Thermal screens for energy saving in greenhouses (1)

Elly Nederhoff
CropHouse Ltd, New Zealand
Elly@CropHouse.co.nz
Published in the Grower 58(6), 2003, p. 27-29

Energy is a burning issue these days due to depleting gas stocks, hydro lake levels, the 'Kyoto protocol' and the threat of carbon tax. For greenhouse growers the looming rise in fuel costs can be a reason to look seriously into energy saving. This article deals with thermal screens. Because the investment costs are substantial, thermal screens are not easily feasible in mild winter climates and with low energy prices.

Thermal screen or shade screen
Screens in greenhouses are mainly known in NZ as devices to reduce solar radiation in summer. Shade screens, mainly used by flower growers and plant propagators, are opened and closed depending on the light intensity. But screens can be used for other purposes too, such as energy saving, blocking the light for day length sensitive plants, increasing the air humidity for young plants, or a combination of these. The construction principle is largely similar, while the screening material can be different for each purpose.
For energy saving in winter one needs a screen that serves as a barrier between the (warm) greenhouse environment and the (cold) top layer of the greenhouse just under the roof. Thermal screening requires a dense and air-tight fabric. It does not have to be transparent for light, as it is only used at night (at least in NZ). In contrast, a dual purpose screen that is also used for shading must be semi-transparent. Dual purpose screens are a compromise and their energy saving qualities are often low. Hence their effect on energy use is hardly noticeable, especially in a mild climate. Thermal screens and dual purpose screens can also be used for humidity control, i.e. retaining moisture.

Construction
Thermal screens are installed as sheets of about 2-4 m wide and infinite length, that can be opened and closed by rolling, folding or packing. They can run either parallel to the gutters or parallel to the trusses. They can be constructed horizontally just under the gutters, or on a slope parallel to the greenhouse roof. Many thermal screens are installed horizontally over the crop, with flaps hanging down along the walls. Gaps near the walls must be avoided, because a lot of energy is lost here. Also, the screens must close very tightly, to avoid heat loss through gaps between screens. However, it is desirable that small gaps can be created by slightly opening the screens.
The screens are supported by steel wires (low rust quality), and are opened and closed by sets of wires or toothgears operated by electro motors. It is critical that the motors start and stop at the right point, and that they can open the screens slowly in accurate steps. Abrupt and complete opening of the energy screens in the morning is undesirable because the temperature would drop instantly.
The greenhouse structure must be strong enough to support the weight and forces of a screen. The greenhouse of Faber, Harford and Redpath are all suitable for installing thermal screens. In an existing greenhouse, though, installation can sometimes be difficult when other installations are in the way (overhead irrigation, heating, CO2 tubes, fans).

Screen fabric

There is a wide range of screen material on the marked, mainly produced in the cold northern European countries. Materials can be woven, knitted, non-woven (e.g. foil), transparent, white, black, aluminised, etc. Many types of screen material are made of narrow strips of polyethylene (PE). It is often a combination of clear PE foil strips, non-transparent aluminised PE foil strips, possibly alternated with open spaces. The ratio of these three components determines the air-tightness, energy saving and light transparency of the material. The light transmission varies from 40 to 85%. The energy saving varies from 20 to 35%. Note that this is the energy saved while the thermal screen is closed; the annual energy saving is much lower. Some other materials e.g. heavy fabrics meant for light blocking can save up to 70% energy while closed.

Several other characteristics have to be considered as well, such as wear and tear due to opening and closing, aging due to UV light, flexibility, thickness of the folded screen packet, shrinking or stretching of the material, fire safety (there have been several fires in packing sheds where the fire spread quickly due to the screen). If plastic foil is used, it is wise to choose a so-called anti-condense type of foil. If condensation occurs, this foil gets covered by a film of water. In contrast, normal foil gets covered by big droplets, which cause a rain storm on the crop.

Economic considerations

An energy saving measure is feasible if the value of the energy savings is higher than the costs of the energy saving measure (on a per annum basis). The savings depend very much on the fuel price. Increasing fuel prices make any investment in energy saving measures more feasible. Of course energy saving is more feasible in cold or very windy conditions. Obviously thermal screens will be more functional in cold locations in the South than in moderate climates in the North.

The costs of a thermal screen depend on the size of the greenhouse. In NZ the price range is about $13 to 16 per m^2 (or more on a very small area). Installation in an existing greenhouse can be more expensive than this. The wires and motors of a thermal screen can be depreciated over 10 years. The fabric is guaranteed for 5 years, but is often used for over 10 years. So the annual costs of thermal screens can be calculated from the investment costs spread over 10 years, plus some maintenance and running costs. As mentioned before, the annual costs are earned back more easily in case of higher energy price and colder winters.

Other points

Energy screens have an effect on the temperature of the heating pipes, air temperature, plant temperature and air humidity. This affects how the plants develop, e.g. the lushness and ‘softness’ of the leaves, the vegetative or generative growth. Other effects are that still air so that fans may be needed. Also, the use thermal screens makes that the peak energy requirement gets lower, and that a smaller boiler is sufficient to maintain the required temperature. These finer details will be discussed later.

***Acknowledgements**. With thanks to Peter Holwerda (Faber Glasshouses), David Williams (Redpath) and Tony Blanchet (Harford).*