A CONVIRON COMPANY

# Dehumidification Strategies

Application Note

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# Dehumidification Strategies



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# DEHUMIDIFICATION STRATEGIES

***Key Concept:*** *With carefully coordinated simultaneous heating and venting, it is possible to control humidity levels while maintaining the climate temperature setpoint.*

In greenhouses, heating and ventilation are the most common methods used to reduce humidity levels relative to the dew point. There are other methods as well, such as mechanical air conditioning (removing water vapor from the air by temporarily chilling it to below the dew point, thus condensing some of the water vapor), and the use of chemical desiccants or brine solutions. These methods are used less often in commercial situations.

Except for chemical desiccants, dehumidification strategies generally involve changing the psychrometric properties of the air, and the temperature of the air, at least temporarily. A given volume of air can hold progressively more water vapor as its temperature increases. Therefore, by manipulating the temperature of the air it is possible to influence the amount of humidity relative to the dew point.

The **Argus Energy Balance** program provides 2 strategies for dehumidification control:

1. **Apply Heat** - to increase the air temperature, thereby reducing the relative humidity
2. **Ventilate** - to exchange moist air with drier external air

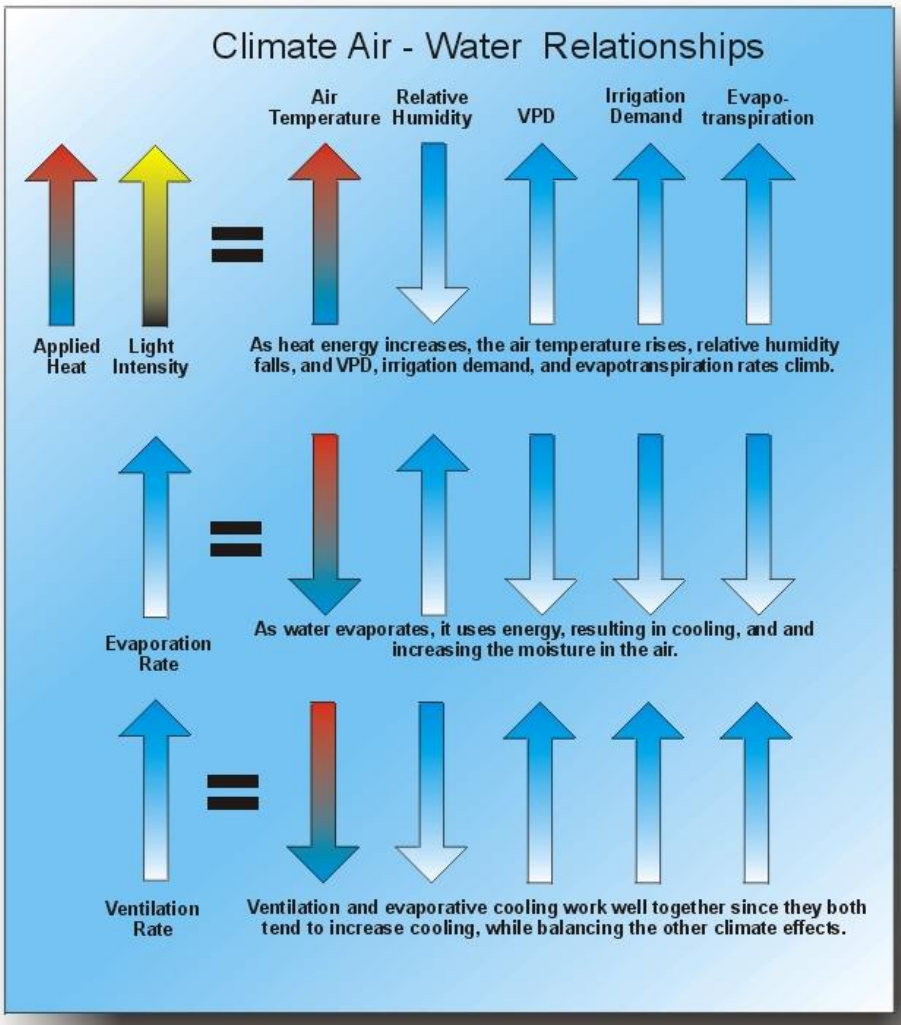
In practice, these strategies must often be used together, particularly when you are trying to hold a steady temperature. It is also important to understand that whenever heating and ventilating are used to manage humidity, they cannot help but affect temperatures levels, since air temperature and humidity levels are so interdependent.

Similarly, heating and venting for temperature control will affect humidity levels. In practical terms, whenever we need to use the same equipment to control both conditions, we can't adjust one without the other.

# Air - Water Relationships

The diagram below illustrates the major relationships between air temperature and humidity. The top row of arrows shows the effects on air temperature, relative humidity, vapor pressure deficit, crop irrigation demand, and evapotranspiration (evaporation and plant transpiration) rates when supplemental heat or the heat from light energy is applied.

The middle row shows what happens as humidity increases due to the evaporation of water in the climate. The third row shows the effects of ventilation: exchanging the climate air with cooler outside air.




Since humidity levels and air temperature are so interrelated, it is seldom possible to adjust one without affecting the other. You might ask: If humidity and air temperature are so interdependent, why should we bother having separate control calculations?

The **Argus Climate Energy Balance** program calculates separate heating and cooling requirements for temperature and humidity control. Separating the two allows us to independently calculate the degree and nature of the control response that is required for both humidity and temperature management, and to act accordingly. We can also control the relative resources that can be used for either objective.

For example, suppose we have a climate where:

- Heating Target is 20 ºC.
- Cooling Target is 25 ºC.
- Dehumidify Target is 80%.
- Current Temperature is 21 ºC.
- Current Humidity is 85% RH.
- Outdoor Temperature is 10 ºC.
- Outdoor Humidity is 85% RH.

From the above information, we can see that the current temperature does not require adjustment since it is between the Heating and the Cooling targets. Therefore, there is currently no demand for heating or ventilation for temperature management purposes. However, the humidity is above the current control target and something needs to be done about it.

The Energy Balance program offers two strategies that can be used separately or together:

- We can apply Heat.
- We can apply Ventilation.
- We can apply both.

## Using Heating for Dehumidification

Let's first assume that we are going to apply Heating for Dehumidification without applying any Ventilation for Dehumidification, here's what may happen:

1. First, the air temperature should begin to rise (because we are actively applying more heat) and the relative humidity will be reduced, at least temporarily. If it is reduced to below the target threshold, the control system will stop applying the additional heat. If we are lucky, the new temperature might stabilize at 24 ºC, still within the heating/cooling deadband. However, chances are that the heat applied will cause the temperature to rise above the cooling setpoint (particularly if the heating and cooling setpoints are close to one another).
2. Due to continued evaporation of free water in the climate, and the moisture released by animals, plants, or human activities, this drier, warmer air may well accumulate more water vapor, again causing the system to apply additional heating, until eventually the air temperature ventilation target is exceeded.
3. Ventilation control will now be applied, not for dehumidification purposes, but to mange this increased temperature. This will result in an exchange of warm moist air climate air for cool (and apparently just as moist) outdoor air.
4. In our example, notice that in the outdoor air and the indoor air are at the same relative humidity (85%) but different temperatures. It may appear at first that bringing in air that is the same relative humidity won't help solve our climate humidity problems. However, the outdoor air is much cooler, and when we bring it in, it is going to be warmed up to at least our heating setpoint (20 ºC).

5. If we were to consult a psychometric chart (a chart used for calculating air properties at various temperature and humidity levels), we would see that when you take air at 10 ºC, 85% RH and warm it up to 20 ºC the relative humidity will actually fall to 45% RH. Therefore, when this cool air is reheated, the net effect will be that we have mixed in a volume of drier air at 45% RH with our 85% RH climate air. The resulting humidity will be somewhere in between the two and hopefully lower than our maximum humidity setpoint.

To accomplish the dehumidification above, we caused the control system to do something that we don't normally want to see happen; we operated our heating equipment and our cooling equipment at the same time. However, this is often the only practical way that dehumidification can be accomplished.

## Using Dehumidify Ventilation

To avoid raising the temperature all the way to the Cooling Target, we can simultaneously employ the Ventilation for Dehumidification options in the Energy balance program. If carefully configured, this will cause the ventilation machinery to act before the greenhouse temperatures rise above the controlled levels.

In this way, it is possible to control excess humidity without significantly affecting the climate temperature, since it is possible to simultaneously exhaust warm moist air and reheat the incoming cool air at a rate that maintains a stable climate temperature. The objective is to achieve a steady ventilation/reheating state that maintains the climate temperature within the temperature setpoints, while at the same time keeping the humidity levels just under the target threshold.

The ventilation and heating systems often do not produce their results at the same rate. For example, ventilation systems can often lower the temperature faster than heating systems can raise it due to differing process lags in the two systems. Therefore, there are offset settings in the Energy Balance program that can help you to adjust for this.

If the heating system takes longer to produce a result, you may want to have the Heating for Dehumidification control kick in before the Ventilation for Dehumidification controls. With the Proportional/Integral tuning settings for each method, you can control how aggressively each method should tackle the problem, and provide tuning for the respective process lags in each system. You can also control the maximum amount of each resource (Heating or Venting) that you wish to use for dehumidification purposes.

## Managing Dehumidification Costs

Simultaneous heating and venting for humidity control can be likened to driving with one foot on the gas and the other on the brake. You can achieve a balance (a constant speed) by applying just a small amount of gas and brake, or by applying lots of gas and countering this with lots of brake. Obviously, for humidity control, we want to apply the smallest amount of resources possible to get the job done. Dehumidification can be expensive, and you might not want to turn all of your heating and cooling resources over to the control system to manage tight humidity targets.

To manage this, you can set maximum limits on your Argus system for both dehumidification heating and dehumidification ventilation controls. This will limit the amount of resources applied by each. You can also create management alarms to monitor current dehumidification requirements. You should also record and regularly review all of your heating, ventilation and humidity control parameters to check system performance.

Whenever you limit the Heating or Ventilation resources that can be applied, there may be times when you may not be able to achieve the Dehumidification Targets you have established. You should make sure that your dehumidification goals are realistic for the intended application. Don't do any more dehumidifying than is necessary to accomplish your objectives.

Also, make sure that the sensors used to monitor humidity levels are working properly and placed in locations that are representative of the average humidity conditions.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