# ENERGY-WISE
# HUMIDITY CONTROL

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## A large part of the energy used in a greenhouse is for temperature and humidity control.

There are two sides to humidity control: in summery conditions it is about avoiding *too low* humidity and the risk of drought stress. In winter, it is about avoiding *too high* humidity, for two reasons: avoiding fungal diseases and keeping plants active. In relation to energy saving, the focus is on high humidity winter-like situations. The standard method of keeping humidity low is by applying concurrent heating and venting, albeit in a smart way. But this wastes energy. The modern approach is based on air movement, air exchange and good screens.

### Preventing condensation and diseases

First a brief recap of last month's article. It is very important to have a uniform temperature pattern in a greenhouse. Greenhouses with an uneven temperature and/or wet areas always harbour cold spots, where condensation occurs and diseases develop easily. This makes it necessary to choose the setpoint for relative humidity (RH) at a very low level, say in the 70% range. In contrast, if there are no cold spots, the RH can be safely maintained at a much higher level, even in the 90% range. Creating a uniform climate saves a considerable amount of energy and should be the first priority. On top of that, the tips of the plants must not get too cold as this attracts condensation – which often happens at night, caused by heat emission from the plant tips to the cold roof.

### Stimulating transpiration and nutrient uptake

The other main reason for avoiding too high humidity is to ensure that plants evaporate enough water, and thus take up enough water with nutrients. In winter, especially at night and especially under a screen, transpiration can stagnate. This can lead to nutrient deficiencies, in particular calcium related problems. Then it can become necessary to 'activate' the plants.

In bright sunshine, transpiration is driven largely by radiation from the sun, while other factors have a relatively small effect. But when solar radiation is lacking, transpiration is low, and other climate factors such as air humidity, air movement, heating pipes and any artificial lighting have a greater impact. We can use those factors to 'activate' the plants, and ensure sufficient nutrient uptake.

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### Negative spiral of combined heating and venting

The standard method of controlling humidity in winter is by applying heating, venting, or both simultaneously. This is often a negative spiral. Imagine you want to avoid the plants becoming damp at night, perhaps under a closed screen. If the humidity is controlled by slightly opening the vents or the screen (1% – 5%), then it gets colder and subsequently a computer controlled system will increase the heating to maintain the required temperature.

Alternatively, if the humidity is controlled by increasing the heating (e.g. pipe temperature), the air temperature rises to the point where the computer calls for further opening of the vents and/or widening of the screen gap, again to maintain the required temperature.

Both scenarios achieve the opposite of what we want: while the computer system tries to prevent condensation, at the same time it stimulates transpiration. The plants add even more water to the greenhouse air, and that water needs to be removed again. In the end it works, but this negative spiral pushes the energy consumption up. There is a need for a more energy-efficient method of humidity control. The answer lies in air movement, air exchange with outside (or with the compartment above the screen), and using proper screens.

### Screens

An energy screen is of great value, especially in cold climate zones. In mild climates, screens are valuable too, although the type of screen can be different: less insulating and more suited to shading in summer. There are many different screen materials, and it is important to choose one that is adequate for the conditions. The benefits of closing a screen in cold weather are clear: warm air stays under the screen, while the cold is kept in the compartment above the screen. Secondly, the tips of the plants do not lose their warmth to the roof, because the screen blocks heat emission. (Heat emission is heat radiating out from the plants to the cold roof, which chills the tips of the plants.) Hence the plant tips do not get wet from condensation and are less prone to infection. Thirdly, good screen material does not gather condensation in large drops, so the plants are not subjected to a continuous trickling of water droplets or rain showers.

### High humidity under a screen

A well-known problem is the accumulation of water vapour under the screen especially at night. A partial solution is creating a small screen gap so water vapour can travel to the top compartment, where it condenses against the cold cladding. Unfortunately, even a small gap of 1% to 5% causes energy loss, which counteracts the intention of an energy saving screen. A partial solution is using a screen material that lets water vapour pass through. The next step is to utilise air movement. A further step towards a solution is allowing air exchange with the compartment above the screen or with the outside air. These steps will be discussed in a following article.