Energy-wise greenhouse control in winter

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It's the middle of winter and greenhouse growers are dealing with high energy need and high energy prices. It is not too late to try to do something about your energy costs this winter. It might be as 'easy' as changing some settings in your greenhouse control computer. This article lists some things that can be done to improve energy efficiency in winter.

Minimum pipe temperature
Minimum pipe temperature is used for reducing greenhouse air humidity, and so reducing the risk of diseases such as grey mould or Botrytis. Minimum pipe can also be used 'to activate the plants' which is in fact stimulating crop transpiration. Both reasons for minimum pipe are only valid on dull days. As soon as the sun comes out, minimum pipe becomes relatively unimportant or even a complete waste of energy.
For energy saving purposes, minimum pipe should be made dependent on the conditions, especially radiation and greenhouse air humidity. Good computers offer settings for 'light influence' and 'humidity influence'. Let's assume the minimum pipe is set at 45 °C. The 'light influence' can be set to reduce the minimum pipe temperature gradually by 20 degrees when radiation climbs let's say from 100 to 250 W/m^2. Hence the minimum pipe will be only 25 °C (45-20=25), when radiation reaches 250 W/m^2. The 'humidity influence' can be used to reduce the minimum pipe when the greenhouse humidity is better (lower). For instance minimum pipe can be completely off when humidity is under 80 %.

Periods for minimum pipe
It is good to distinguish several periods in the day (early morning, mid day, late after noon), and choose different settings for minimum pipe for each period. Humidity problems are most severe early in the morning, so the humidity control should be set sharpest for this period. It starts 1-2 hours before sun rise, and ends about 2 hours after sunrise. Minimum pipe is less required during mid day; a good radiation influence will take care of that.
For a different reason, minimum pipe can be used in late afternoon under winter conditions, especially in the South Island. It helps prevent a sudden temperature drop after a sunny day. As the sun goes down, radiation falls rapidly, and therefore the heat demand rises rapidly. This can go fast, and a coal boiler responds slowly. To avoid a cold period around sunset, the minimum pipe can be set at 35 or 40 °C by mid to late afternoon. This triggers the burner to fire up, so that heat is available in time. A small radiation influence can be used, e.g. 20 °C in the range 50 to 150 W/m^2 radiation, to have the minimum pipe come in gradually. It is important to chose the start and end times of the period correctly, preferably coupled to sunset.

Pump switching off
There are hours when the pipes are only luke-warm (say 25-26 °C). Such low pipe temperature has hardly any effect on the plants, especially if there is ample sunshine. It may even waste energy, certainly electricity, but also some heat. In periods when there is no need for heating or for minimum pipe temperature, the pumps may as well be switched off. Advanced computers can do this for you. Only, you must allow the conditions to be suitable for the pump to switch off. For instance, if the pumps are set to switch off when pipe temperature drops below 25 °C, and if minimum pipe temperature is set so that it never gets under 25 °C, then the pumps will never switch off. Some computers have a setting called 'absolute minimum pipe temperature'. This is default set at 25 °C, but can better be set at 0 °C to allow pump switch-off. Alternatively, the pump is set to switch off at pipe temperatures below 26 °C.

Humidity control
There are various ways of humidity control: by minimum pipe (see above), heating temperature, venting temperature, minimum ventilation, purging with vents, purging with heating temperature, and combinations of it. You want a method that is effective, but also energy efficient. Some things don't work: heating alone (without venting) will give only a short drop in relative humidity. It is necessary to vent in order to remove the excessive moisture, and at the same time to heat to maintain the required temperature.
A good way of doing is choosing the base line for venting temperature about 1-2 degrees above the base line for heating temperature, say heating at 21 °C, and venting starting at 22.5 °C. When humidity is low enough, venting and heating are done at their base line levels. However, you can set certain settings so that heating and venting deviate from their base lines levels. For instance at higher humidity, the heating and venting temperature get closer to each other: either the venting temperature is lowered (say to 22 °C) or venting temperature is lowered and heating temperature increased (21.5 °C). Some growers opt to have the venting temperature temporarily below the heating temperature. This is not recommended, or only when humidity gets really dangerously high.

Venting
Vent control is a hard one, and also different between computer brands. Here follow some things related to venting that can cause energy loss. If you observe something like this, find out what causes it and try to fix it. The venting performance can also be checked (afterwards) by looking at the graphs.
On cold winter days, venting is used mostly for humidity control rather than temperature control. Minimum ventilation is sometimes used too generously for humidity control (similar to excessive use of minimum pipe for humidity control). Another thing is concurrent venting and heating by mistake, wasting a lot of energy (see discussion above about humidity control).
Also, we often see technical shortcomings. For instance that vents are still on a small crack when they are supposed to be closed. In other cases we see sometimes that vents are open for more than 10%, when they are meant to be open for 5%. This can be due to the greenhouse or the computer and how vents are steered. Good calibration will help here.
In other situations we see that vents are moving (opening & closing) all the time. The frequent movement causes unrest and unnecessary wear-and-tear in the venting mechanisms. It can be due to the fact that the vents are steered open too wide and too abrupt under cold weather conditions. Wide open vents cause a quick temperature drop, which in turn forces the vents to close again and sometimes the heating to come on. This can be overcome by adjusting the vent opening control, in many systems this is done by a P-band setting. On cold days, the P-band should be high, at least 5 °C at leeward side, and perhaps 10 °C at the wind side. In winter, the vents on the wind side should have restrictions to how far they can open, if possible.

Screen
For the few growers who do have an energy screen, it is important to close it early enough in the evening, and to open it late enough in the morning. Closing time is before sunset, before the temperature starts to drop. Opening in the morning is after the sun has gained enough power. Opening before sunrise causes an enormous temperature drop in the greenhouse, and a drain on the heating system. Then the heating pipes have to work double: to heat the very cold air that came from above the screen, as well as increasing the temperature of the greenhouse air to the day-time level.

If the humidity gets too high under a screen, it is good to partly open the screen in small steps to a gap of about 5%. The gap is to let water vapour escape, so that it condensates against the cold glass in the roof. (This is especially cold if a screen was closed). At the same time the screen still keeps most of the warm air down.

Graphs

If your computer can make graphs, use them! Things to look for are for instance periods when pipes are hot and vents are open at the same time. Is this what you want? Was it necessary? Was the humidity dangerously high, or was it acceptable? If there was no reason for simultaneous heating and venting, you better change the settings.

You can also look at minimum pipe temperature. Did you have a minimum pipe for some time, while humidity was low enough? Or was minimum pipe used for another reasons? If there was no good reason for minimum pipe, you may as well change the settings.

Did you have sudden peaks in pipe temperature, perhaps alternating with dips in pipe temperature? Was this for a reason? If not, you may want to change the settings to create a smoother line for the pipe temperature.