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## Air humidification inside healthcare facilities: why it is so important?

Regulating air humidity is of fundamental importance for healthcare facilities, as the health conditions of patients, correct functioning of medical equipment, well-being of doctors and visitors depend on it.

First of all, humidity strongly affects the capability of bacteria to develop, propagate and overcome our defenses. Therefore, if suitably managed, it can result in an excellent tool to limit the number of hospital infections, and safeguard health.

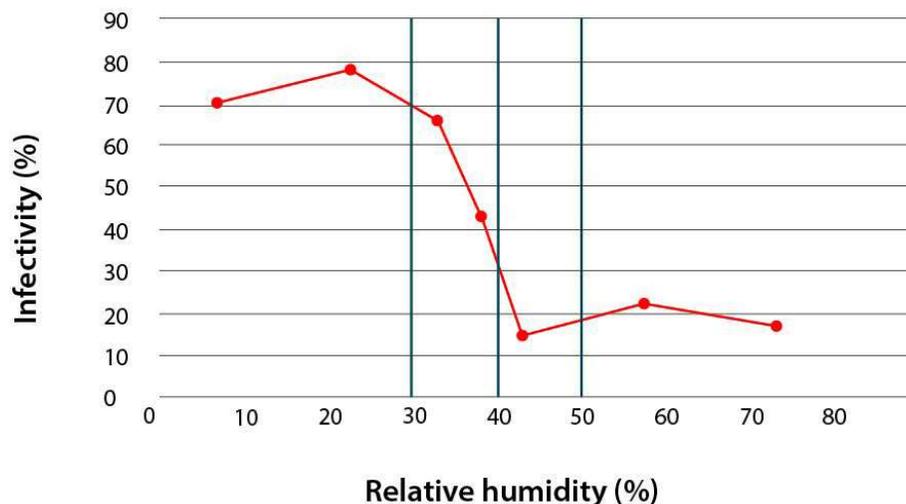
The true challenge when managing humidity therefore goes from eliminating pathogens to impeding their transmission and helping our natural defenses to ward them off.

Several researches suggest how relative humidity is the most important factor in environmental control for the airborne transmission of bacteria and viruses.

A first study, conducted for one year in a US hospital, monitored all environmental parameters in ten rooms as well as the medical conditions of the patients who stayed in these rooms. Relative humidity was the variable with the closest connection to the number of infections contracted by the patients.

When relative humidity reached and exceeded 40%, infections were drastically reduced from a maximum of 10/month to zero!

A second study was conducted investigating influenza virus spread within a confined environment. Infectivity dropped from 80 to 20% once relative humidity was between 40 and 70% (Noti, et al 2013)!

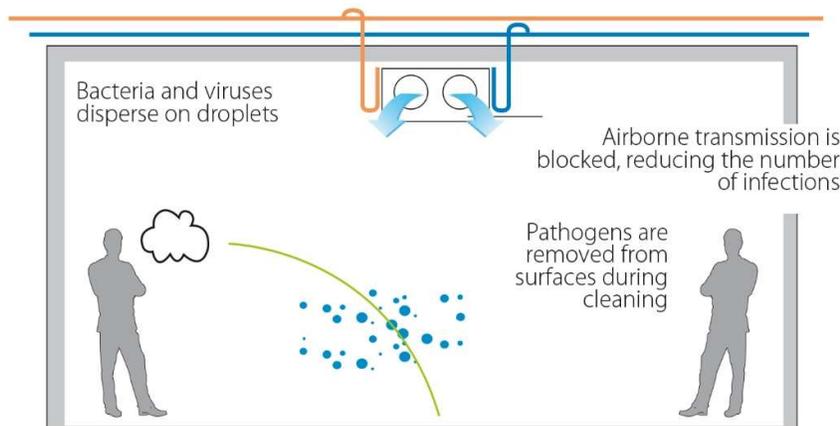
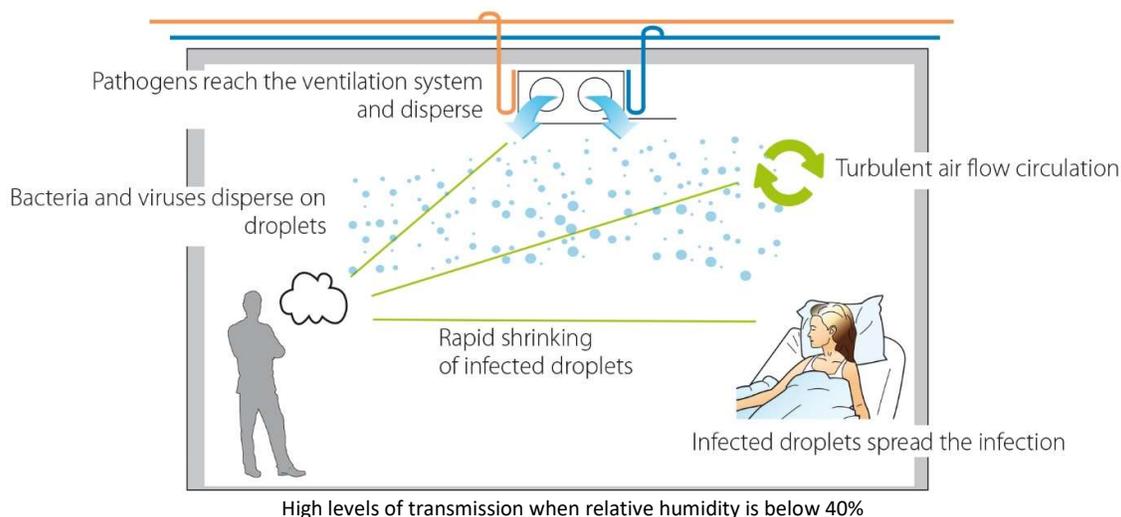


The infectiousness and transmission capacity of the influenza virus drops when relative humidity is between 40 and 70%

This is due to the fact that the influenza virus can no longer remain suspended for a prolonged period of time and to the reduced lifespan of many airborne bacteria and viruses in this relative humidity range.

In addition to hindering the growth of microbes and bacteria, suitable humidity monitoring has the effect of drastically reducing their transmission rate and is absolutely essential in environments such as hospitals, where pathogens and exposed patients particularly sensitive to infections coexist.

However, what emphasis do we put on proper Air Humidification throughout a healthcare facility? We know that pathogens thrive, traveling further and living longer, in dry air, enhancing greatly their transmission capabilities.



We know that people are overall healthiest in a properly hydrated environment, between 40% - 60% RH (Sterling, et al 1985). Nevertheless many facilities barely track the RH levels outside of critical areas such as OR's, NICU's or sterile supply rooms. Significant patient hours are spent in the facility outside of these areas, such as in Patient recovery rooms and Step Down units, or Nursing stations. Does it seem like we should consider addressing the proper Air Humidification levels in these areas and throughout the entire facility, or at least be consistently monitoring these areas to identify potential problems? Could we improve Staff healthiness and Patient outcomes by adding this area to our protocols? As the studies mentioned before demonstrate, yes, we should.

### **Humidification to guarantee the correct functioning of machinery**

Air humidity can also be a tool to protect electronic equipment against the damage caused by electrostatic discharge.

The damage could include the destruction of some components, the turning off of the machine, wrong measurements and the accumulation of static electricity on X-ray.

Once again, humidity management can be fundamental, impeding the accumulation of charges to dangerous values in favour of a gradual dispersion towards areas with a lower potential.

Considering the delicate function played by most of the equipment in hospitals, it is important to prevent the problems caused by dry air. To avoid electrostatic charge problems, it is recommended to maintain relative humidity above 35%, taking care not to neglect other anti-ESD precautions, especially those concerning the machine's construction.

### **Humidifying to ensure the well-being of room occupants**

The main reasons why humidity management in hospital is essential are the reduction of the infectiousness and transmission of bacteria and the protection of the equipment. Nevertheless, humidification is also very important for the well-being and comfort of those living and working in the hospital.

Air temperature is the parameter we can most easily identify as the cause of discomfort, but humidity also plays a considerable role as it alters our perception of air temperature and affects skin transpiration as well as our internal energy balance. A suitable level of relative humidity prevents excessive skin, eye and respiratory tract dryness and enables us to breathe and perspire more easily. This way, we can avoid subjecting our thermoregulation system to excessive effort that may cause discomfort.

Managing humidity correctly also makes it possible to reduce any dust particles in the air by making them adhere to the walls.

### **Requirements of the humidification system**

As far as hospital humidification systems, considering the importance of the processes carried out in these facilities, specific manufacturing measures must be taken to guarantee the hygiene and reliability of installation.

The following are essential characteristics:

- Hygiene
- Reliability

Secondly:

- Energy saving
- Connectivity

### Hygiene

The humidification system must be designed so as not to provoke the indoor accumulation and diffusion of bacteria and harmful elements.

For example, specific precautions must be taken against the Legionella bacteria, which have a very high mortality rate and have caused many deaths connected to nosocomial epidemics in the past. This is why isothermal humidifiers are historically more widespread in hospitals, as water is boiled at 100°C to produce steam, guaranteeing aseptic conditions and therefore a hygienic system.

Their use is at times required by law in some hospital areas such as operating rooms, as to prevent the humidification system from being the cause of the diffusion of pathogens such as Legionella.

The Legionella bacteria is in fact instantly deactivated when the temperature exceeds 70°C, therefore being completely eliminated by isothermal humidifiers.

Certain types of adiabatic humidifiers, such as high-pressure and ultrasonic ones, can also be used in hospital applications, as long as they are manufactured in such a way as to be hygienically safe.

The Carel high-pressure humiFog system, for example, consists of a pumping station, a distribution system and a droplet separator made entirely from stainless steel, a material resistant to dirt build-up and corrosion. humiFog also does not allow any water to stagnate inside, carrying out drain cycles during periods of inactivity and periodic washing cycles, so as to prevent the creation of areas where bacterial colonies may form and grow.

In addition, the quality of input water must also be monitored reverse-osmosis systems, as any excess mineral salts and micro-organisms may spread into the environment if they are not filtered.

Carel integrates into its systems UV-ray lamp treatments carried out to eliminate any bacteria that survived reverse osmosis treatments. Alternatively, chemical biocides could be used. These, however, are rather expensive and require special provisions to dispose of waste water as well as frequent bacterial load analyses. In addition, in case of a failure in the biocide management and distribution system, humidifiers might continue to function with hygienically impure water: it therefore is not an intrinsically safe solution and anyway unsuitable for hospital applications.

Moreover, in order to prevent condensation, some humidifiers are equipped with a remote ON/OFF function, which blocks humidity production should the duct ventilation system not function.

Further safety can be guaranteed by limit probes. They are sensors that, placed in ducts or in the room, detect when humidity exceeds a set threshold.

Finally, the presence of certifications issued by specialised bodies must also be checked, such as the German VDI 6022. These prove that the manufacturer has adopted solutions that safeguard the hygiene of the system.

### Reliability

Hospitals are facilities of primary importance that need to be reliable also in case of malfunctions, maintenance or special weather conditions. The humidification system must therefore be reliable and keep machine down-times to the minimum to guarantee absolute service continuity.

A first suggestion is to choose systems that minimise the need of down-time to carry out maintenance operations. In general, the humidifiers requiring less maintenance are those operating with purified water, as there is less limestone and therefore cleaning and/or periodical replacements are not needed as much.

This aspect penalises some humidification technologies such as the immersed electrode one, as they cannot function with purified water and may require frequent interventions to replace/clean the cylinders.

On the contrary, heater humidifiers are preferred, as they can operate on a wide range of feedwater and require less maintenance. Carel's heaterSteam Titanium uses titanium heaters that are unique on the market, guaranteeing the highest possible reliability and continuity of service.

Higher reliability means shorter idle-time, during which the machine is active but is not actually capable of dealing with the humidity load.

Humidifiers equipped with rotation and redundancy functions are strongly recommended. Rotation enables the alternation of humidifiers so as to maintain them all in operation and extend the interval between maintenance. Redundancy enables operations to be carried out continuously.

### Energy savings

Installing efficient systems that use less energy has the double benefit of saving on operating costs and complying with the most recent regulations in terms of air conditioning.

Adiabatic humidifiers are better from the point of view of consumption, as the power needed to supply high-pressure atomizer pumps (< 4 W) and to vibrate ultrasonic humidifier transducers (< 80 W) is extremely low. Despite the little power needed to supply low-pressure pumps, wetted media humidifiers significantly increase the unit's fan power consumption with a permanent increase on load losses.

Should you want to take advantage of the cooling effect of evaporation in summer months, then adiabatic humidifiers are the perfect option. This type of application guarantees the best performances in warm dry environments, as it humidifies and cools down air while at the same time maximising energy saving. The cooling effect is of 0.7 kW for each litre of evaporated water, with insignificant power consumption.

By humidifying and cooling return air before it passes through a recovery exchanger, cooler air can be obtained in summer months even before recurring to air conditioning systems, thus reducing energy consumption (indirect evaporative cooling).

### Connectivity

Connectivity functions are not strictly necessary, but they are preferable and are becoming increasingly important due to the growing need to manage, monitor and collect information in complex systems with different set points such as hospitals. This is why it is more and more common to find HVAC systems managed by a BMS (Building Management System) that also monitors the humidification system, thus providing a centralised multi-

site management. In this context, it is essential that humidifiers integrate the most popular communication protocols such as Modbus and BACnet.

Some state-of-the-art humidifiers are also equipped with an integrated web server. It is a system that enables the management, supervision and monitoring of the entire humidification system on a local network directly from PC or tablet. If connected to a suitable supervision system, it can also be managed remotely, making it easier to monitor the multiple units installed in hospital facilities.

## Conclusions

Humidification is an aspect more important than one would think for the operativeness of an healthcare facility due to its great impact on the:

- development of pathogens and transmission of patient infections;
- protection of medical machinery against electrostatic discharges;
- well-being and performance of patients and medical staff.

This is true not only for the most critical environments, like ORs, but for the whole facility.

Numerous studies show that the optimal relative humidity range is between 40 and 60% and the standards regulating the installation of ventilation and humidification systems in hospitals recommend similar values.

This is why humidification systems are compulsory in hospitals and the various components must be selected so as to be suitable for application needs regarding hygiene, reliability and connectivity. When possible, choose adiabatic or high performance isothermal humidifiers as they combine humidification needs with the energy saving objectives, desirable in energy-consuming facilities such as hospitals.

This choice has a relevant effect on both the medical condition of patients and the related expenses for the entire community.

For more information, read CAREL [white paper on air humidification in hospitals](#)

