DOE/GO-102001-1165
NREL/BK-710-29267
May 2001

5.2.5 Desiccant Dehumidification

Desiccants are materials that attract and hold moisture, and desiccant air-conditioning systems provide a method of drying air before it enters a conditioned space. With the high levels of fresh air now required for building ventilation, removing moisture has become increasingly important. Desiccant dehumidification systems are growing in popularity because of their ability to remove moisture from outdoor ventilation air while allowing conventional air-conditioning systems to deal primarily with control temperature (sensible cooling loads).

Opportunities

Desiccant dehumidification is a new approach to space-conditioning that offers solutions for many of the current economic, environmental, and regulatory issues being faced by facility managers. Indoor air quality is improved through higher ventilation rates, and achieving those fresh air make-up rates becomes more feasible with desiccant systems. At "low load conditions" outdoor air used for ventilation and recirculated air from the building have to be dehumidified more than they have to be cooled.

Properly integrated desiccant dehumidification systems have become cost-effective additions to many building HVAC systems because of:

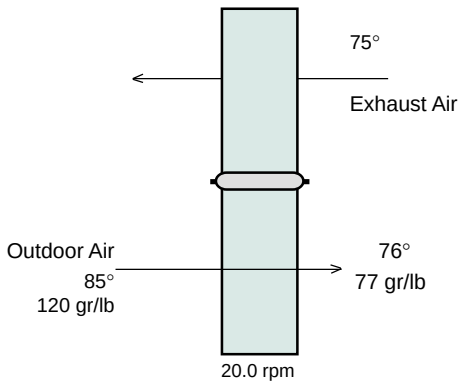
- Their ability to recover energy from conditioned air that is normally exhausted from buildings.
- The lower cost of dehumidification when low-sensible load, high-latent load conditions are met.
- The greater comfort achieved with dehumidified air.
- The promotion of gas cooling for summer air-conditioning by utilities in the form of preferential gas cooling rates.
- High electric utility demand charges, which encourage a shift away from conventional, electrically driven air-conditioning (which requires a heavy daytime loading).

Desiccant systems offer significant potential for energy savings (0.1 to 0.4 quads nationwide). They also inhibit microbiological growth by maintaining lower humidity levels. Better control of humidity prevents moisture, mildew, and rot damage to building materials.

Desiccant dehumidification is particularly attractive in applications where building exhaust air is readily available for an energy-recovery ventilator (ERV, or "passive" desiccant system) or where a source of waste heat from other building operations is available to regenerate an "active" desiccant system.

Moisture Exchange

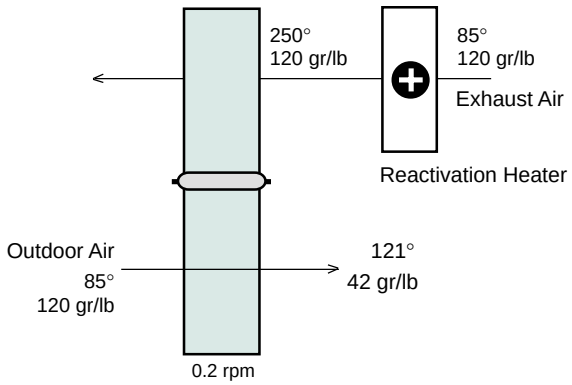
(Energy Recovery, or "Enthalpy" Wheel)



An energy recovery wheel has a small amount of desiccant, so it can transfer moisture. But with no heat for reactivation, dehumidification depends on the dryness and temperature of the exhaust air.

Moisture Removal

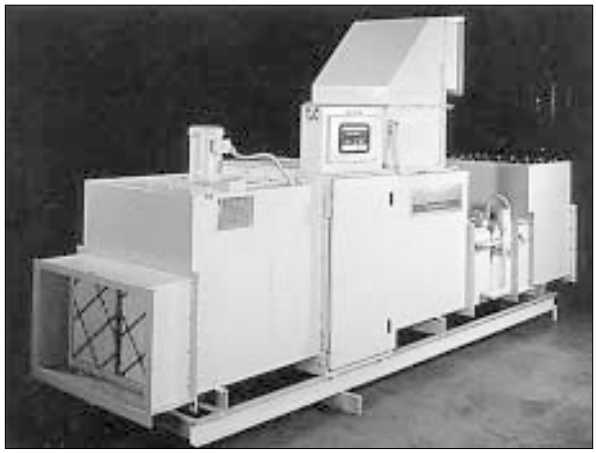
(Desiccant Wheel)



A desiccant wheel rotates slowly and contains more desiccant than a heat recovery wheel. By heating the reactivation air, the desiccant wheel removes much more moisture than heat recovery wheels.

"Passive" versus "active" desiccant wheels

Adapted from American Gas Cooling Center materials



Source: American Gas Cooling Center

The DRYOMATIC Dehumidification System from the Airflow Company may be installed indoors or outdoors.

Technical Information

To dehumidify air streams, desiccant materials are impregnated into a lightweight honeycomb or corrugated matrix that is formed into a wheel. This wheel is rotated through a supply or process air stream on one side that is dried by the desiccant before being routed into the building. The wheel continues to rotate through a reactivation or regeneration air stream on the other side that dries out the desiccant and carries the moisture out of the building. The desiccant can be reactivated with air that is either hotter or drier than the process air.

"Passive" desiccant wheels, which are used in total ERVs and enthalpy exchangers, use dry air that is usually building exhaust air for regeneration. Passive desiccant wheels require additional fan power only to move the air and the energy contained in the exhaust air stream. However, passive desiccants cannot remove as much moisture from incoming ventilation air as active desiccant systems and are ultimately limited in *sensible* and *latent* capacity by the temperature and dryness of exhaust air leaving the building.

"Active" desiccant wheels use heated air and require a thermal energy source for regeneration. The illustration above shows the operational characteristics of active and passive desiccant wheels. The advantage of active desiccant wheels is that they dry the supply air continuously—to any desired humidity level—in all weather, regardless of the moisture content of the building's exhaust air. They can be regenerated with natural gas combustion or another heat source, independent of—or in combination with—building exhaust air, which allows more installation flexibility. The regeneration process, however, requires heat input to dry the desiccant; this usually increases the operating cost of the system. Active desiccant wheels can remove much more moisture than passive systems and thus are the only desiccant approach that allows truly *independent* humidity control to any desired level.

$ Because the sizing of desiccant systems is based on the airflow rate (cfm), costs are typically given in terms of $/cfm. Passive desiccant system costs have been estimated by one HVAC manufacturer at $3 to $4/cfm. For large, active desiccant systems, the cost is usually about $6/cfm, while smaller units (less than 5,000 cfm) may cost up to $8/cfm. Installation costs vary according to specific site requirements.

References

"Two-Wheel Desiccant Dehumidification System," *Federal Technology Alert*, April 1997; www.pnl.gov/fta/8_tdd.htm.

"Applications Engineering Manual for Desiccant Systems," American Gas Cooling Center, Washington, DC, 1996.

Contacts

Distributed Energy Resources Program, Office of Power Technologies, EERE, U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, DC 20585-0121.

Building Equipment Research Program, Energy Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6070; (865) 574-2694.

American Gas Cooling Center, Inc., 400 N. Capitol Street, NW, Washington, DC 20001; (202) 824-7141; www.agcc.org.

Advanced Desiccant Cooling & Dehumidification Program, National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, CO 80401; (303) 384-7527; www.nrel.gov/desiccantcool.