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Improper Humidifier Substitutions Are All Wet

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In the construction world—much to the chagrin of specifiers—product substitutions are frequently made, usually because an alternate product is available to the contractor at a lower cost, or is part of a package the contractor gets a better deal on. Sometimes these substitutions work, but often, especially with more critical or technical systems, the results are less than stellar.

Take, for example, Mercy Medical Center in Canton, Ohio, which was undergoing a renovation, including a refurbished air-handling system. The consulting engineer, LRM Engineer, Akron, in their specification, called for the replacement of several AHU components, including very specific instructions regarding a new humidifier. But the

hospital took a shortcut that backfired—and ended up travelling a long road back to the exact specification.

The original prescription

Because there was 5-psi steam available on site, LRM chose a steam-dispersion panel that would disperse boiler steam directly into the airstream. Depending on the load and absorption requirements, this type of steam injection humidifier includes a dispersion tube or set of tubes.

While several manufacturers make this type of product, the distance from a steam-injection dispersion tube to the point of absorption varies greatly among products and manufacturers, with short absorption distances the most difficult to achieve. If there is plenty of room in a duct or AHU, a humidifier that requires a long absorption distance may be adequate. But in a duct or AHU with elbows, fans or filters downstream of the humidifier, it is absolutely essential that absorption occurs before the steam hits those objects. Otherwise, it will condense and drip, which can cause microbial growth and result in foul smelling, unhealthy air. In addition, if humidification steam is not absorbed, desired humidity levels will not be met.

For the Mercy retrofit, the new humidifier was to be installed about 4 ft. upstream of a filter bank within the AHU. To ensure that moisture absorption would occur completely before air reached the filters, the engineer selected a multiple-tube assembly with separate steam supply and condensate headers. Additionally, the panel was sized to span the width and height of the available airflow in the AHU to maximize air/steam mixing. LRM also wrote a performance specification that stated the humidifier must provide absorption to preclude water accumulation on any surfaces within 15 in. downstream of the humidifier.

The actual installation

While these important considerations were incorporated into the design, the hospital veered from the plan in the field, substituting an alternate.

Making a successful humidifier substitution, however, requires an understanding of some often-misunderstood absorption basics (see "Humidification Specification Advice," p.52).

Absorption is affected primarily by three things:

- **Duct or AHU temperature.** Cool air absorbs less moisture than warm air and will require a longer absorption distance.
- **The difference between *entering* and *leaving* relative humidity (RH).** The

more humidity that needs to be dispersed into the airstream, the longer the absorption distance.

- **Mixing of air and steam.** Uneven airflow, nonuniform mixing of steam with air and the number of steam discharge points in the airstream will affect absorption distance.

Misunderstanding this final principle—mixing air and steam—meant the hospital had to install three different humidifiers before getting it right.

First, a single-tube humidifier—made by a company not originally specified, and bought as part of a package—was installed and started up. Unfortunately, there is no single-tube humidifier on the market that could have met the absorption requirements of this job. As a result, it proceeded to completely saturate the filter bank. On-site staff quickly removed the filters and noted that steam was absorbing several feet downstream of the filter bank location.

A second humidifier—this time, a multiple-tube assembly, but from the same manufacturer—was installed. The unit covered about one-third of the available airflow, but even if it had covered the full airflow, it would not have been able to provide absorption before the filter bank because each tube had only one row of steam discharge points. Thus, when started up, it absorbed better than the first humidifier, but it still fully saturated the filters, causing dripping.

Again, hospital staff promptly removed the filters and noted that the absorption distance was 2 ft. past the filter bank—much more than the required 15 in. from discharge.

Finally, a third humidifier—the one specified—was installed. Once it started up, it provided full absorption within 12 in., actually improving on the engineer's specification.

This unit easily met the absorption requirements for three distinct reasons: First, the unit had two rows of steam orifices on each tube, allowing superior mixing; second, the panel was sized to span the height and width of the available airflow, optimizing mixing; and third, the unit had a second header designed for managing condensate, so discharged steam is always dry, with no entrained condensate.

The moral of the story: Consider more than just the price.

Humidification Specification Advice

Substituting a different product for the humidifier specified on a retrofit project at Mercy Medical Center, Canton, Ohio, led to problems that can teach a number of lessons, including the following:

- *Find a representative you can trust.* Many HVAC engineers do not design humidification systems nearly as often as they design heating systems, and so, they are not as familiar with humidification system design. Given the complexities of providing proper humidification, it is important to work with a manufacturer's representative who really understands humidification. This is especially important with critical applications, where either short absorption distances or accurate control are required.
- *Write a performance specification.* Because, in this case, the design engineer wrote a performance specification, the contractor was required to meet that specification, regardless of how many times he tried a substitution. Anticipate substitutions and cover yourself with a performance spec.
- *Consider the reputation of the manufacturer.* The manufacturer of the first two humidifiers did not stand behind their product, at great cost in time and money to the contractor and engineer.
- *Insist on published absorption distances.* Only the last installed humidifier had an absorption distance guarantee with absorption data published in a printed catalog. One way the engineer, in this case, might have improved his specification would have been to add a note to the "acceptable manufacturers" section stating, "The manufacturer must provide published data guaranteeing the required absorption distance." Don't settle for a note on the product order. Insist on data printed in a catalog or published on a web site.
- *Improve mixing action to reduce absorption distance.* Add more tubes—or use tubes that have double rows of steam orifices—to increase the amount of steam mixing with available airflow. To ensure absorption upstream of a filter bank, install a fan or heating coil downstream of steam discharge to improve air and steam mixing action. And size dispersion assemblies to span the full height and width of the available airflow to maximize air/steam mixing.
- *Manage condensate.* Some condensation is inevitable in steam dispersion, but condensate can be controlled and directed away from where it will cause problems. A double-header multiple-tube dispersion panel uses gravity to remove condensate. Steam enters the top header, escapes through the steam orifices and condensate drains out the bottom header. Many large-capacity steam injection systems will have strategically-placed steam traps to ensure that only the hottest, driest steam is discharged into the airstream.