CHOOSING A FOG HUMIDIFICATION SYSTEM

FOR GREENHOUSE APPLICATIONS

Controlling Conditions in the Greenhouse

Plants normally thrive within a "comfort zone" of humidity and temperature. Stomata on the leaves open and close depending on the ambient conditions and will largely be more active when a plant is in its particular "comfort zone."

In growing conditions with humidity levels below 40%, plants tend to lose too much water through their leaves (as the air pressure is less than the pressure in the leaf) and cannot receive enough water from the roots. As a result, the plant becomes stressed and its natural defenses come into play which slows (or stops) growth.

- Control Temperature
- Control Humidity
- Create Varying Climate Zones



On the other hand, where humidity is high (generally over 85%), the pressure differential is so small that little or no transpiration takes place. Without transpiration, there is no movement of nutrients through the plant and the fruit is starved.

"high and low humidity levels cause plant stress"

To solve these problems, environmental conditions can be controlled with MicroCool fog systems so that plants produce superior crops and higher yields. Fog systems are used for two distinct applications in horticulture; humidification and cooling. The fog production is the same in both applications but is controlled by different methods.

How Does a High Pressure Fog System Control Humidity?

The air in a greenhouse contains a certain amount of moisture that is available to plant material at all times. But, environmental conditions such as heat, poor ventilation and solar effects change the amount of available water moisture.

MicroCool high-pressure fog systems control the amount of moisture and humidity by producing billions of small droplets of water that are evaporated into the air.

ABOUT MICROCOOL FOG DROPLETS

- **Billions produced** — Billions of small droplets of water from each fog nozzle are evaporated into the air. The nature and structure of these droplets is crucial to the operation of the system and the performance of the unit. The droplet's change of state (from liquid to gas) absorbs energy from the surrounding air and creates water vapor.
- **Microscopic in size** — Droplets of fog from a MicroCool system have been independently tested to have a median diameter of less than 8 microns. As a comparison, a human hair is between 40 and 200 microns; MicroCool fog droplets are 10% of the diameter of a human hair.

Why is droplet size important?

By reducing the droplet size to 10 microns, two things are achieved. First, the surface area of the droplet in relation to the volume of water is greatly increased. (Remember that water evaporates only from its surface. So, the greater the surface, the faster the water evaporates, and the faster the ambient conditions are changed.)

Secondly, the smaller the droplet, the longer it stays airborne. And, since fog is produced while droplets are airborne, these smaller droplets produce a greater amount of fog.

What is Flash Evaporation and How Does it Add Cooling?

The flash evaporation process is defined as adiabatic cooling and humidification. To illustrate the adiabatic process, imagine the air in a greenhouse as a sponge. When the sponge is dry (low humidity), a large amount of water can be poured into the sponge and can be absorbed before it begins to seep. This large amount of water can be utilized in the adiabatic process for cooling and humidification.

However, if you squeeze the sponge but leave it damp (representing high humidity), much less water can be added to the sponge and therefore less water is "available" for the adiabatic process. This illustrates why adiabatic cooling is much more efficient in arid conditions.

Cooling with Fog

The cooling process is a dynamic event that requires continuous air exchange to facilitate maximum cooling. Once the fog has evaporated and saturation is achieved, no further cooling is possible. However, an influx of warmer, dryer air allows the process to continue.

Flash evaporation also increases humidification as it adds water vapor to the air. Be aware that as humidification levels rise, the rate of "flash evaporation" slows, and accurate control of the process becomes more critical. MicroCool's control systems can help monitor these situations in order to achieve maximum effectiveness.

A psychometric chart can be used to determine the amount of cooling that can be obtained from the evaporation of water and the amount of water required for the process.



FOG SYSTEM DESIGN

The design of a high-pressure fogging system is determined by the particular needs of the individual grower. Is the prime requirement for cooling or humidification? If cooling – what is the desired level and what is the maximum humidity that plants can tolerate?

If only humidification is required, other factors need to be considered. Will humidification be required when vents are opened? If so, will a rise in temperature reduce the amount of available water (thus reducing the humidity)?

Once the grower's requirements are known, then atmospheric conditions must be studied. And, although averages are often reported by meteorological offices and stations, these are of little use to the MicroCool engineer as extremes can distort an average reading. If in doubt, your specialist can consult ASHRAE charts to determine sample data from your area. This data is then factored into the systems' cooling potential.

The most important data required is the ambient temperature and humidity when cooling (where humidification is required). One of the biggest mistakes people make in submitting this information is to offer the maximum daytime temperature and the maximum daytime humidity for the period. However, these two comparisons aren't useful, **as both "maximums" never occur at the same time**. Recording the temperature and humidity readings on an hourly basis offers a more accurate representation for sizing an appropriate configuration.

In addition, it's important to know the **humidity level at the maximum temperature**. Because as the humidification level rises, the rate of "flash evaporation" slows. This data must be calculated to ensure a sustained flow of fog.

Additional Design Factors

The type of ventilation and positioning of vents and/or fans are important factors in designing and optimizing a fog system. And, any thermal or shade screen installations will affect the air flow. Knowing how the air moves within the greenhouse dictates the positioning and layout of nozzles and pumps.

An efficient fog installation also depends on calculating the proper amount of open space above the crop height. Generally a space of approximately 30-36" (750-1,000mm) is required for successful evaporation. Without sufficient space to "move" and evaporate fog, wetting and dripping could occur.

The MicroCool engineer will compile all this data and calculate the amount of water (usually expressed as "pounds" or "kg") required for the desired functionality. Based on years of fog system design experience, he creates a carefully designed nozzle pattern to deliver optimal fog distribution.

Depending on the number of nozzles required, a high-pressure pump unit is specified and the hydraulic distribution systems are mapped out. Correct pipe sizing and lengths are determined to ensure correct drainage and operation.

Finally, sectioning controllers are used to divide the room into different climate zones. Engineers will calculate the fewest number of zones possible to provide an optimal yet cost effective installation. Your MicroCool fog system is now ready to handle varying demands of humidification and cooling to multiple zones throughout the greenhouse.

SYSTEM CONTROL IS CRITICAL

A well-designed fog system with a non-integrated controller can cause problems. So, scrimping on an inexpensive controller at this stage is a false savings. MicroCool controllers on the other hand provide:

- **Integration** — MicroCool controllers will measure both temperature and humidity with electronic sensors. The sensors integrate the opening of ventilators with fan operation for optimal air exchange and control. More complex computer driven systems are able to predict situations and change the operating frequency of the fog system to accommodate changing environments.
- **Temperature control** — For cooling, the humidity level is generally the guiding point. The desired temperature is entered into the controller and the maximum humidity level for optimal plant growth is entered. If the system reaches the maximum humidity level, no further cooling will take place since the air has reached saturation.
- **Ambient condition tracking** — Although fogging occurs only when the humidity is below the set point, MicroCool systems track changing ambient conditions and make adjustments to provide maximum environmental control.
- **Humidification control** — Humidification is monitored with the same controller. However, when trying to achieve maximum levels of 85 – 90% humidity (for propagation), care must be taken so that the system does not "overshoot" and saturate the air. Careful design by your engineer generally avoids this issue.



CONCLUSION

By following some simple guidelines and practices, your MicroCool fog system will help achieve the climate conditions you desire. As with any machinery, regular maintenance is essential for trouble-free operation. Your fogging specialist can recommend and schedule service appointments based on your particular configuration.

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