MOISTURE MANAGEMENT

Getting operating room humidity under control

Controlling humidity in operating rooms provides a host of benefits, which contribute to a healthier and more cost-efficient building. However, it is easier said than done. Here, John Gowing of EI Solutions Inc. discusses the challenges of curbing humidity and provides climate control strategies.

Why is humidity a challenge in operating rooms?

An operating room requires high volumes of outdoor air. If air entering an operating room is drier (or less humid) than the room itself, it will reduce the amount of humidity in the operating room. Conversely, if air entering an operating room is more humid than the room itself, then the humidity level will rise within the operating room.

Warmer air can hold a higher level of water vapour or humidity. Therefore, a room that is 18 C with 50 per cent relative humidity (RH) has a lower level of absolute humidity than a room that is 20 C with 50 per cent RH. The absolute

humidity level can be measured in terms of dew point temperature or vapour pressure. Air with a higher absolute level of humidity has a higher dew point and corresponding vapour pressure.

In winter, colder outdoor air limits the dew point temperature to a very low level, which results in very dry air. As a result, healthcare facility managers are challenged with having enough humidification capacity to compensate for the lower humidity level within the outdoor ventilation airstream and the reduction in humidity in the operating room (as higher indoor vapour pressure moves out of the building). Fortunately, medical professionals prefer a lower space dry-bulb temperature in the operating room since they must wear heavy gowns that can make surgery uncomfortably hot. Lowering the operating room temperature has the benefit of increasing the room's relative humidity.

Spring until fall also poses a challenge to facility operators because outdoor air is very humid. Most traditional cooling coil and reheat systems provide suitable cooling or lower space temperature levels in the operating room during this time. Regrettably, the same cannot always be said for the absolute humidity levels that are required to be maintained in the operating room. To dehumidify an operating room with a cooling coil, the coil must be designed to operate with very low leaving temperatures in order to supply drier (low dew point) air to the space. It is important to note that the room dew point temperature will always remain higher than the supply air dew point temperature due to internal latent loads (people and infiltration).

The gradient or difference between a cooling coil's optimum dew point and the operating room is dependent on the humidity load in the operating room; leaks in the ductwork feeding the operating room; and the effectiveness of the vapour barrier between the operating room and surrounding spaces. It is important that adjacent spaces not have high vapour pressure as it will push humidity into the operating room. A good practice for slowing down the rate at which moisture migrates from a surrounding area into the operating room is to provide a buffer zone of reduced humidity.

The shoulder months of the seasons can also be of concern to facility operators. Some ventilation systems employ an enthalpy control strategy, which allows for free cooling from outside air during cooler periods. However, when the temperature is low and humidity is high, the outdoor dew point will be too high to control the humidity level in the operating room. This free cooling strategy can be corrected by inserting a control loop that takes the outdoor dew point temperature into account.

What is the recommended humidity level and temperature range for operating rooms?

Based upon CSA Z317.20-10, the recommended humidity level in an operating room is within the range of 40 to 60 per cent RH. An acceptable space dry-bulb temperature range is 18 C to 23 C.

In terms of absolute humidity levels, a room that has an 18 C space temperature with 40 per cent RH has a corresponding dew point temperature of 4.2 C. Similarly, a room at 18 C with 60 per cent RH has a 10.1 C dew point temperature. At higher space temperatures, a room at 23 C with 40 per cent RH has a corresponding space dew point temperature of 8.7 C.

To achieve these humidity levels during the dry months of winter, the dew point in the ventilation air must be higher than the space dew point temperature. Conversely, to achieve the prescribed humidity levels during the humid months

of spring through fall, the dew point in the ventilation air must be lower than the space dew point temperature.

What can occur if humidity is too high?

Many bacteria and viruses can thrive in high humidity, putting patients and healthcare workers at risk.

How can humidity be controlled in operating rooms?

A suitable vapour barrier and buffer zone between an operating room and adjacent spaces can help control humidity. The latter will slowdown the rate at which moisture from more humid surrounding spaces migrates into an operating room.

During winter months, the facility should have enough humidification capacity to overcome the net losses of humidity due to ventilation and the migration of moisture out of the operating room.

In the high humidity months, the facility must have enough dehumidification capacity (at a low dew point level) to overcome the humidity in the ventilation air, the humidity loads within the operating room and moisture migration from areas surrounding the operating room.

How does dehumidification equipment work?

There are two main ways in which dehumidification systems work.

Most traditional systems employ a cooling coil and reheat system. With a cooling coil dehumidification system, air passing over the coil is sub-cooled to a temperature where moisture condenses out of the airstream. The lower dew point temperature that leaves the coil governs how much the humidity level can be reduced inside the operating room. The very cool air that leaves the cooling coil must be reheated so that the operating room is not over-cooled.

A central chiller supplies most operating rooms' air-handing units with chilled water. Common chiller systems are designed to supply 6.7 C chilled water but lower chilled water supply temperatures can be achieved (3.3 C). However, lower temperature chillers are more expensive, provide less capacity and are far less efficient than standard chillers.

Contemporary system designs use desiccant technology to target the new standards for low dew point levels in operating rooms. These systems employ an active desiccant rotor/wheel to provide very low supply air dew point temperatures. The first stage of dehumidification is accomplished with cooling coils, which lowers the conditioned air dew point temperature to 10 C (where the chiller remains efficient). The air then passes through a desiccant rotor where moisture is removed in the vapour phase, producing very low dew points (typically between -5 C and 0 C). These low dew point levels cannot be achieved by traditional cooling systems. ■