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## Humidifier Fills Critical Control Need in Norwegian Hospital Burn Unit

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Departments

Consulting-Specifying Engineer

When Norway's largest hospital—the Riks-hospital—opened in Oslo, it quickly became apparent that the installed electrode-type humidifiers could not maintain stable, reliable humidification.

Of particular concern was the skin culture laboratory of the burn unit, where relative humidity (RH) needs to be consistently maintained at 60%, with no more than a 1%

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fluctuation in RH. Otherwise, skin grafts won't take.

The installed electrode-type system could not meet this requirement. Frequent draining and filling cycles caused wide fluctuations in humidity. In addition, electrical interference from the humidifiers was negatively affecting the nearby magnetic resonance imager.

Christian Gamborg, the hospital's chief engineer, contacted consulting engineers at Technoconsult who recommended resistive-element electric humidifiers. Working with a Norwegian equipment distributor, they created a new, more demanding specification. At the Riskhospital, the bigger issue was tight RH control.

### **Achieving tight RH control**

Controlling RH in commercial and industrial environments can be easy or challenging, depending on the level of control required. In commercial buildings, RH fluctuations of 5% to 7% are common and relatively easy to maintain. But humidification in industrial or medical processes, where fluctuations significantly affect process quality, is much more challenging. The closer to set point that RH levels track, the more processing productivity improves.

To achieve RH control within 1% of set point at the Rikshospital skin culture lab, many variables must be managed, the most important of which is dry-bulb temperature; as dry-bulb fluctuates, so does RH. A 1°F drop in temperature causes a 2-3% increase in RH. Key to controlling temperature is careful attention to air-handling system design. Moisture containment, accomplished with vapor barriers and proper pressurization, is important, as are the number of air changes per hour. As air changes per hour increase, humidifier output fluctuations become more apparent.

Other variables affecting RH are controller capabilities, sensor type and placement, dispersion assembly placement, location of duct components and duct temperatures. But variables most relevant to achieving  $\pm 1\%$  control in the burn unit were the humidifier make-up water type and energy source control.

### **Water hardness is a factor**

All isothermal humidifiers boil water into steam. They have a make-up water fill valve, a drain valve for periodic or end-of-season draining and a water level control mechanism. Some systems also possess a water surface skimmer for reducing particulates at the high-water level.

Isothermal humidifiers also use a variety of water types from purified, demineralized water such as deionized (DI) or water filtered by reverse osmosis (RO), to softened or tap water. Water hardness ranges from zero grains/gallon for DI/RO water to more than 20 grains/gallon for tap or well water. As water hardness increases, so does the need for regular skimming, draining and flushing of the humidifier to remove accumulated minerals in the humidifier tank. Skimming removes precipitated minerals before they attach to humidifier tank walls and elements as scale. As water is skimmed off, cold makeup water is introduced into the tank. This cold water often causes a delay in steam output—creating an RH fluctuation—until the cold water is heated to boiling.

Drain and flush cycles—usually automated—completely drain the humidifier and then typically flush the tank with cold water. In this situation, not only is the humidifier off-line for a period of time, but the tank needs to be filled and heated to boiling before it can produce steam. In the meantime, the RH level can drop 5% or more until the humidifier is producing steam again. In process-critical environments, humidifiers typically use softened or DI/RO water, depending on the level of control required. The fewer the minerals in the water, the better the control capability.

Norway's water supply contains almost no minerals. The controller on Rikshospital's new humidifier allowed programming to eliminate skimming and drain/flush cycles. The water fill rate was adjusted so that make-up water entered the humidifier tank slowly so as to not break the boil. Along with a consistent energy supply, the steam output remained constant so that the RH in the burn unit stayed consistently within 1% of 60%.

#### Energy delivery and modulation

Another important requirement is providing consistent energy to the heating components. There are two ways to modulate energy delivery: full analog modulation, such as with a steam or gas valve, or on/off modulation such as with a time-proportioning electric element system. With the latter, heaters cycle on and off at a rate corresponding to the demand signal. Cycle times range from one to 100 seconds. Mechanical contactors are typically used when cycle times are above 60 seconds; electronic controllers are used for rapid cycling, tight control and quiet operation. The faster the heaters cycle on and off, the closer the humidifier output tracks humidity set point.

When a humidifier has more than one heater, heater duty time is shared. For example, if a humidifier has four output stages controlled by four contactors to achieve a 55% system demand using a 60-second cycle time, two contactors are on—each providing 25% of the output—and a third contactor is on for 5/25 of 60 seconds, or 12 seconds on and 48 seconds off. On/off cycling duty is typically rotated to reduce contactor

wear. To increase the cycling rate (up to 1 second), a single solid state relay or silicon-controlled rectifier can be added and do all the cycling; this is called SSR modulation with contactors. Or, all heat stages can be controlled by SSRs or SCRs—called 100% SSR or SCR modulation—allowing the tightest possible control because all heat stages can cycle rapidly.

#### A worthwhile switch

At the Rikshospital burn unit where tight RH control was required, switching from electrode-type to electric-element humidifiers caused steam output to remain constant within 1% of set point.

The project included replacement of the burn unit electrode humidifiers, as well as all the hospital's electrode boilers. The relative humidity in the skin culture laboratory is now predictable and stable. The burn unit is able to help more patients more effectively, and the hospital is able to keep maintenance costs down.

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