Fog humidification: fact and retrofits

Ensuring adequate humidity is seen increasingly as another way to maintain worker productivity. The author examines one type of humidification system, how it should be engineered for optimum efficiency, and some of the challenges involved with incorporating it into an existing hvac system.

BY CHARLES HOUSTON

Each year as winter rolls around, it is the same old story — mothers bundle up little children, pharmaceutical companies spend millions running ads promoting the "cold and flu season," and human resources directors struggle to cope with massive amounts of absenteeism. While science may some day come up with a cure for the common cold, hvac engineers can do something to mitigate the problem right now without having to wait for a medical miracle: install a humidification system.

Although more and more companies and building managers are including humidification equipment as part of their hvac system specs in new construction, a retrofit on an existing system presents unique problems. This article examines what makes up a fog humidification system, how it should be engineered for optimum efficiency, and some of the challenges involved with retrofitting an hvac system with high-pressure fog.

HUMIDIFICATION CONCERNS

Although wearing warm clothing helps protect one's health when outdoors, people spend 90% of their time indoors, where air quality issues can have a significant effect on employee health. In addition to data correlating indoor pollutants with various illnesses, other studies have shown that absenteeism and respiratory illness increase when the indoor relative humidity (rh) goes below 40%.

Accordingly, an office safety manual from the Centers for Disease Control (CDC) of the National Institutes of Health states that, "Low humidity conditions (which typically occur in the winter months) dry out the nasal and respiratory passages. Low humidity may be associated with an increased susceptibility to upper respiratory infections. Static electricity problems (affecting hair and clothes, particularly synthetic fibers) are good indicators of an office with low relative humidity." The CDC manual goes on to recommend that relative humidity be kept in the range of 30% to 50% rh.

Health issues, however, are not the only reasons to be concerned with relative humidity. Many manufacturers have discovered that carefully controlling the humidity greatly affects the quality of output from production processes. Electronics manufacturers rely on humidification to handle problems with static electricity. Offices and commercial establishments use it to increase the comfort and productivity of their employees and customers. Landlords are finding hvac issues, both temperature and humidity, to be key factors in determining the satisfaction of tenants, and thereby the building occupancy rates.

COMPONENTS OF A HIGH-PRESSURE FOGGING SYSTEM

High-pressure fogging is a type of adiabatic humidification system that is ideal for installations requiring over 200 lbs of water/hr (see sidebar). Installing a high-pressure fogging system in an air-handling unit (ahu) typically consists of four main elements: a supply of water, the equipment which produces the fog (pumps, nozzles, and associated pipes), excess water I handling components (droplet filter, drip tray, and drain pan) and a control system (Figure 1).

First, as with any humidification system, there must be a supply of pure water. Minerals in the water can cause calcification of the system as well as produce a fine dust which can eventually spread throughout the facility, resulting in lower indoor air quality (IAQ). Responsible fogging equipment manufacturers test the water supply and recommend a reverse osmosis or demineralization system if needed.

The second component is one or more high-pressure pumps and the associated plumbing. Producing droplets small enough to rapidly evaporate requires pressures from 1,000 to 2,000

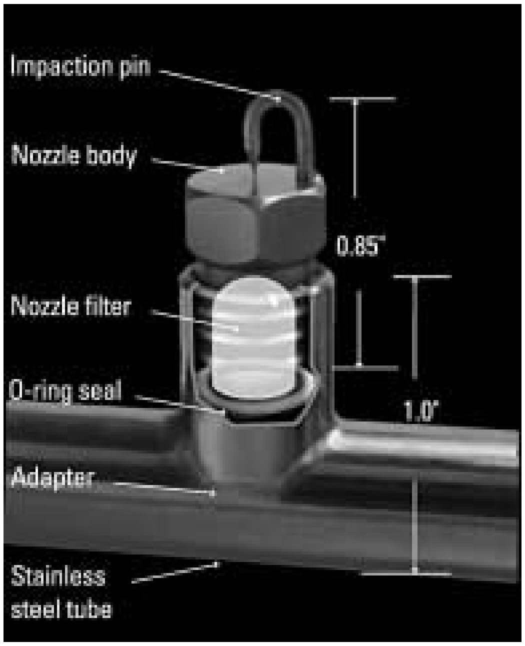


FIGURE 1. An impaction pin nozzle used in fog humidification systems

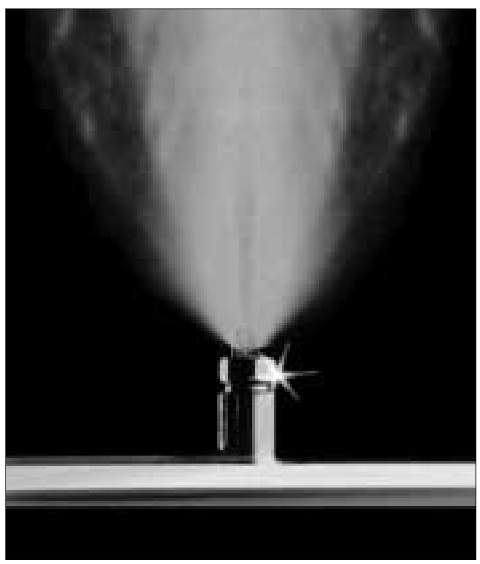
psi. To achieve this, ceramic plunger pumps with stainless steel or bronze heads are used. They should be operated at low speeds to reduce noise and vibration and have totally enclosed, fan-cooled electric motors. It is particularly important not to undersize the pumps and run them at high speeds as this usually results in premature failure.

The pumps send pressurized water to a manifold containing an array of nozzles placed within the air stream. The manifold generally consists of 0.5-in. OD tubes that do not impede the airflow and so do not result in a pressure drop. For best results, use stainless steel impaction pin nozzles with replaceable filters for ease of maintenance. Each of these nozzles produces more than three billion fog droplets per second with a mean size of around 15 microns. Thus evaporation is rapid, with little chance of duct wetting or mold growth. For greater placement flexibility, place nozzles on extenders. Where feasible, the spray is directed against the direction of airflow to improve evaporation and reduce space requirements.

A properly designed fogging system will result in 75% to 80% evaporative efficiency. To remove excess water, a droplet filter is typically installed downstream of the nozzle manifold. This filter catches any droplets that did not fully evaporate. It should be set at a 15-degree angle to the vertical so that water caught flows off it. Underneath the filter is a drain pan connected to the building's drainage system. A stainless steel drip tray extends from under the fog nozzles to the drain pan. The floor of the ahu should also be waterproofed and connected to the drain, so an overflow in the drain pan does not cause water to leak from the system.

Finally, there is the control system. This normally consists of on-off switches or variable-speed drives which alter the fog output to meet demand for humidification. Sensors are placed in the treated space to control the level of fog input, and an additional high-limit sensor is placed in the ducting, usually set at 85% rh, to prevent wetting of the ducting. Where the level of moisture is high, variable-speed drives are used to regulate the pressure of the fog spray in order to prevent oversaturation. As an alternative, high-pressure solenoid valves can be employed to allow for staged operation of a single ahu or to allow several ahu's in close proximity to use a single pump.

In Washington, DC, for example, a U.S. Post Office site uses a variable-speed drive for capacity control in a 150,000-cfm ahu with an air velocity of 500 fpm and 2,300 lbs of added water/hr. This amounts to 24.5 grains of moisture for each pound of air moved.



Top-quality fog systems produce more than three billion fog droplets per second, with a mean size of around 15 microns, allowing rapid evaporation.

RETROFITTING: FACTORS & OPTIONS

When retrofitting a fog system, the first thing to do is calculate system needs. Here are a few factors that need to be considered.

- The desired temperature and humidity in the conditioned space.
- The size of the space to be conditioned.
- The ambient air temperature and humidity during the times of day and seasons when humidification will be used.
- The amount of air moved by the air-handling system.
- Percentage of outdoor air in the ventilation system.
- Features of the building/space envelope — the amount of outside air that enters through doors, windows, cracks, etc.
- Other sources of humidity in the space including people, equipment, and industrial processes.

The ASHRAE *Fundamentals Handbook* has a number of charts and formulas which will help with the calculations, or the fogging manufacturer's representative can assist. The end result is determining how much water needs to be added to the system per hour in order to achieve the desired humidity level.

The next action is to assess the building's existing air-handling equipment and the space available for installing the fogging unit. The nozzle manifold is typically installed inside the ahu, downstream of the coil or the air filter. For greatest efficiency, the nozzles should be directed upstream, but this requires at least 14 in. between the nozzle tips and the coil or filter. If there is not enough space to do this, the nozzles can be directed either downstream or perpendicular to the flow of air.

If space is severely limited inside the ahu, fog nozzles can be installed inside the ducts instead. In such a case, however, a "fog plenum" must be added to the duct to reduce the air velocity to around 500 ft/min. This plenum must be watertight, well drained, and large enough to allow the water to fully evaporate. Ideally, it would allow for at least 5 ft of spray distance.

Finally, have a laboratory test the water supply to see if it is adequate. Some fog system vendors offer analyses that can track as many as 25 separate factors, including hardness, turbidity, and mineral content. Depending on what the tests reveal, the vendor will advise what is needed to bring the water up to an acceptable level.

SUCCESSFUL INSTALLATIONS

Installing a high-pressure fogging humidification system is not a difficult or lengthy process, and is one that can pay for itself quickly in terms of reduced absenteeism, increased productivity, and lowered energy costs. Consulting with an experienced vendor can ease and expedite the process, and today's turnkey systems make it relatively easy to install fog in most commercial or industrial environments. ES

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