SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.®

2007 Version

Energy Efficiency & Customer Research & Development
Technology Brief…The FREUS™

Contents

Background

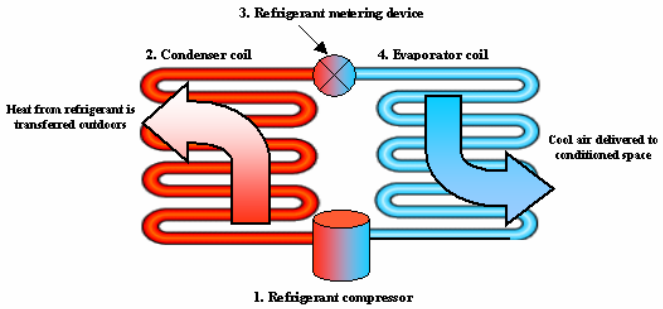
It's another sizzling summer day in Sacramento. Radio and television weather forecasters wearily predict temperatures of over 100°F all week long. The California Independent System Operator (Cal ISO) urges people all across California to conserve electricity. Electricity demand and prices soar as air conditioners struggle to keep people comfortable. Although the energy crisis of 2001 may be over, the need for high efficiency air conditioning systems remains stronger than ever.

This technology brief focuses on a new residential air conditioning system known as the FREUS™. The FREUS is a water-cooled air conditioning system that shows great promise. Based upon recent test results, the FREUS may be nearly twice as energy efficient as conventional air-cooled systems!

HVAC 101: The Basic Refrigeration Cycle

In simple terms, air conditioning systems are designed to transfer heat from one location to another (refer to the inset "The Basic Refrigeration Cycle" for more information). This is accomplished by using heat exchangers (similar to the radiator in your car), a compressor, fans and substances known as refrigerants. The real key is the refrigerant. By using a compressor and a refrigerant metering device (i.e. a valve) to change the pressure of the refrigerant, we cause it to change from a hot-high pressure liquid to a cool gas. This characteristic enables us to use refrigerants to transfer heat from one location (inside) to another (outside). The residential market sector is currently dominated by systems that transfer heat from the conditioned space to the outside air ("air-cooled systems").

The Basic Refrigeration Cycle



1. The compressor compresses cool refrigerant gas causing it to become hot, high-pressure gas (shown in red in the diagram above).

2. As the hot refrigerant gas travels through the condenser, it transfers its heat to the outside air until it condenses into a hot, high-pressure liquid.

3. When the liquid refrigerant passes through the refrigerant metering device, it loses pressure and becomes a cool, low-pressure liquid. This is due to the properties of the refrigerant itself. When the pressure is reduced, the refrigerant becomes cooler.

4. As the refrigerant passes through the evaporator coil, it absorbs heat from the inside air and becomes a low temperature gas. The cool air is then delivered to the conditioned space via a fan.

5. Finally, the refrigerant enters the compressor and the process starts again.

A 'Ton' of Air Conditioning

Have you ever heard someone mention that they just purchased a "four-ton" air conditioning system? Does that mean it weighs 8,000 pounds? Thankfully no. Since air conditioners come in all different shapes and sizes, a standard has been developed to quantify the cooling capacity or amount of heat that the system is designed to transfer. Heat is quantified by a unit of measurement known as the British Thermal Unit or BTU. Technically speaking, a BTU is the amount of heat required to raise the temperature of one pound of water one degree

Fahrenheit - roughly the amount of heat contained in a kitchen match. To melt a 2,000 lb. (one ton) block of ice in 24 hours requires transferring 288,000 BTUs or 12,000 BTUh (BTUs per hour). Thus a 'four-ton' air conditioner would have a cooling capacity of 48,000 BTUh (12,000 BTUh/ ton x 4 tons).

What Are EER and SEER?

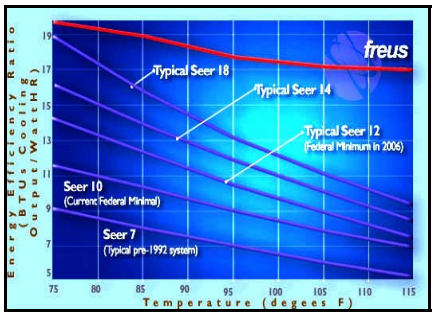
Air conditioners come in all shapes and sizes. So how do we know which systems are the most energy efficient? To help consumers make informed decisions, two rating systems have been developed to rate the efficiency of residential air conditioning systems:

- **Energy Efficiency Ratio (EER):** a ratio that compares the cooling capacity (in BTUs) to the amount of power (in Watts) a system requires. It is based upon a single point measurement that is taken at an outside air temperature of 95°F. As a point of reference, systems that are over ten years old usually have an EER of about 6 to 8, while newer systems are available with EERs of 10 to 12.

- **Seasonal Energy Efficiency Ratio (SEER)**: a rating system developed to more accurately reflect overall system efficiency on a seasonal basis. Essentially, the higher the SEER, the more efficient the system. However, since SEER is a national standard, there is growing concern that it is not suitable for dry southwestern climates such as California. Several utilities, including SMUD, are encouraging consumers to consider both SEER and EER when choosing a system.

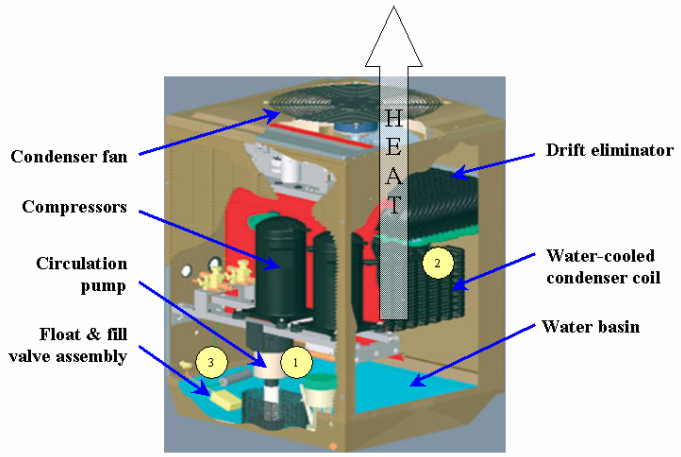
Is FREUS Energy Efficient?

It's no secret that water-cooled systems are much more efficient in hot weather than air-cooled systems. Historically water-cooled systems have dominated the market for larger commercial cooling applications. The reason that water-cooled systems are more efficient is simple: It is easier to reject heat into water than into air. The energy consumption of refrigeration compressors is directly proportional to the pressure it must produce. Since water-cooled systems operate at lower condensing temperatures (90°F versus 120°F), they allow refrigeration compressors to operate at much lower pressures. This is why they require so much less energy to provide cooling.



How Does FREUS Work?

FREUS uses the same components as a conventional air-cooled system, plus a few more. The main difference is that FREUS uses water instead of air to remove the heat from the refrigerant within the condenser coil. Here's how it works:



(1) Water in the basin of the unit is drawn into the circulation pump and then sprayed onto the condenser coils (2) to remove the heat from the refrigerant. The water then falls into the basin and the cycle repeats again. Finally, the float valve assembly (3) is used to replenish the evaporated water.

Recommendations

Thirty SMUD customers installed Freus systems between 2002 and 2006. Despite a rough beginning, FREUS has improved dramatically due to system improvements and efforts to train contractors. The study revealed that FREUS is a very energy efficient option but requires maintenance to function correctly. For more information, please download the technology evaluation reports now available via the CAT program web page http://www.smud.org/education-safety/cat.html.)

Based upon these improvements, and studies conducted by other utilities, SMUD is now offering rebates for FREUS. For more information, please contact SMUD at 1-888-742-SMUD (7683).