Keeping Comfortable in our Home or Church Building
Part 3

We all like to stay comfortable wherever we go. In the winter, we turn on the furnace to stay warm, and in the summer, we turn on the air conditioner to stay cool.

Consider a regular air conditioner. As describe in this video, it moves heat from inside the house to the outside air. There is a compressor that takes the refrigerant gas and squeezes it to a higher pressure, thereby adding energy to the gas and raising its temperature. The refrigerant flows to the outside coils where its temperature is higher than the outside air. It is cooled by the outside air and condenses to a liquid. The liquid then passes on thru a nozzle into an area of low pressure where it evaporates and drops in temperature. This cooling is similar to how our bodies cool by evaporation of perspiration. This cool gas is then ready to enter the compressor and traverse the cycle again. Thus, the indoors is kept comfortable.

If the direction of flow is reversed, then heat is moved from the outside to inside the building. This is called a heat pump. On a cool day, a heat pump, typically delivers 3or 4 units of heat into a building for every unit of electricity used which is very helpful. However, on a colder day, more electricity is needed, so that less heat is delivered into the building for each unit of electricity used. Also, on a cold day, the outside coils are colder than the air, and may become covered with frost. In this case, these coils must be heated to defrost them, perhaps by electrical heating elements, which consume electric energy. A detailed animation is available here.

For an outdoor temperature of 50° F, a heat pump would deliver 3 or 4 units of heat for every unit of electricity used. But, if the outside temperature is 0° F, a heat pump might deliver only 1 unit of heat for each unit of electricity used. This will vary with make and model, but at some temperature any heat pump operating on outside air becomes less effective. Below the earth's surface, at depth of 20 feet, the temperature is between 50° and 60° F, which could be used as a source of heat at a nearly constant temperature, as seen here. This is called a ground source heat pump, and can deliver 3 or 4 units of heat for each unit of electricity used, regardless of the temperature outside. The operation of this system is described. Such a ground source heat pump is more expensive to install than an air source heat pump, but it uses less electricity to operate. The payback period is 3 to 10 years for recouping the larger initial cost.

The Environmental Protection Agency (EPA) has indicated that a ground source heat pump would use up to 44% less electricity than an air source heat pump. The working life of the in building machinery is estimated to be about 25 years, while the underground equipment could last 50 years. There are at least three varieties of ground source heat pump. In one, called direct exchange, the refrigerant is circulated in the underground tubing. In another, called closed loop, a mixture of antifreeze and water is circulated in the underground tubing, and heats the refrigerant in a heat exchanger inside the building. In the last variety, called open loop, naturally occurring groundwater is pumped out of the ground, circulated through a heat exchanger with the refrigerant, and returned to the ground, by wells or other means. More information is available.

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