Dehumidification Solutions for the 21st Century

Trane Helps Customers Manage Humidity with Leading-Edge HVAC Technologies

Museums and printing plants aren't the only ones that require humidity control – it should be a key design consideration in any heating, ventilating and air conditioning (HVAC) application. High humidity levels can reduce the quality of indoor air, make occupants uncomfortable, and damage a building's structure and furnishings. To avoid problems associated with high humidity levels, it's important to understand how well an HVAC system will dehumidify at both full load and part load.

Dehumidifying at Part Load

It's a myth that traditional HVAC systems control humidity along with temperature. In fact, part-load dehumidification performance varies by system type and control strategy.

Most basic, constant-volume (CV) systems (packaged terminal air conditioners, small packaged rooftop units, fan-coils, etc.) supply a single zone with a constant amount of air regardless of the cooling load. A thermostat compares the dry-bulb temperature in the occupied space to a set point and then modulates the system's cooling capacity accordingly. To avoid overcooling at part load, the system must supply warmer air.

In a typical chilled water application, a modulating valve reduces system capacity by throttling the water flow rate through the cooling coil. The warmer coil surface that results provides less sensible cooling (raising the supply-air dry-bulb temperature)—but it also removes less moisture from the passing air stream (raising the supply-air dew point).

In a typical direct expansion (DX) application, the compressor cycles off regularly to avoid overcooling. As the compressor operates for a smaller percentage of the hour, dehumidification capacity decreases significantly. The compressor doesn't run long enough for the accumulated condensate to fall into the drain pan, and it stays off for longer periods of time, allowing the remaining moisture on the coil surface to re-evaporate while the fan continues to run.

Briefly stated, the basic CV system matches sensible capacity to the sensible load; dehumidification capacity is coincidental. As the load diminishes, the system delivers ever warmer supply air. Some dehumidification may occur… but only if the sensible load is high enough.

Trane Offers Better Part-Load Dehumidification

Fortunately, with proper system design and control, HVAC systems can dehumidify better over a wide range of conditions—and do so cost-effectively and energy-efficiently.

Cool, Dry & Quiet: A Dehumidification Solution for the 21st Century

The Office of Building Technologies in the U.S. Department of Energy (DOE) is working with the HVAC industry to broaden the market for innovative dehumidification systems that balance indoor air quality (IAQ) and energy concerns.

Through a partnership with DOE and the Florida Solar Energy Center, Trane developed the CDQ™ (Cool, Dry, Quiet) desiccant dehumidification system. This unique system places a desiccant wheel in series with a traditional DX or chilled-water cooling coil (Figure 1). Unlike other desiccant dehumidification systems, a separate regeneration air stream is not needed.

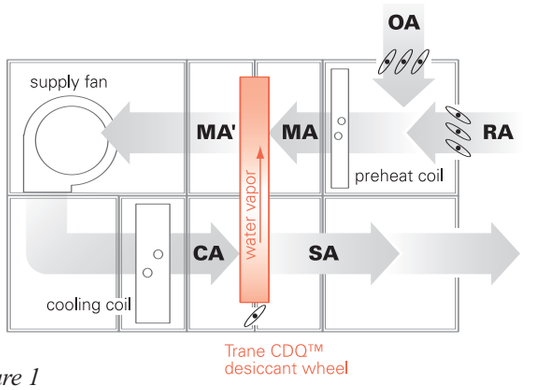

Figure 1

The "process" side of the CDQ desiccant wheel adsorbs water vapor from the air downstream of the cooling coil, while the "regeneration" side of the wheel adds it back into the air upstream of the coil, essentially giving the coil a second chance to remove water vapor from the air. In effect, adding the CDQ wheel increases the coil's dehumidification (latent) capacity without increasing its total cooling capacity.

Unlike most systems that use a traditional cooling coil for dehumidification, the dew point of the air leaving the Trane CDQ system can be lower than the surface temperature of the coil. This allows the system to achieve lower dew points with standard cooling equipment.

Adding a CDQ desiccant wheel to an air handler with a traditional DX or chilled-water coil results in a 20–300 percent improvement in dehumidification capacity, a 5°F to 15°F lower dew point, and a 20–80 percent reduction in energy consumption when compared to a system that uses a cooling coil with reheat.

Hot Gas Reheat: Cost-Effective Humidity Control

Hot gas reheat allows control of space humidity by recycling heat energy that would otherwise be rejected outdoors. When space humidity exceeds the desired limit, hot gas leaving the compressor is redirected through a reheat coil downstream of the cooling coil (Figure 2). The compressor continues to operate, dehumidifying the air, while reheat avoids overcooling the space.

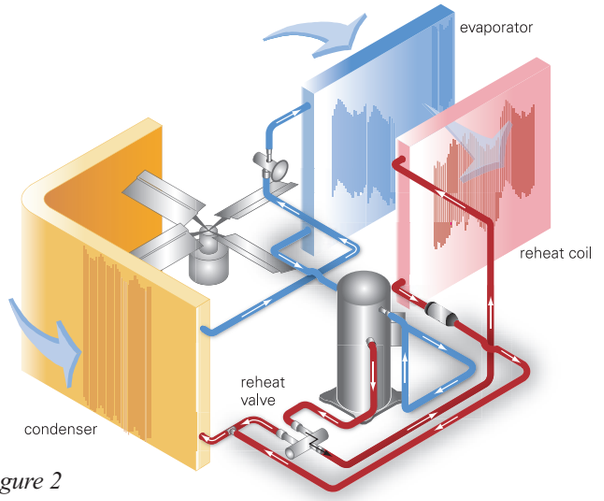

Figure 2

Hot gas reheat can be factory-installed in many Trane packaged rooftop units and water-source heat pumps. Trane's direct digital controls coordinate cooling, heating, and hot gas reheat functions over a wide operating and ambient temperature range. The feature complies with ASHRAE 90.1 requirements that limit the amount of new energy used for reheat during dehumidification, and achieves 13 SEER standards on Trane's Precedent™ rooftop line.

For customers seeking affordable humidity control, hot gas reheat is an excellent choice for new and retrofit applications.

VAV: Effective Dehumidification for Many Applications

Variable-air-volume (VAV) systems typically dehumidify effectively over a wide range of indoor loads. As long as any space needs cooling, the VAV air handler provides supply air at a dew point that's low enough (sufficiently cool and dry) to offset the latent load in the space.

One caveat: Avoid using supply-air-temperature reset during the cooling season. Warmer supply air means less dehumidification at the coil and higher humidity in the space. It also increases the supply fan's energy consumption—perhaps enough to negate the cooling energy savings.

Trane offers the broadest VAV product line in the HVAC industry, including VAV terminal units, packaged rooftop units, cataloged and custom-built air handlers, and Tracer™ controls. Trane's Integrated Comfort™ Systems feature pre-engineered controls, making VAV systems reliable and cost-effective.

Dedicated Outdoor-Air Systems: Decoupling Latent and Sensible Loads

Directing all outdoor air through a dedicated unit can eliminate the sensible and latent cooling loads associated with ventilation. This conditioned outdoor air is then delivered either directly to the spaces or to local units. Each local unit then cools or heats only recirculated air to maintain the target space temperature.

To obtain the most cost-effective and energy-efficient dedicated outdoor-air system:

Dehumidify the outdoor air so that it's drier than the space. This allows ventilation air to offset the latent space load, compensating for the inability of the local constant-volume units to dehumidify at part load. Size the dedicated outdoor-air unit to limit relative humidity to some maximum level (60% RH, for example) at worst-case conditions. Designing for drier indoor air requires larger equipment and increases operating costs.

Deliver the dehumidified air cold (not reheated to a "neutral" temperature), whenever possible, to offset part of the sensible cooling load in the space. "Neutral" air requires not only more cooling capacity from the local units, but also reheat at the dedicated outdoor-air unit. Delivering the air cold at full load permits smaller local units, which helps minimize the first cost of the system. Consider using communicating controls to determine when a space is at risk of overcooling, and then limit use of reheat to those times.

Trane offers DX or chilled-water dedicated outdoor-air units. And Trane's Integrated Comfort Systems can optimize the performance of the entire system, maximizing comfort and minimizing energy costs.

Improve the Dehumidification of Your HVAC Systems

Better dehumidification that's both cost-effective and energy efficient is possible using common HVAC systems. The right dehumidification choice for a given project depends on climate, building use, available budget and operating cost goals.

The time has never been better to offer customers systems that improve IAQ, reduce energy use, and comply with industry and regulatory standards.

References

Murphy, J.; "Dehumidification in HVAC Systems" applications engineering manual, SYS-APM004-EN, Trane, 2002.

Murphy, J. and Bradley, B.; "Better Part-Load Dehumidification", *Engineers Newsletter*, Volume 33, No. 2, Trane, 2004.

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