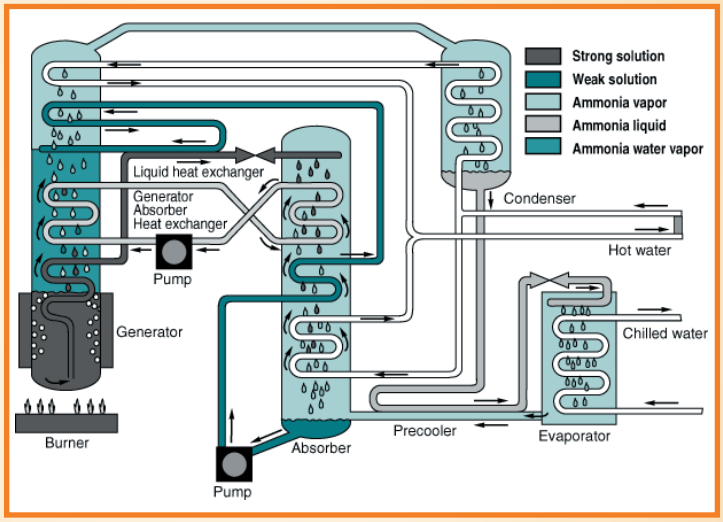
DISTRIBUTED ENERGY RESOURCES

Tech Brief

Thermally Activated Technologies: Absorption Heat Pumps

Distributed Energy Resources (DER) are a suite of onsite, grid-connected or stand-alone technology systems that can be integrated into residential, commercial, or institutional buildings and/or industrial facilities. These energy systems include distributed generation, renewable energy, and hybrid generation technologies; energy storage; thermally activated technologies that use recoverable heat for cooling, heating, or power; transmission and delivery mechanisms; control and communication technologies; and demand-side energy management tools. Such decentralized resources offer advantages over conventional grid electricity by offering end users a diversified fuel supply; higher power reliability, quality, and efficiency; lower emissions; and greater flexibility to respond to changing energy needs.

According to the 2001 BTS Core Databook, space heating and cooling use 39 percent of all energy consumed in U.S. buildings. Thermally activated heat pumps (TAHPs) are a new generation of advanced absorption cycle heat pumps being developed to more efficiently condition residential and commercial space Operating on natural gas fuel, this new technology will maximize energy efficiency consistent with economic competitiveness and minimize emission of global environmental pollutants. Air conditioning is the single leading cause of peak demand for electricity and is a major user of chlorofluorocarbons (CFCs).



GAX Absorption Heat Pump

TAHPs can revolutionize the way residential and commercial buildings are heated and cooled. This technology enables highly efficient heat pump cycles to replace the best natural gas furnaces, reducing energy use by as much as 50 percent, while also providing gas-fired air conditioning.

Heat pumps take in heat at a lower temperature and release it at a higher one, with a reversing valve that allows the heat pump to provide space heating or cooling as necessary. In the heating mode, heat is taken from outside air when the refrigerant evaporates and is delivered to the building interior when it condenses. In the cooling mode, the function of the two heat-exchanger coils is reversed, so heat moves from inside to outside. Most heat pumps are electrically driven, but can be run from natural gas-fired distributed generation technologies.

A major advantage of the heat pump over conventional furnaces is that it can deliver more than one unit of output energy per unit of input energy. In other words, its coefficient of performance (COP) is greater than 1. The COP for the best combustion heating processes is only about 0.95 because of thermodynamic losses. The heat pump can be driven directly by thermal energy from natural gas, avoiding the substantial energy conversion losses (around 70 percent) associated with electric power generation and distribution.

Market Potential

- The primary U.S. market for the GAX heat pump will be in the northern states because of its superior heating performance.
- The Hi-Cool heat pump will be developed for the southern states, where cooling is the priority.

Environmental Benefits

- Advanced energy conversion technology can save 50% of the energy used by conventional furnaces and eliminate CFC use completely.
- Advanced systems substantially reduce emissions of carbon dioxide, a greenhouse gas, as well as sulfur dioxide and nitrogen oxides, which contribute to smog and acid rain.

The "GAX" heat pump, which is based on a generator-absorber heat exchange (GAX) cycle, is envisioned as the technology of the future because of its energy efficiency (as much as a 40-percent improvement over existing technologies), lower maintenance, and use of environmentally benign refrigerants.

Applications

The GAX heat pump and its successor, the "Hi-Cool" heat pump, show great promise for future technological use in residential applications.

The technology of large commercial chillers is quite different from that of residential heat pumps and is undergoing intensive development efforts. The advanced Double Condenser Coupled (DCC) commercial chiller is expected to be 50 percent more efficient than conventional chillers now being sold in the United States.

Because all commercial chillers require cooling towers, the DCC chiller market is limited to large sizes (over 150 tons). An air-cooled chiller will be developed in the 5- to 20-ton range suitable for the U.S. climate. In addition to normal building air conditioning, such a chiller would be ideal for cooling microturbines used in cooling, heating, and power (CHP) systems for buildings.

Program Goals and Activities

The objective of the TAHP program is to commercialize a new generation of advanced absorption cycle heat pumps and chillers for residential and commercial space conditioning. The current emphasis is the residential market, which has the largest potential for energy savings, although development of advanced absorption chillers for large commercial buildings is proceeding in tandem with residential advances. The TAHP program is primarily targeting two technologies—the GAX heat pump and the Hi-Cool heat pump.

The objectives of the TAHP Program will be achieved by the following activities:

- Expanding the residential market of the second-generation Hi-Cool residential absorption heat pump technology to include markets in southern states; the targeted 30-percent improvement in cooling performance can only be achieved with major new advancements in absorption technology or with an engine-driven system
- Working in parallel with the first-generation GAX effort to determine the most attractive second-generation Hi-Cool technology
- Fabricating and testing the 8-ton advanced cycle VX GAX ammonia/water heat pump
- Fabricating and testing the 3-ton complex compound heat pump and chiller

For further information:

Office of Power Technologies
www.eren.doe.gov/power/

Distributed Energy Resources
www.eren.doe.gov/der/

IEA Heat Pump Centre
http://www.heatpumpcentre.org

Partners:

American Gas Cooling Center

Gas Technology Institute

Gas utilities such as:

Southern California Gas

Gas Utility Limited Liability Corporation

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