

Thermal screens for energy saving & climate control (2)

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The previous article was about *thermal screens* also called *energy screens*, in particular about their construction and the wide range of materials. The use of a thermal screen may have effects on the climate and hence on how the plants grow. This article first lists some economic considerations to decide if a screen is interesting, and secondly it discusses the control of a thermal screen.

Thermal screen or dual-purpose screen

Thermal screens can be air-tight and non-transparent, meant to be closed during the night and opened during the day. Alternatively, thermal screen can be made of transparent foil material and can be closed during night and day. A good air-tight thermal screen reduces the energy use by 35% during the hours when the screen is closed. In contrast, NZ growers tend to prefer so-called 'dual purpose' screens. These screens are more designed for shading in summer; they are not air-tight and their energy saving qualities are very limited. What is written below for thermal screens does not necessarily apply to dual-purpose screens.

Considerations

In the decision whether a thermal screen can be interesting there are many issues to consider.

- Thermal screens are most interesting for areas with cold winters; they will become more feasible when the energy price rises.
- A screen is easy to install when a greenhouse is erected, but it can be costly to install in an existing greenhouse.
- A moveable thermal screen is normally used in combination with hot-water pipe heating and a boiler, and not normally in combination with hot-air heaters.
- The greenhouse must be high enough to allow a good growing environment under a screen.
- A thermal screen remains in the greenhouse throughout the year, and a folded screen intercepts a bit of the natural light. This light loss causes some yield loss.
- The costs can be calculated from the investment costs (spread over 5-10 years), running costs, maintenance costs, and yield loss due to reduced natural light.
- The savings in energy are a percentage of the energy used when the screen is closed; the percentage saving depends on the screen material chosen.
- A greenhouse insulated by a thermal screen can be heated by a smaller boiler. Alternatively an extra greenhouse can be added without increasing the boiler capacity, if all greenhouses are equipped with a good thermal screen.

High air humidity

A good thermal screen divides the greenhouse in two compartments: the lower one (under the screen) where the heating pipes are located and where the plants release water vapour. Since warm air can hold a lot of water vapour, the air in this compartment becomes very humid (and warm).

The upper compartment (above the screen) is cold. Cold air cannot contain a lot of water vapour. Any excessive water vapour in the air condensates against the cold cladding. With a screen closed the cladding is even colder than without a screen, so there is more condensation. This causes that the air above an air-tight thermal screen is very dry (and cold). Note that this is different with a dual-purpose screen material, which is not air-tight: the heat and water vapour can travel freely through such screens.

Controlling air humidity

An air-tight thermal screen forms a barrier for warmth and moisture. This is good for energy saving, but the high humidity makes the plants soft and lush. In addition, high humidity hampers the plant transpiration, and this reduces the nutrient uptake, resulting in weak plants. Moreover high humidity promotes fungal diseases such as grey mould (*Botrytis*). Altogether high humidity is undesirable.

Fortunately the humidity under a screen can be managed. This is done by leaving the thermal screen open on a tiny little crack, for instance 10 mm per 4 m (this is not necessary if the screen material is not air-tight). A small gap between the screens lets the water vapour escape to the upper compartment where it mixes with the dry air, or condensates against the cold cladding. When it is not freezing cold, the vents can be opened on a very small crack as well to remove the moisture to the outside. It is inevitable that a bit of heat is lost too, but this is a small sacrifice necessary to lower the humidity. By controlling the thermal screen accurately (by using a computer!) one can create the ideal growing environment with optimal temperature and humidity, while the energy consumption is reduced considerably.

Opening a screen

In the morning it is unwise to open the thermal screen abruptly because the warm air would get lost immediately and the plants would get a cold shock. The best method of opening a thermal screen is to first increase the temperature. The sun will not be strong enough to do this, and therefore the temperature of the heating pipes must be increased. Then the screen is carefully opened on just a small crack. The air from under and above the screen will gradually mix and the heating pipes need time to warm the colder air. When the set temperature is restored again, the thermal screen can be opened a bit further. This is repeated a few times, and so the screen is opened in about four steps. In this way the plants are not exposed to a temperature and humidity shock. In large greenhouse complexes, different compartments are opened one after the other, to avoid that the boiler has to provide too much heat at once.

Effects on the crop

Under a thermal screen the plants become a bit weaker due to low transpiration under high air humidity. This won't happen when it is sunny during the day: the sun's energy will stimulate the transpiration and photosynthesis. However, when it is dull for several days the plants need to be activated by heating during the day to stimulate the transpiration. This can be done by a minimum pipe temperature (plus some venting to remove the moisture) for a larger part of the day, or by giving a temperature peak during the middle of the day.

A point is that the pipes don't get as hot under a screen as in an unscreened greenhouse, which is an advantage in some situations. Another point is that plants grown under a screen may develop slightly more generative than plants grown without screen.

In a future article, we will publish the results of a research project on the economic aspects of thermal screen.