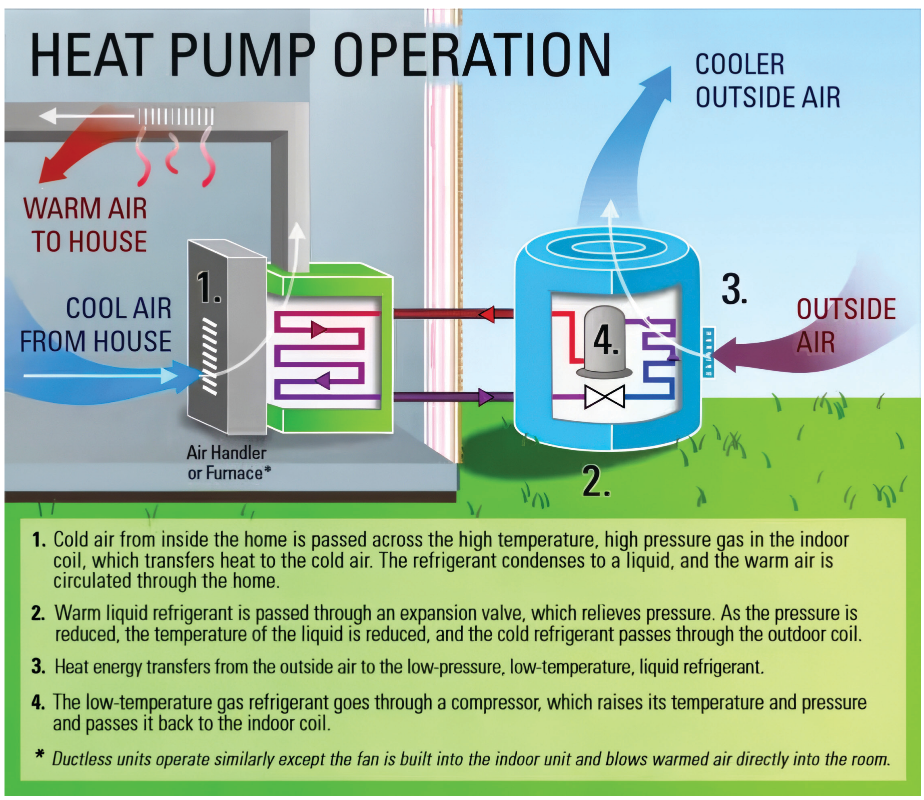
Heat pumps have the unique ability to either heat or cool a home through a simple device called a reversing valve. There are four key components required: an evaporator, a condensor, a compressor and an expansion valve. By adding the reversing valve, the heat pump can "reverse" the role of these key components and be able to provide heating or cooling from the same compressor.

Coefficient of Performance (COP)

Another term unique to heat pumps is Coefficient of Performance (COP). This term expresses *how* efficient the heat pump is with regards to the amount of energy it uses relative to the amount of energy it delivers.

The term was developed to compare heat pump systems according to their energy efficiency. A higher value implies a higher efficiency between the pump's consumption of energy and its output. Design conditions will impact the heat pump's COP performance factor. Air-to-Air and Air-to-Water heat pumps have, in the past, been negatively impacted in their performance by colder outdoor temperatures. However, with the advances in compressor technology, specifically invertor-driven compressors, these Air-to-Air and Air-to-Water heat pumps are capable of extracting energy (heat) from very cold outdoor temperatures and transferring to the energy to the heating medium (water or air).

If you have any questions or comments, e-mail *gcarey@fiainc.com*, call (800) 423-7187 or follow me on Twitter at @Ask_Gcarey.



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