DER
DISTRIBUTED ENERGY RESOURCES

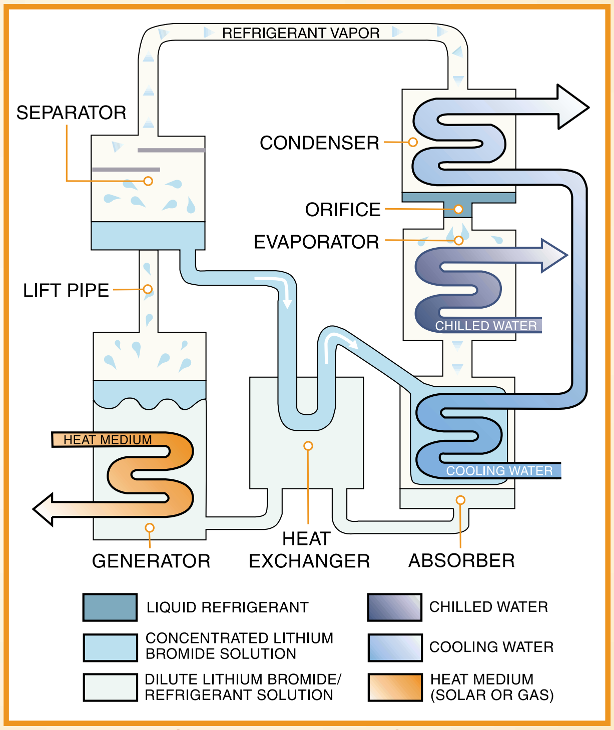
Tech Brief

Thermally Activated Technologies: Absorption Chillers for Buildings

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.

Absorption chillers provide cooling to buildings by using heat. This seemingly paradoxical but highly efficient technology is most cost-effective in large facilities with significant heat loads. Absorption chillers not only use less energy than conventional equipment, they also cool buildings without the use of ozone-depleting chlorofluorocarbons (CFCs).

Unlike conventional electric chillers, which use mechanical energy in a vapor compression process to provide refrigeration, absorption chillers primarily use heat energy with limited mechanical energy for pumping. These chillers can be powered by natural gas, steam, or waste heat.



Single-Effect Absorption Chiller

An absorption chiller transfers thermal energy from the heat source to the heat sink through an absorbent fluid and a refrigerant. The absorption chiller accomplishes its refrigerative effect by absorbing and then releasing water vapor into and out of a lithium bromide solution. The process begins as heat is applied at the generator and water vapor is driven off to a condenser. The cooled water vapor then passes through an expansion valve where the pressure reduces. The low-pressure water vapor then enters an evaporator, where ambient heat is added from a load and the actual cooling takes place. The heated, low-pressure vapor returns to the absorber, where it recombines with the lithium bromide and becomes a low-pressure liquid. This low-pressure solution is pumped to a higher pressure and into the generator to repeat the process.

Absorption chiller systems are classified by single-, double- or triple-stage effects, which indicate the number of generators in the given system. The greater the number of stages, the higher the overall efficiency. Double-effect absorption chillers typically have a higher first cost, but a significantly lower energy cost, than single-effects, resulting in a lower net present worth. Triple-effect systems are under development.

Market Potential

- The most promising markets for absorption chillers are in commercial buildings, government facilities, college campuses, hospital complexes, industrial parks, and municipalities.
- Absorption chillers generally become economically attractive when there is a source of inexpensive thermal energy at temperatures between 212°F and 392°F.

Environmental Benefits

- When combined with CHP systems, absorption chillers can increase energy efficiency dramatically, improve power reliability, and reduce greenhouse gas emissions .
- Gas-fired absorption chillers use distilled water rather than ozone-depleting CFCs.

Applications

Absorption systems fit well into cooling, heating, and power (CHP) schemes. When used with a microturbine or engine-driven generator, they can take waste heat from these components and use it as power, while producing useful cooling for space conditioning.

Absorption chillers can change a building's thermal and electric profile by shifting cooling from an electric load to a thermal load. This shift can be very important for facilities with time-of-day electrical rates, high cooling season rates, and high-demand charges. Some facilities with high-demand charges find it economical to install hybrid chiller plants with both electrical centrifugal and absorption chillers. Building energy managers can take advantage of fuel diversity if absorption chillers are used when electric rates and demand charges are high, and electric centrifugal chillers are used when electric rates and demand charges are low.


Broad Absorption Chiller

Facilities with high thermal loads—such as data centers, grocery stores, and casinos—may become early adopters of absorption chiller technologies. Facilities with 1,500 hours per year or more of air conditioning loads, low fuel costs, high peak demand costs, and waste heat sources are ideal locations for absorption chillers. Such facilities may include commercial buildings with access to steam, industrial processes, commercial buildings with natural gas availability, and government buildings.

Program Goals and Activities

The Absorption Chillers for Buildings program plans to continue its work with industry to make chillers more efficient in their engineering and more prominent in the marketplace. One general goal is to compare thermally activated chillers with conventional heating, cooling, and air conditioning (HVAC) systems.

Working with York International, the program is developing, testing, and marketing an advanced Double Condenser Coupled (DCC) commercial chiller, which is expected to be 50 percent more efficient than conventional chillers. The DOE-patented DCC technology uses a $LiBr/H_20$ refrigerant solution and is targeted for near-term commercialization.

The program also will develop mobile demonstrations of advanced desiccant dehumidifier and chiller systems to inform the public about these technologies, which will often be used in tandem for greater efficiency.

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