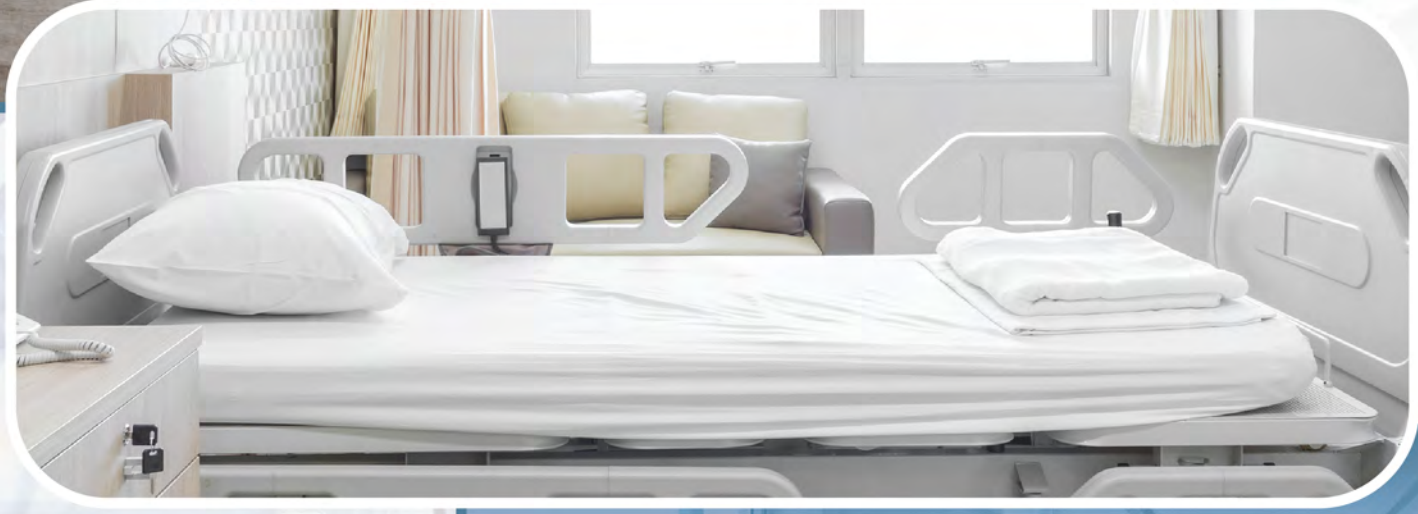
Humidity Control Combats Healthcare Associated Infection



Mee Industries Inc.

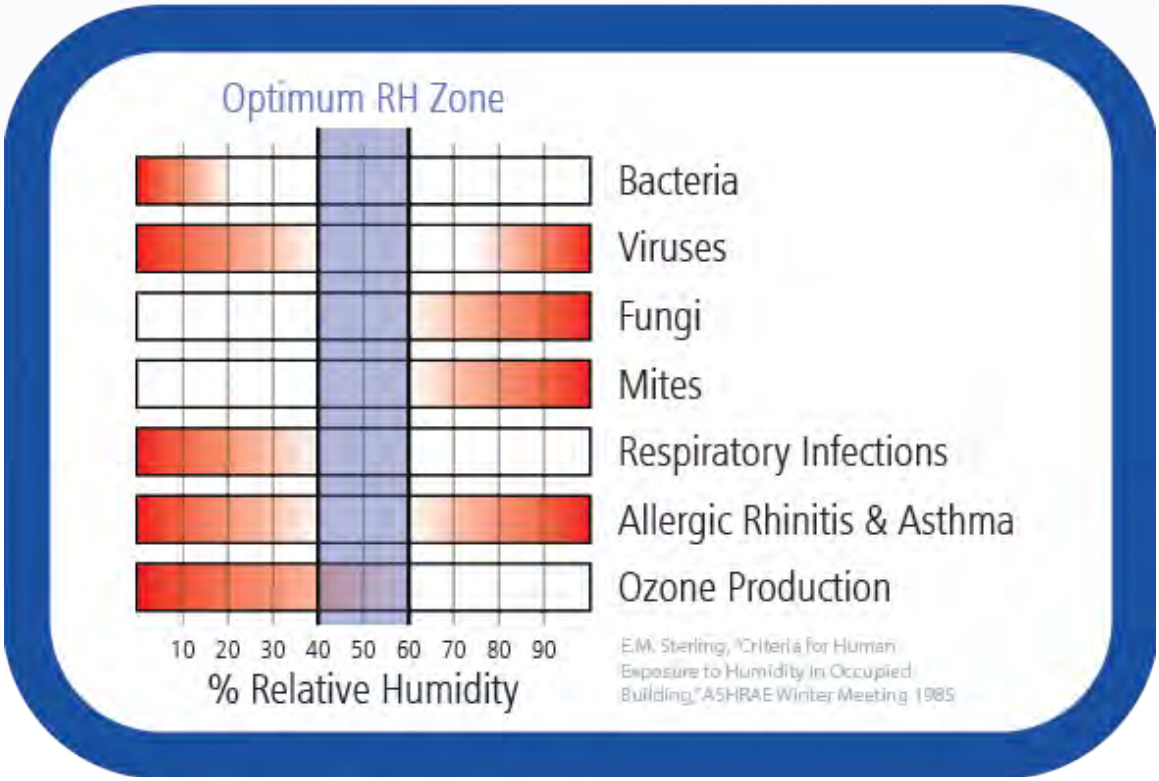
Executive Summary

While our hospitals perform daily miracles, the system is far from perfect. About one third of patients are subject to some kind of medical error during their stay and nine percent get sick from infections they acquired after they enter the facility.

Part of the reason is the hospital environment itself. Climate control systems recirculate air throughout the building, along with airborne viruses and bacteria. As these microbes have had to withstand a heavily disinfected and thoroughly cleaned environment, they can cause serious problems to patients who may already have a lowered resistance to infection.

Unfortunately, existing building practices with regard to humidity levels may be exacerbating the problem. Many hospitals have very dry air with relative humidity (RH) levels of around thirty percent or less. Unfortunately, this helps to spread infection. How? Infectious droplets—expelled from a sneeze or a cough, for example—have a larger diameter in higher humidity and therefore fall out of the air faster. At 60% relative humidity (RH), droplets are about 100 microns, and settle within four to six feet. In a low humidity environment, though, the droplets shrink in size to as little as 0.5 microns and remain airborne for long periods of time. They are carried away by recirculating air, enter the ventilation system and are transported throughout the facility.

A best practice, then, is to keep humidity levels in the 40% to 60% range as a way to reduce the frequency of infection (See chart below). Not only are potentially infectious particles larger and less harmful in a higher RH space, many pathogens have decreased



survival in a humid environment. Humans, too, are healthier in the presence of optimized levels of humidity.

Accurate control of humidity in the 40% to 60% range, then, can play a significant role in lowering the incidence of infection in hospitals. High-pressure water atomizing humidifiers from Mee Industries are now part of ASHRAE Standard 170-2013 Addendum M. The systems combat low relative humidity health issues in hospitals and medical facilities by introducing pure water humidification into building systems.

MeeFog does not require compressed air or steam. Direct pressure operation means few moving parts (and none in the air handler). The energy consumed is a small fraction of other technologies, such as compressed air, ultra-sonic, or steam systems, with MeeFog using about 1% of the energy that steam systems use. The installation of this system represents a major upgrade to building systems and a way to boost patient recovery.

Infectiousness of Hospital Environments

The healthcare sector has prided itself in a very high level of cleanliness for more than a century. Rooms, equipment, and instruments are kept spotless under strict protocols. Similarly, hands are washed, and staff wear gloves and face masks to prevent the spread of infection.

Despite these actions, however, healthcare professionals find themselves presiding over what has become an increasingly unhealthy environment. According to Dr. Stephanie Taylor, CEO of Taylor Healthcare Commissioning (M.D., M. Arch, CIC), about 9% of patients pick up a new infection inside a hospital during their stay.

Known as a health care-associated infection (HAI), the cost (to the hospital and society) is estimated at around $100 billion per year in the United States. The shocking truth is that HAIs kill more people than the combined totals from AIDS, breast cancer and car accidents.

Climate control only adds to the challenge. Mechanical ventilation, prevalent throughout most U.S. facilities, circulates a much higher volume of human-related bacteria than rooms with open windows accessing outside air. By their nature, hospitals are already the scene of a high volume of infectious microbes. But with air conditioning and heating systems in operation, many of the pathogens brought into the hospital by sick patients, visitors, and staff remain in circulation. Activities such as conversation, coughing, vomiting, skin shedding, toilet-flushing and sneezing send hundreds of thousands of tiny, potentially infectious particles into the air.

These microbes have evolved in extremely clean environments. They build up immunity to detergents, disinfectants, bleaches and other cleaning agents and can be quite virulent when they infect patients, many of whom already have a weakened immune system. That's why the number of recorded HAI cases has increased by 36% in the last 20 years. It is growing every year despite stepped-up surface hygiene measures.

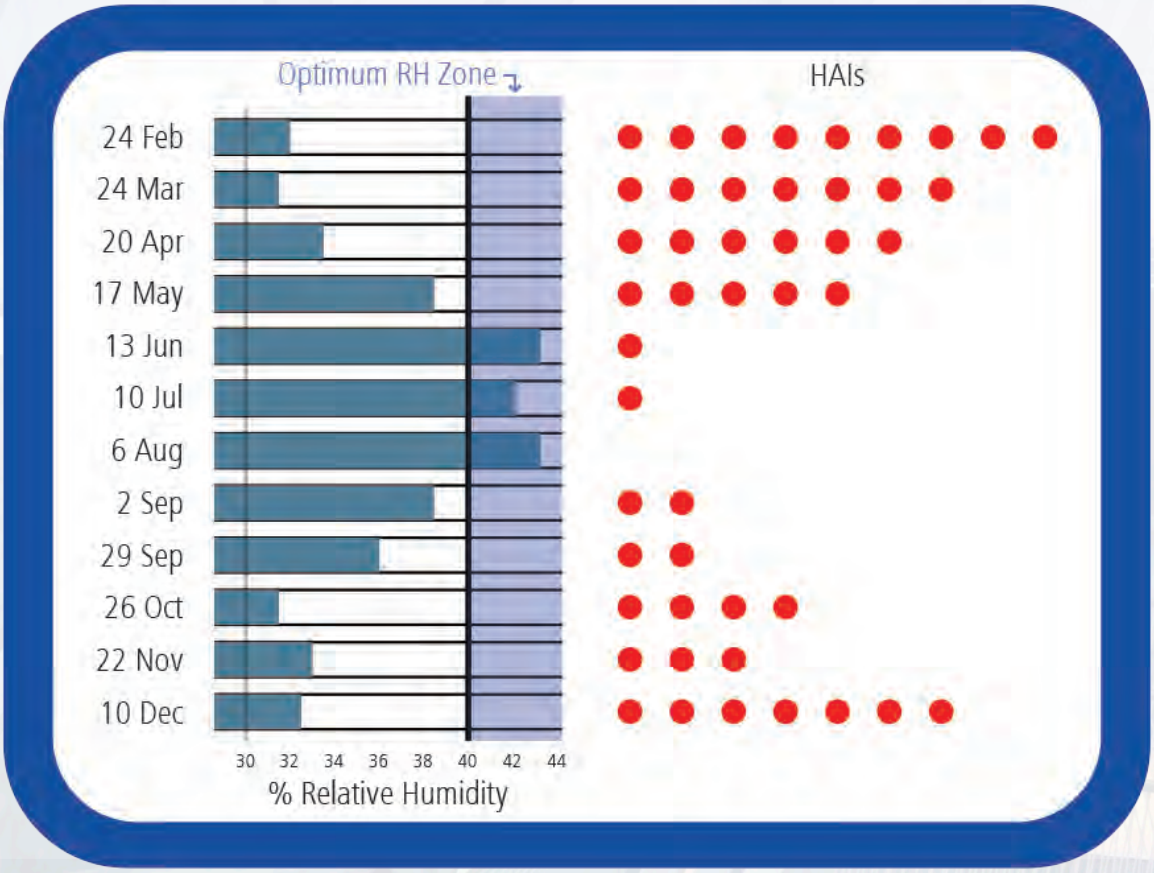
The Relationship Between HAIs and Humidity

It has recently been discovered that there is a strong relationship between HAI prevalence and hospital relatively humidity (RH) levels. Dry spaces, it turns out, worsen the problem. Droplets of pathogen expelled from the body get 90% smaller when they encounter dry air – defined as being less than 40% RH. This greatly magnifies their transportability.

Particulate with diameters of 80 to 100 microns will only travel four to six feet whereas those below 10 microns, especially tiny nuclei with diameters less than 0.5 microns, can then remain airborne for long periods. Building climate systems, then, will suck them up and carry them throughout the facility. It was previously thought that these tiny, dry particles were inert. However, they are merely dormant. Inhalation by the patient of desiccated droplets causes re-hydration and potential infection.

But increase RH into the 40% to 60% range and droplets maintain diameters of about 100 microns. They settle close to their source and are comfortably addressed by hospital hygiene protocols. Very little of this material is transmitted through building mechanical systems.

Further, the bacteria and viruses themselves find it more difficult to survive when RH levels are in the correct range. Patients also don't suffer from dehydration (with air at only 20% RH, patients lose up to 2 liters of water per day).



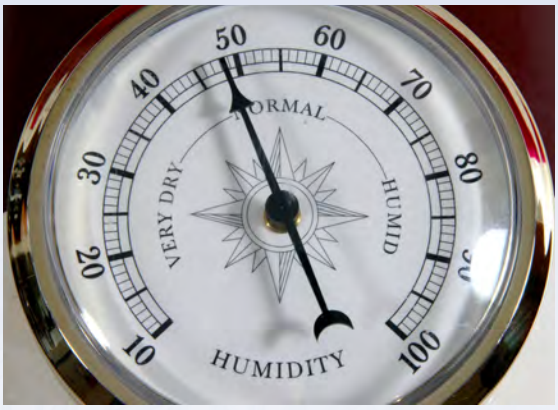
A study conducted in a new 250-bed academic hospital in the U.S. demonstrated the impact of RH on health. For more than a year, room temperature, absolute and relative humidity, lighting levels, room air changes, outdoor ventilation fractions, carbon dioxide levels, and room traffic were monitored in 10 patient rooms each hour. Of all metrics tracked, indoor RH most closely matched measured rates for HAI. As indoor RH was increased into the optimum range, patient HAI rates decreased.

Combat Low Relative Humidity Issues with a Pure Water Adiabatic Humidifier. Proper Humidification Lowers Risk of Infection in Hospitals and Keeps Tissue Moist for Proper Healing.

The hospital's physical environment, therefore, can exert a major impact on patient health. Maintaining RH between 40% to 60% can reduce the potential for infections from airborne pathogens.

How about mold? Hospitals are understandably leery about the detrimental health impact of inviting mold into the facility. This causes some to lower RH to dangerously low levels. Facility managers worried about the potential for mold are urged to look to the example of museums and libraries throughout the nation. Tight control of RH at around 50% has been done by thousands of facilities without mold becoming an issue.

The Center for Disease control is another advocate of correct humidification. It advises humidity levels be kept in the range of 30% to 50%. Hospitals are advised to favor the higher end of this scale.



Fog Humidification Approved by ASHRAE

Building managers will be familiar with the American Society for Heating, Refrigeration, Air Conditioning Engineers (ASHRAE). ASHRAE Standard 170-2013 had Addendum M issued in late 2016 which covers humidification and RH levels.

6.6 Humidifiers. When outdoor humidity and internal moisture sources are not sufficient to meet the requirements of Table 7.1, humidification shall be provided by means of the health-care facility air-handling systems. Steam or adiabatic high-pressure water atomizing humidifiers shall be used.

In this case, adiabatic means relating to a process or condition in which heat does not enter or leave the system. MeeFog adiabatic high-pressure water atomizing humidifiers from Mee Industries comply with all ASHRAE Standard 170-2013 Addendum M requirements. They bring humidity to required levels via a turnkey design that includes the necessary reverse osmosis water treatment systems, and valves for recirculating water in the pressure lines back to a UV treated holding tank.

Atomized water particles of pure water are generated within the Air Handling Unit (AHU). Electronic controls along with a series of high pressure pumps, variable frequency drives, and staged nozzles ensure humidity is maintained between a range of 30% to 50% as recommended by the CDC.

This type of system is a step up from traditional steam humidification systems. ASHRAE Standard 170-2013 Addendum M demands that the chemical additives used in the steam systems that serve humidifiers serving health care facilities comply with FDA requirements. Despite this, these chemical additives become another unwanted item circulating around the building and could pose negative health consequences. The use of MeeFog removes the need for harmful additives.

MeeFog high-pressure fogging racks are placed inside the AHUs. As a result, installation can typically be done in one to two days. They require no compressed air or steam. As they make use of direct pressure generated by pumps on the fog skid, they have very few moving parts and none at all inside the air handler. That's why their energy consumption is a small fraction of other technologies, such as compressed air, ultra-sonic, or steam systems.

A key to the effectiveness of MeeFog is the generation of ultra-fine fog droplets. Droplet size is the single most important factor governing fog system performance. Smaller droplets mean faster and more efficient humidification and lower energy consumption. The MeeFog nozzle sets the standard for inlet fogging nozzles and has been shown to consistently outperform other nozzles.

Meefog uses variable speed pumps to pressurize demineralized water to 2000 psi and pipe the water to an array of impaction pin nozzles in the AHU. The water then passes through a .006" orifice and strikes a pin which atomizes the water into billions of minute droplets (8.5 microns average diameter) which quickly evaporate in the airstream, to add the desired level of humidity. Everything is controlled by a programmable logic controller. The fogging array has multiple phases of humidification available and can control RH levels down to within 1%.

As well as precision humidity control, the benefits include reduced electrostatic shock, and lower energy consumption. As the system is made from corrosion-resistant stainless-steel components, it requires little maintenance.

For those engineers wishing an estimate of running costs, a typical fog system uses one horsepower for every 600 lbs. of water, which is 3% of the energy usage of compressed air-type systems and about 1% of the energy usage of electric steam systems.

Case Study

The Upper Peninsula Medical Center is located in the City of Marquette, on the Southern shore of Lake Superior in Michigan's Upper Peninsula. Established in 1965, the Marquette Medical-Dental Center provides private offices for over 120 physicians and other health care professionals.

Extreme winter conditions and more than half a million patients per year placed strain on its air handlers. The previous steam humidification system struggled to keep up with the humidifying loads and consumed too much power, especially in winter. The facility installed MeeFog high-pressure humidification systems inside its air handlers.

The benefits included reduced energy consumption, lower maintenance costs, improved indoor air quality and $26,000 savings per year, with a further reduction of $3,000 in annual maintenance costs. The load is matched to bring on fog nozzle arrays in various combinations. Excess moisture that is not absorbed into the air stream is collected on droplet filters and drained away. The total electrical load for this system is 2.25 kW. A complete reverse osmosis system to remove unwanted minerals from the water was also installed as part of the system.

Conclusion

Precision indoor air humidification with MeeFog improves clinical outcomes by reducing the prevalence of new infections picked up during a hospital stay. This has major financial ramifications: shorter in-patient stays, decreased readmissions, and lower non-reimbursable hospital expenditures.

For more information, visit
www.Meefog.com

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