WHITE PAPER

Saving Energy With Evaporative Media

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Introduction

In recent years building designers and engineers have been faced with a challenge: to develop buildings that operate more efficiently than ever before. Increasingly stringent energy standards and programs such as LEED are drivers for designing more efficient and environmentally responsible buildings than ever before. For HVAC system designers, being able to balance the need for a comfortable and healthy indoor environment with the impacts in energy performance is essential to deliver the best possible design.

Humidification in particular can pose a challenge for modern engineers and designers. On one hand, the benefits of humidification are widely recognized, and humidity plays an important role in creating a healthy indoor environment. Research has shown that proper humidity levels can reduce the transmission and survival of bacteria and viruses, minimize respiratory infections, and reduce the effects of allergies and asthma. (1) It is also important for creating a comfortable indoor environment, as lack of humidity is a major complaint from building occupants. (2)

On the other hand, humidifiers are often associated with high energy consumption creating a problem for designers; how can humidity be introduced as efficiently as possible, with the lowest impact on building energy performance?

Evaporative Media Humidification

Evaporative media humidifiers are becoming an increasingly popular solution to this problem. They can provide humidity very efficiently while consuming very little electricity. In many applications, they can also contribute to the building cooling load, reducing the amount of mechanical cooling that is required, and making buildings even more efficient.

This whitepaper will explore ways to use evaporative media humidification systems to deliver the humidity while being as efficient as possible.

How Evaporative Media Humidifiers Work

Evaporative humidifiers work on a very simple principle; evaporation. In simple terms, evaporation is the process in which liquid water changes state to gaseous water vapor. This water vapor is absorbed into the air and where we feel and measure it as humidity.

Components

Evaporative media humidifiers typically consist of several components, as demonstrated in *Figure 1: Evaporative Media Humidifier Components*.

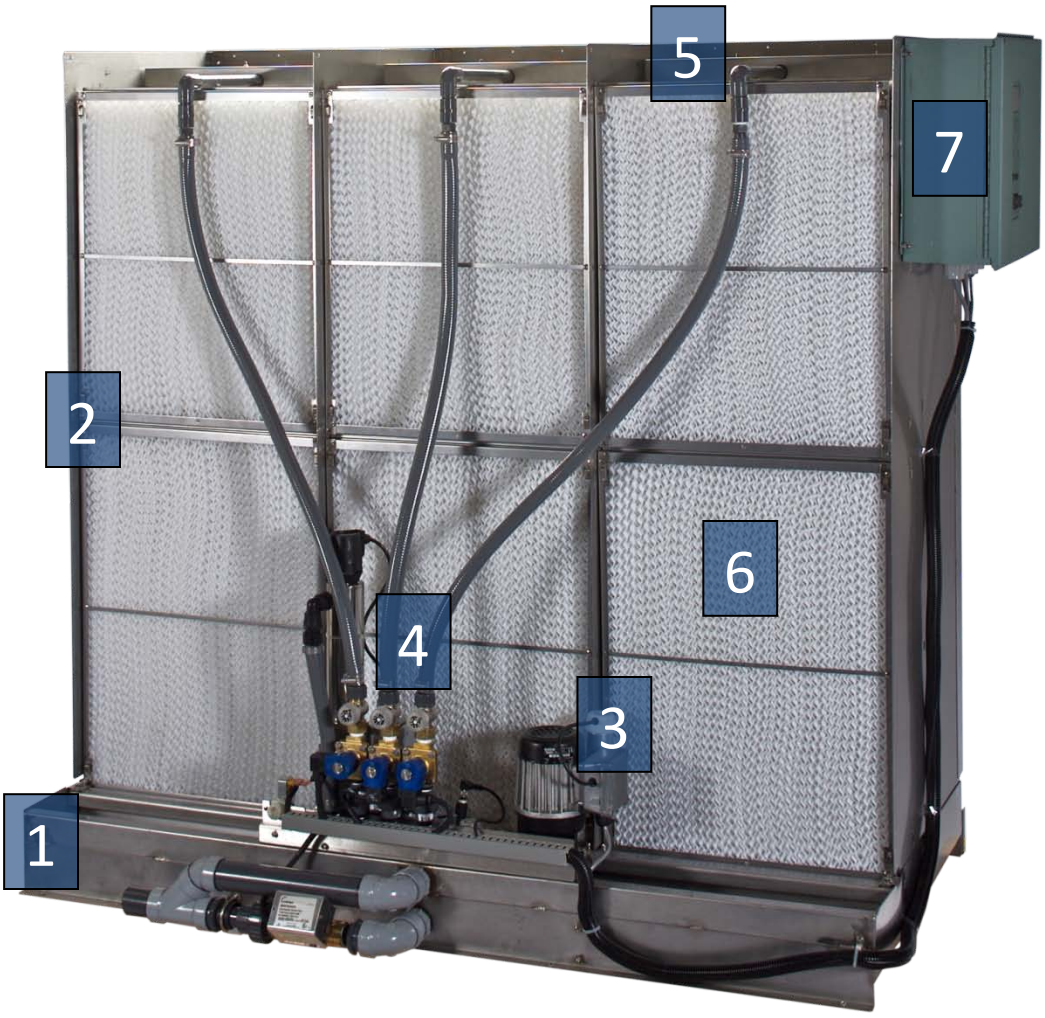

Figure 1: Evaporative Media Humidifier Components

1. Tank – The tank forms the base of the unit and provides support for the unit framing, and in turn the media. It also serves the function of catching any unabsorbed water and acting as a reservoir for models with a pump.

2. Support Framing – The support framing provides the structure from which media is hung. This allows units to be free standing without relying on the surrounding ductwork for support.

3. Recirculation Pumps – Some models recapture excess water from the media and re-circulate it through the media to ensure the highest water efficiency. The recirculation pump provides the pressure and lift to send the water back up to the media. This feature is especially useful when

using reverse osmosis or de-ionized water, which can be costly to produce.

4. Hydraulic Unit – The hydraulic unit is a compact module that includes all of the devices needed to supply water to the media. For models that modulate their output, this module would house the staging and adjustment valves. Additionally, devices like tank level sensors, water conductivity sensors, fill valves, and UV water sterilization systems may also be found here.

5. Distribution Hoods – After the water leaves the hydraulic unit it enters the distribution hoods. These hoods spread the water over the top of the media, ensuring that water evenly flows over the media.

6. Media – The media is where the actual evaporation takes place. Evaporative media is specially designed with corrugated pattern to provide a large surface area of the air and water to mix. The channels are designed to efficiently allow the passage of air through the media while evaporating as much water as possible. To help this process the media is often treated with coatings or fibers to enhance wicking and fire protection.

7. Control panel – The control panel provides the control logic for the unit and determines when to activate control valves, pumps, or other devices. Modern control panels also include programmable flushing and washing cycles, provide on-screen troubleshooting, and interface with building automation systems.

The Principle of Evaporation and Adiabatic Cooling

There are two types of humidifiers in existence today, isothermal humidifiers and adiabatic humidifiers. Isothermal units are those that boil water to create steam, which is then distributed into the air to increase the humidity. The process is referred to as “isothermal” since ideally the steam does not have an effect on the temperature of the air as it is absorbed.

Adiabatic humidifiers on the other hand, add the water directly to the air and rely on evaporation for the moisture to be absorbed into the air. Evaporative media humidifiers fall into this category.

Regardless of the type of humidifier used the physical principle remains the same; in order for 1 pound of liquid water to become 1 pound of vapor, approximately 1000 BTU of energy is required to drive the phase change. In the case of isothermal humidifiers, this energy comes from electricity, natural gas, or another heated fluid stream. For adiabatic humidifiers the energy comes from the air itself, resulting in sensible cooling of the air.

This means that the key to saving energy with evaporative media humidifiers is simple; take advantage of this cooling effect to reduce mechanical cooling requirements while providing humidity at the same time.

Applications

There are many great applications where evaporative media humidifiers can be used to save energy by providing both cooling and humidity. Some of the best applications are those where the building has a large internal heat gain, such as from computer equipment, or a manufacturing process. Other great applications are the result of regional conditions, such as locations with hot and dry conditions. Several examples will be explored below:

Data Centers

Data centers are often great applications for evaporative media humidifiers. In this case the servers and networking equipment are generating a considerable amount of heat and need to be supplied with cool air in order to function efficiently. Additionally computer manufacturers often mandate humidity ranges within which their equipment is designed operate. Humidity is important for data centers and electronics in general to help prevent issues with static discharges which can damage the sensitive circuits.

Evaporative media humidifiers can be installed in the supply air system to condition the air before it is delivered to the server rooms. By doing this the evaporative media can help contribute to the cooling of requirements and provide the humidification requirements at the same time, reducing the amount of mechanical cooling required.

Manufacturing Facilities

Many manufacturing facilities involve processes that give off heat and require humidity control for proper production. As well these facilities often bring in large volumes of air to dilute pollutants, and ensure a healthy environment. Conditioning this air through other means can prove to be costly in terms of energy, whereas an evaporative media humidifier delivers cool humid air to provide the process humidity requirement while keeping space temperatures to a minimum.

Some of the more common industrial applications include automotive paint booths, electronics manufacturing, industrial laboratories, and printing and paper.

Universities and Colleges

Another common application is university and college campuses. These facilities are often looking to reduce operating costs, but recognize the importance for healthy indoor environments. Evaporative media humidifiers are particularly useful for campus computer rooms, auditoriums, gymnasiums and laboratories.

Regional Projects

Many locations across the United States are located in areas where the climate tends to be warm and dry, often year round. In these locations evaporative media is an excellent choice since it can provide year round humidification, and significantly offset cooling costs for summertime operation. States such as Nevada, Arizona, Nebraska, and Kansas are just a few examples of such locations. In these places the applications for evaporative media are found nearly everywhere; office towers, corporate campuses, gymnasiums, sports facilities, shopping malls, and commercial buildings are common examples.

LEED® Projects

Evaporative media humidifiers can also help contribute to LEED® project credits when applied in a manner that saves energy. While no one product can earn credits under the LEED® Green Building rating system, evaporative media humidifiers can be part of the overall strategy to reduce building energy consumption. Some possible credit synergies include Energy and Atmosphere Prerequisite 2: Minimum Energy Performance, Energy and Atmosphere Credit 1: Optimize Energy Performance, Indoor Environmental Quality Credit 7: Thermal Comfort, and Innovation & Design Process Credit 1: Innovative Design for particularly novel applications.

Key Application Criteria

In order for evaporative humidifiers to function efficiently and effectively it is important to ensure that the application meets some key criteria. Following these guidelines will help ensure that the system performs as intended.

Duct Conditions

As water evaporates it draws energy from the airstream causing sensible cooling. It is important to be able to provide sufficient heat before the unit to account for the cooling effect. The best applications are those where the heat comes from a process or equipment, since the evaporative cooling can then be used to reduce mechanical cooling requirements.

The temperature drop of an evaporative humidifier can be estimated if the humidification load (in pounds per hour) and the airflow rate (in cubic feet per minute) are known.

$$\Delta T = \frac{load \times 1000\ BTU/lb}{CFM \times 1.10}$$

In the above formula, the load is multiplied by the energy required to evaporate a pound of water. This result is then divided by the product of the airflow rate and a constant of 1.10. It is common to see temperature drops of more than 10°F for evaporative media humidifiers.

The cooling rate, in BTU/hr, for an evaporative media humidifier can also be estimated if the humidification load (in pounds per hour) is known:

$$Cooling = load \times 1000\ BTU/lb$$

A final note on the topic; the constant 1000 BTU/lb required for the phase change is known as the *standard heat of vaporization*. For water this value varies between 970 BTU/lb at the boiling point and 1075 BTU/lb at the freezing point. (3) For estimation purposes it is common to use 1000 BTU/lb, which tends to produce slightly conservative values for cooling capacity.

Duct Velocity

As the air passes through the evaporative media humidifier, friction causes pressure losses. As duct velocities increase, so do pressure losses. As a rule of thumb, duct speeds should be kept to 500 feet per minute or lower to minimize pressure losses. At 500 feet per minute, typical pressure losses will range from 0.3 to 0.5 inches water column depending on the thickness of evaporative media being used.

Water Quality

The quality of the water used will also have an impact on the performance of evaporative media used. As water evaporates, any dissolved minerals will precipitate out and can become deposited on the media. This is commonly referred to as scaling of the media. As the media scales, some air channels can become blocked and the air is forced to go around them. This increases the air velocity through the media and increases the pressure drop across the unit. When the pressure drop reaches a level where it is no longer tolerable, or when scaling affects the humidity that the unit can provide, the media will need to be replaced.

For areas with hard water, flow through type units should be used to keep concentrations of minerals low and continually flush minerals to drain. Water treatment systems, such as softeners or reverse osmosis units, can also be used. It is important to evaluate the costs of ownership and operation when deciding whether to add water treatment.

For many areas potable water will work well with a recirculation unit, particularly if a conductivity sensor is installed. The conductivity sensor monitors the concentration of minerals in the tank and flushes water when necessary to minimize the buildup of scale. For units that are not equipped with conductivity sensors, timed flushes determine when water is replaced.

Air Filtration

A final consideration is the cleanliness of the air that is passing through the unit. Good upstream filtration is important in preventing the media from trapping dust and dirt found in the airstream, which could contribute to fouling of the media and require more frequent replacement.

As a rule of thumb, filters with a MERV 8 rating are recommended upstream of evaporative media humidifiers.

Economic Considerations

Evaporative media and other adiabatic humidifiers in general, can often have a higher first cost than steam units with similar capacities. When correctly applied and saving energy, the payback period on an evaporative media humidifier can be relatively short.

When calculating the payback period it is important to consider all aspects of the project, including the maintenance costs, and the impact of the cooling capabilities of the unit.

Selecting an Evaporative Media Humidifier

Once it has been determined that an evaporative media humidifier is a good match for the project, a particular model needs to be selected. Selecting a well engineered unit is essential to having a successful installation.

Types of Media

There several types of media available on the market today.

1. Cellulose Media – Cellulose media resembles cardboard in appearance and tends to be sold in rigid blocks. The individual layers are held together with glue, and some manufacturers offer a hard plastic coating for the leading edge of the media to improve rigidity and resist scale. Cellulose media tends to be very inexpensive, however it lacks a flame and smoke rating, and should not be used in general HVAC applications. Rather cellulose media is best suited for exhaust cooling or agricultural applications. This media tends to collapse over time which leads to air bypassing the unit and poor performance.

2. Fiberglass Media – Fiberglass media is pinkish in appearance and is sold in either rigid blocks, or framed cassettes. While commonly used in HVAC applications, a key disadvantage of this media is the presence of potentially harmful glass fibers which break free and become distributed throughout the HVAC system over time. This type of media also tends to collapse over time, although some manufacturers offer edge coatings to resist this effect. Fiberglass media has a mid-

range flame and smoke rating.

3. Polyester Media – Polyester media is one of the newest types of media on the market, and is white in appearance. It is commonly sold in framed cassettes. Polyester media solves the problem of glass fibers in the airstream while offering excellent flame and smoke ratings. This media also tends to have excellent performance characteristics by allowing for even water distribution throughout the media. Polyester is recommended for most HVAC applications.

Unit Configurations

When selecting an evaporative media humidifier, it is essential to purchase a complete packaged unit from a reputable manufacturer. Many manufacturers offer packages that include all of the components and controls needed for a unit to operate safely and efficiently. Be sure to look for features such as:

1. Automatic Washing Cycles – These cycles run water from the media directly to drain, even on recirculation units. This helps prolong media life by removing contaminants from the surface.

2. Automatic Drying Cycles – Drying cycles temporarily lockout humidifier operation to completely dry the media. This drying helps prevent any microorganisms from growing on the media by removing the water they require to live.

3. Automatic Tank Draining – To help maintain a clean tank it is important to avoid standing water.

4. Automatic Line Flushing – Similar to above, the lines leading up to the humidifier need to be flushed periodically to prevent the water from sitting for too long.

5. UV Water Sterilization - UV water treatment kits are available to sterilize the water prior to being supplied to the media to ensure that the unit operates as hygienically as possible.

6. Smart Water Management – Look for units that include water saving features such as conductivity based draining or adjustable drain timers.

7. Onscreen Help and Troubleshooting – Be sure to select a unit with a full function control panel that includes a display with onscreen troubleshooting. These control panels help maintenance staff take care of the unit by providing maintenance warnings and step by step resolution of problems. These control panels often allow for connection to building management systems for centralized monitoring and control.

These features are signs of a well engineered and well designed unit. It is important to avoid “do it yourself” units. These units are often inexpensive, however have much larger potential to grow bacteria or have standing water in the duct. As well they are often function poorly, waste water, and require frequent media replacement.

Summary

A well designed and properly installed evaporative media humidifier will provide years of reliable service while helping building HVAC systems function more efficiently. Evaporative media humidifiers work by passing water directly over media that is placed in the airstream. Passing airflow causes the water to evaporate, which generates cooling through a phenomena known as adiabatic cooling. The net result is sensibly cooler air temperatures and an increase in humidity levels.

Taking advantage of the cooling effect is the key to saving energy with evaporative media humidifiers. The cooling effect can reduce loads on mechanical cooling systems, and allow buildings to operate more efficiently while delivering the humidity essential to both occupants and processes. Some of the best applications for evaporative media systems include data centers, manufacturing plants, campuses, projects located in warm and dry regions, and LEED® projects.

When considering an evaporative media humidifier it is important to consider the psychometric conditions, filtration requirements, water quality, and the economics of the project. Properly designed and installed units will operate more efficiently and require less maintenance.

When selecting an evaporative humidifier it is important to insist on a well engineered packaged product from a reputable manufacturer. These units are equipped with intelligent controls that ensure the unit operates efficiently and hygienically. As well it is important to select media that matches the needs of the project. For most HVAC applications polyester is recommended due to its excellent performance and superior fire ratings.

Evaporative media humidifiers are becoming increasingly popular as a solution to today's increasingly stringent energy requirements. With innovative and modern units on the market, this technology is more accessible than ever before. How can an evaporative media humidifier help make your next building project more energy efficient?

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Why Nortec?

Nortec specialized n the design and production of superior humidification systems. We create the most appropriate solutions to meet our customer's specific needs in the most efficient and cost effective way. To this end, we draw upon our extensive experience to develop an ever growing range of products manufactured to our stringent ISO 9001:2000 certified maximum reliability, minimum maintenance and a choice of energy sources.

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