Controlling humidity efficiently

Effective humidity control is essential for workplace health and also for many other reasons in various indoor environments. *John Barker* of Humidity Solutions explains how humidification and dehumidification can be achieved with optimum energy efficiency.

Awareness of the importance of humidity control is nothing new, but it is probably true to say that there has been less focus on this aspect of the indoor environment than has been the case for thermal comfort. This situation is now changing, with many building operators from diverse sectors now seeking to take better control of relative humidity (RH) levels.

Depending on the exact nature and purpose of the buildings/spaces, delivering good RH control may require humidification, dehumidification – or both at different times of the year. Whatever the requirement, in an energy-conscious world the chosen solution needs to be as energy-efficient as possible.

Humidification

The traditional approach to humidification has been to heat water to produce steam – still the best solution for many projects. However, with energy and carbon rising high up the agenda, there is an appetite for solutions that use less energy than steam-generating systems.

Low energy alternatives to steam generation include evaporating water from wet media (evaporative humidifiers), and spraying water under high or low pressure directly into the air. Both techniques use cold water, avoiding the energy consumption required to boil water and generate steam. An additional benefit of evaporating water into the space, or into the ventilation system, using either method is adiabatic cooling – essentially 'free cooling'. This occurs when liquid water evaporates (changes state) to form water vapour suspended in the air. Heat energy is taken from the surrounding air to provide the energy required for this change of state to take place.

Historically, evaporative humidifiers have had limited effect but the latest generation offers a more sophisticated, controllable solution. In these units, water is supplied to the top of the evaporative module and flows down wet media. Warm dry air passes through the wet media, evaporates water and thus raises the humidity level and reduces the temperature. Latest models offer up to 12°C of cooling as a result of the transfer of energy when the water evaporates.

Another low energy option is to spray water through nozzles, so that the water is atomised and absorbed into the air (adiabatic humidification). The water may be sprayed – at low or high pressure - into ductwork or directly into the space being humidified. Low pressure nozzles use pressurised air so energy is consumed by the air compressor. High pressure nozzles take the energy for atomisation from high pressure water, so here the high pressure pump is the main energy consumer, although very low.

Achieving effective humidity control while minimising

lifecycle costs was a consideration for bespoke cardboard tube packaging manufacturer Visican, where there were problems with paper curl and static electricity resulting from low humidity in both the storeroom and the factory. The solution proved to be an adiabatic humidification system introducing water to the factory and store room through high pressure nozzles to maintain an RH of 55%.

A similar solution was used for a manufacturer of injection-moulded plastic drink bottles, again delivering moisture through fan-assisted nozzle heads, each configured to suit the area being served and to ensure effective humidification without risk of wetting or condensation on machines and products.

Dehumidification

Excessively high humidity can also be a problem in a number of situations. For example, in a cold room moisture in the air will condense onto the evaporator coil and freeze, resulting in reduced efficiency of the refrigeration plant. There can also be problems of ice formation in other areas, potentially creating hazards and almost certainly resulting in downtime for defrosting.

The most effective form of dehumidification for cold room applications is generally to use a desiccant rotor system that uses a constant and simultaneous flow of two airflows through a desiccant rotor in opposite directions. One airflow is for drying (process air) and the other is for rotor reactivation (wet air).

Desiccant rotor systems can reduce moisture levels at temperatures as low as -70°C and can now be supplied with a recovery plate heat exchanger, which recovers heat from the dry air and ensures there is no net transfer of heat to or from the surroundings.

Nor is desiccant dehumidification confined to cold stores. It was also the ideal solution for a pharmaceutical manufacturing facility in the South West of England, to ensure that the humidity being delivered to the space is below 15% RH at 21°C. These conditions are necessary for the production of reagent strips used in urinalysis, which are very sensitive to moisture.

In this instance the air from the facility was pre-cooled before passing through the desiccant wheel. This increased the relative humidity of the air to make the desiccant wheel more efficient and able to remove the moisture load from the air. The drying process adds heat to the process air, so this was cooled using a post-cooler to deliver the air back into the space at 21°C.

Swimming pools can also experience problems with high humidity, as the relatively high temperatures required for comfort also enable high levels of humidity. Traditionally, this is performed with air handling units that replace the moist air with fresh, drier air. This fresh air must be tempered to the pool hall condition (typically 30°C) and, even with heat recovery modules this is a high energy option.

To address this, a new generation of refrigerant cycle-based dehumidifiers has been introduced that extract the latent heat in the moist extract air and then use this to re-heat the dried air. The process dramatically reduces the air volumes involved thus saving on fan power and, if surplus energy is recovered, this can be transferred to the pool water using a plate heat exchanger.

With all humidity control projects the key is to understand the customer's priorities and devise a solution that meets them. Increasingly, energy-efficiency will be one of the criteria that needs to be taken into account, so it makes sense to seek guidance from specialists in arriving at the best system design.