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Engineering White Paper

SPECIFYING HUMIDIFICATION SYSTEMS FOR MISSION CRITICAL ENVIRONMENTS

EMERSON Network Power

Summary

Precision humidity control is essential to the effective operation of data centers, server rooms and other facilities housing sensitive electronics. Humidity control is typically provided by the precision air conditioning system, with the humidification system playing the central role in the process.

Although a number of technologies have been developed to provide humidity in the data center –– evaporative, ultrasonic, immersion, infrared, steam canister and steam grid –– steam canister and infrared are the most commonly used.

Infrared is the preferred choice for mission critical applications because it provides faster, more responsive operation than steam canister systems. However, application or size limitations may prevent the use of an infrared system. In these cases, steam canister systems can provide an effective solution to humidification in the data center.

The Importance of Humidity Control

With ever-increasing requirements for reliability and availability, environmental control is critical to protecting today's sensitive computer systems. A clean, filtered environment with precise control over temperature and humidity is mandatory. This requirement is not limited to large data centers. With space at a premium, small offices, storage rooms and even closets are being utilized for servers, routers and other electronic equipment. Proper consideration for temperature and humidity control is just as important for these locations.

During facility design or remodeling, humidity control is often given less priority than temperature control, air movement and other more obvious variables. Temperature changes, dust, drafts, radiant heat and odors are sometimes more noticeable than slight changes in humidity. However, ignoring the impact of humidity can result in serious long-term problems, including damage to equipment and to the facility's infrastructure.

In most cases, the optimal relative humidity range for a data center environment is 45-50 percent. An above-normal level of moisture in the air can corrode switching circuitry, which can result in malfunctions and equipment failures. In data processing equipment, hygroscopic (moisture absorbing) circuit boards expand and contract with fluctuating humidity levels. Expansion and contraction of these boards can break microelectronic circuits and edge connectors. On the opposite end of the spectrum, low humidity can cause static electricity that will interfere with normal equipment operation and potentially destroy electronic components should a static discharge occur.

Humidity must be considered within the context of the total data center environment. The 2001 ASHRAE Fundamentals Handbook states, "A well-planned control system must coordinate the performance of the temperature and humidity equipment." This suggests that humidity control, and more specifically, the type of humidifier, be considered as an important factor in an overall environmental control plan specific to the needs of a particular facility.

A Word About Vapor Seals

Any effort to maintain acceptable relative data center humidity levels is virtually impossible without use of a vapor seal to isolate the room's atmosphere from conditions external to the room. Vapor barriers may be created using plastic film, vapor-retardant paint, vinyl wall coverings and vinyl floor systems, in combination with careful sealing of all openings, such as doors and windows, into the room. The vapor seal may be one of the least expensive, but most important and often overlooked, factors to controlling relative humidity levels in a data center.

Humidifier Types

A number of approaches have been developed to provide data center humidification, including:

Evaporative:
The evaporative approach to humidification uses an evaporative pad with air blowing across it. Typically, hot water is run over the pad and evaporated as the air travels through it. The warmer the water, the more effective the process is, using the energy in the water to aid the process. This approach is commonly seen in residential applications and is an inexpensive method of humidification. However, it generally does not provide the precision, cleanliness or speed-of-response required by data center operations.

Immersion:
Immersion humidifiers incorporate electric heating elements in a reservoir of water to provide humidification. Immersed heating elements raise the temperature in a tank, boiling the water and generating steam that is sent to a dispersal unit for absorption into the air. This type of humidifier is slow to react to humidity changes if it has been off for a while, and typically does not control the amount of minerals from the water that get introduced into the air. This method is generally not recommended for data center applications.

Infrared
Infrared humidifiers use high intensity quartz infrared lamps over a stainless steel humidifier pan. The infrared radiation from the lamps breaks the surface tension of the water, allowing the air flowing across it to evaporate and carry the moisture away as a particle-free vapor. This provides very precise and fast humidification.

Steam Canister:
Steam canister humidifiers use electrodes inserted into the water reservoir to pass current through the water, causing it to boil and to discharge pure steam at 212°F at atmospheric pressure through a steam distributor. This approach provides greater application flexibility than the infrared since the canister does not need to be mounted in the conditioned air stream, but it cannot react to changes in humidity as quickly if it has been off for a while.

Steam grid:
This approach is limited to use in steam-heated buildings or where steam can be otherwise injected into the system. Consequently, it is not an option for most data center facilities.

Ultrasonic:
The ultrasonic approach uses a Piezoelectric transducer that converts a high frequency electronic signal into high frequency

mechanical oscillation, which ultimately converts water into vapor at low temperature and pressure. Ultrasonic humidifiers get high marks for energy efficiency, but they require mineral-free water for trouble-free operation. The cost and maintenance of the water treatment system plus the cost of the humidifier itself can often negate potential energy savings. Additionally, humidifier placement is very critical to proper operation.

Steam Canister Humidifiers

Steam canister humidifiers discharge pure steam at 212°F at atmospheric pressure through a customized steam distributor. The canister portion of the humidifier can be installed inside the air conditioner or outside the air conditioner on ducts, on walls or in other locations. The distributor can be mounted in the air conditioner, in duct work or with a special blower box for free discharge in the space. The piping for the distributor is specifically sized to match the humidifier's capacity and must be located to avoid condensate blockage during operation.

A steam canister humidifier must bring the water in the canister up to boiling temperature before it is at full capacity, a process that can take several minutes. It does this by passing an electrical current through the water between electrodes. The mineral content in the water provides the conductivity for this to occur. The unit is consuming energy during this time, and the relative significance of this energy consumption varies based on how many times the unit turns on and off. Consequently, if operation is intermittent, steam canister systems will operate less efficiently than anticipated, and the efficiency of the system may be reduced over time as the system ages and the electrodes are consumed.

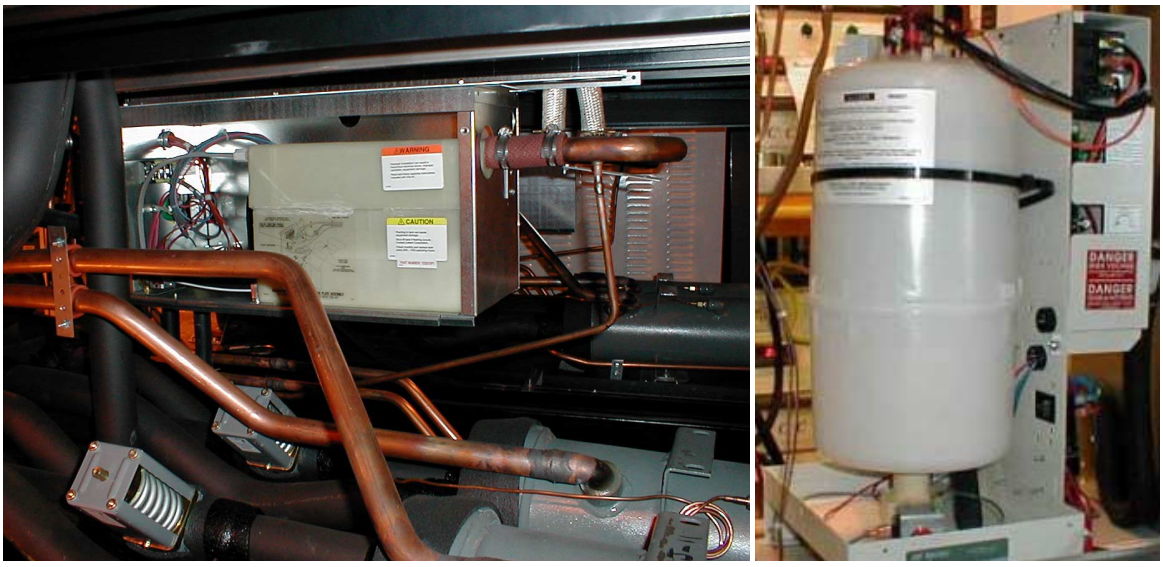

Figure 1. Typical steam canister humidifiers

Also, because steam canister humidifiers must "pipe" their moisture into the air unit's air stream, efficiency can be affected by losses in the hose and distributor system. The amount of loss depends primarily on the length of the hose and number of bends. For example, if the canister is generating 20 lbs/hr of moisture at the canister and 4 lbs/hr is lost due to condensation, the net output is reduced to 16 lbs/hr emission (for the same kW input required for 20 lbs/hr). This loss is evidenced by water running back down the hose to the drain or back into the bottle.

Efficiency can also be negatively impacted if the distributor is located close to the cold metal surfaces on the leaving side of the evaporator coil because some of the hot steam will condense on the metal rather than being absorbed into the air.

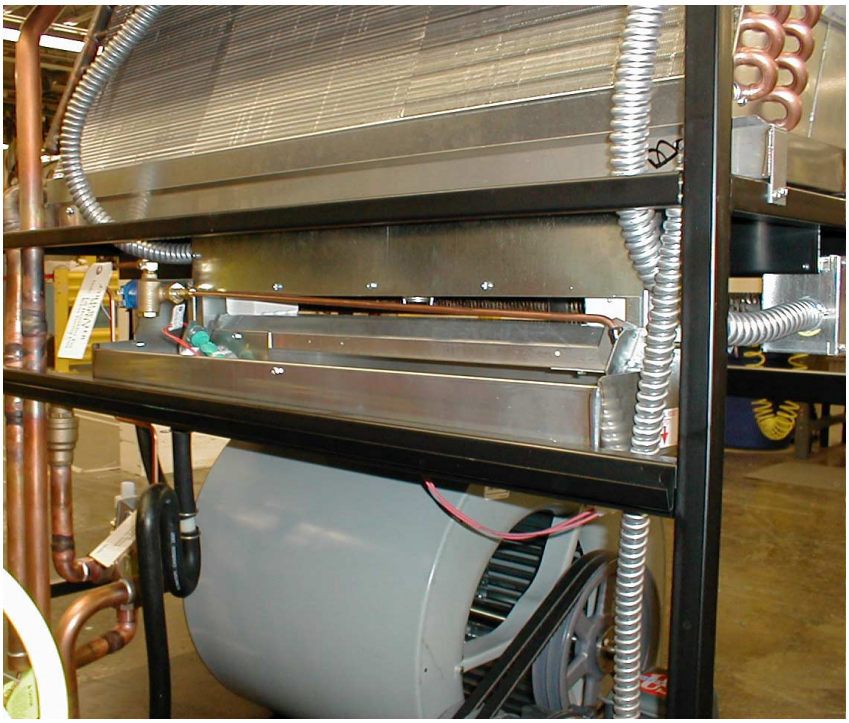

Figure 2. Infrared Humidifier

Another consideration for steam canister systems is water quality. They require water conductivity levels of between 200MM (micromho) and 500MM for optimal performance. Higher levels may result in excessive arcing, and at levels below 060MM, there is insufficient conductivity for current to flow between the electrodes. The water quality and number of hours of operation determine the life of the electrodes, which are part of the replaceable canister assembly. The minerals in the water cause the consumption of the electrodes, and accordingly, canisters can last for several weeks or several months. This is typically the only maintenance item in the system.

Infrared Humidifiers

Infrared humidifiers are typically installed within precision air conditioning units. This type of humidifier utilizes high intensity quartz infrared lamps over a stainless steel humidifier pan. The number and wattage of the lamps depends on the size of humidifier and voltage utilized.

When humidification is called for, heat energy from the lamps is reflected onto the water in the pan. The infrared radiation breaks the surface tension of the water, allowing the air flowing across it to evaporate and carry the moisture away as a particle-free vapor. This is the same principle that occurs when water evaporates from a puddle on a sidewalk. The process takes less than six seconds from turning on the bulbs to achieving full capacity, making infrared humidifiers very responsive. The only time capacity is reduced is if a bulb fails, but it can be easily and quickly replaced.

Because they do not depend on boiling water for evaporation to occur, and because there is no loss due to condensation, infrared units typically provide full rated capacity when operating. But because airflow for an infrared humidifier comes from the precision air unit through a bypass, the precision air unit's airflow must be at the recommended level for the humidifier to operate at full capacity.

Water quality as measured in micromho (MM) and total dissolved solids (TDS) has a negligible effect on the performance and effectiveness of infrared humidifiers. Infrared humidifiers can be used at any MM level, even where water conductivity levels are less than 060MM. The minerals in the water are not evaporated into the air stream in the infrared process. Instead, they are flushed through the system and either go down the drain or settle out in the bottom of the pan.

Serviceability of infrared humidifiers is simple, with all components easily accessible for periodic cleaning. The quartz lamps are located above and away from the water in the pan, minimizing the possibility of corrosion and burnout. The water pan must be cleaned or changed out periodically because sediment drops out of the water and scales on the pan. Most users simply keep two or more pans on hand that can be changed out as necessary and cleaned as maintenance resources permit.

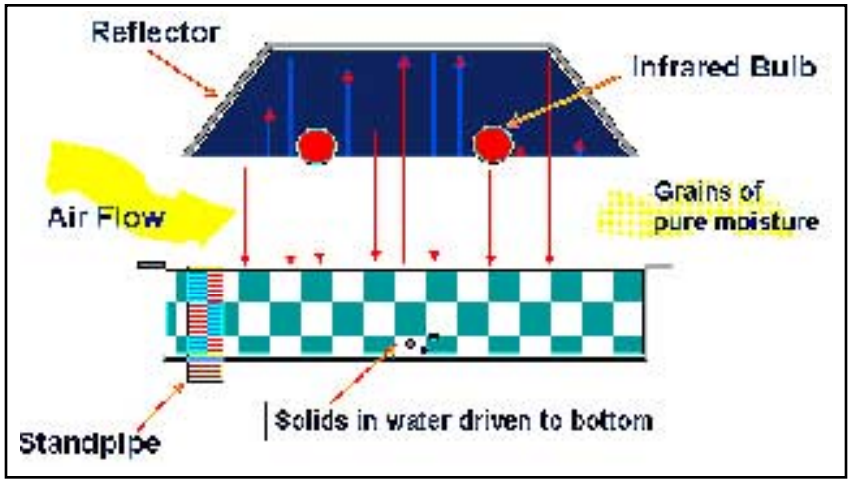

Figure 3. Infrared Humidifier operation.

Conclusion

The importance of humidity control in data centers and other critical system environments is often underestimated. Rather than being treated as an afterthought, it should instead be given priority consideration in the facility and system planning process.

Whenever possible, mission critical applications should be designed to use infrared humidification. Infrared provides a fast, energy efficient humidification solution that is not sensitive to water quality and requires little maintenance.

However, there will be some applications for which space or other limitations will prevent the use of infrared systems. In these cases, steam canister systems provide a viable alternative.

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