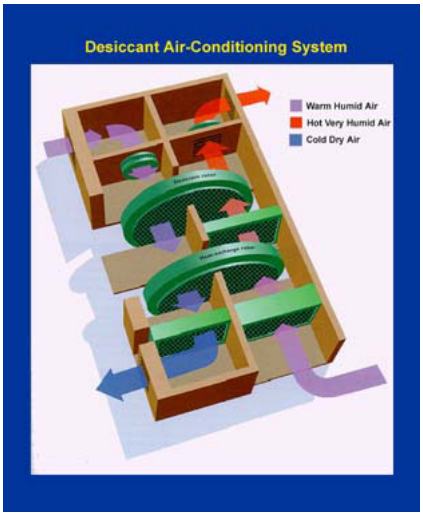
Thermally Activated Technologies

Technology Description



Thermally Activated Technologies (TATs), such as heat pumps, absorption chillers, and desiccant units, provide on-site space conditioning and water heating, which greatly reduce the electric load of a residential or commercial facility. These technologies can greatly contribute to system reliability.

System Concepts

- TATs may be powered by natural gas, fuel oil, propane, or biogas, avoiding substantial energy conversion losses associated with electric power transmission, distribution, and generation.
- These technologies may use the waste heat from on-site power generation and provide total energy solutions for onsite cooling, heating, and power.

Representative Technologies

- Thermally activated heat pumps 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 as much as 50%. Heat pumps take in heat at a lower temperature and release it 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 inside to outside.
- Absorption chillers provide cooling to buildings by using heat. 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. The chiller transfers thermal energy from the heat source to the heat sink through an absorbent fluid and a refrigerant. The chiller achieves its refrigerative effect by absorbing and then releasing water vapor into and out of a lithium bromide solution. In the process, 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, reducing the pressure. 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 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.
- Desiccant equipment is useful for mitigation of indoor air-quality problems and for improved humidity control in buildings. The desiccant is usually formed in a wheel made up of lightweight honeycomb or corrugated material (see figure). Commercially available desiccants include silica gel, activated alumina, natural and synthetic zeolites, lithium chloride, and synthetic polymers. The wheel is rotated through supply air, usually from the outside, and the material naturally attracts the moisture from the air before it is routed to the building. The desiccant is then regenerated using thermal energy from natural gas, the sun, or waste heat.

Technology Applications

- Thermally activated heat pumps are a new generation of advanced absorption cycle heat pumps that can efficiently condition residential and commercial space. Different heat pumps will be best suited for different applications. For example, the GAX heat pump is targeted for northern states because of its superior heating performance; and the Hi-Cool heat pump targets the South, where cooling is a priority.
- Absorption chillers can change a building's thermal and electric profile by shifting the 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. Facilities with high thermal loads, such as data centers, grocery stores, and casinos, are promising markets for absorption chillers.

- Desiccant technology can either supplement a conventional air-conditioning system or act as a standalone operation. A desiccant can remove moisture, odors, and pollutants for a healthier and more comfortable indoor environment. Facilities with stringent indoor air-quality needs (schools, hospitals, grocery stores, hotels) have adapted desiccant technology.
- CHP applications are well suited for TATs. They offer a source of "free" fuel in the form of waste heat that can power heat pumps and absorption chillers, and regenerate desiccant units.

Current Status

Thermally activated heat pump technology can replace the best natural gas furnace and reduce energy use by as much as 50%, while also providing gas-fired technology.

Desiccant technology may be used in pharmaceutical manufacturing to extend the shelf life of products; refrigerated warehouses to prevent water vapor from forming on the walls, floors, and ceilings; operating rooms to remove moisture form the air, keeping duct work and sterile surfaces dry; and hotels, to prevent buildup of mold and mildew.

Companies that manufacture TAT equipment include:

York International	Broad
Trane	Air Technology Systems
Munters Corporation	American Power Conversion Company
Kathabar Systems	Goettl

Technology History

- In the 1930s, the concept of dehumidifying air by scrubbing it with lithium chloride was introduced, paving the way for development of the first desiccant unit.
- In 1970, Trane introduced a mass-produced, steam-fired, double-effect LiBr/H2O absorption chiller.
- In 1987, the National Appliance Energy Conversion Act instituted minimum efficiency standards for central air-conditioners and heat pumps.

Technology Future

- Expand the residential market of the second-generation Hi-Cool residential absorption heat pump technology to include markets in southern states; the targeted 30% improvement in cooling performance can only be achieved with major new advancements in absorption technology or with an engine-driven system.
- Work in parallel with the first-generation GAX effort to determine the most attractive second-generation Hi-Cool technology.
- Fabricate and test the 8-ton advanced cycle VX GAX ammonia/water heat pump.
- Fabricate and test the 3-ton complex compound heat pump and chiller.
- Develop, test, and market an advanced Double Condenser Coupled commercial chiller, which is expected to be 50% more efficient than conventional chillers.
- Assess new equipment designs and concepts for desiccants using diagnostic techniques, such as infrared thermal performance mapping and advanced tracer gas-leak detection.