Electric Heating for Horticultural Applications

Heating is one of the major costs in greenhouse crop production. Depending on the locality, crop and type of production, heating accounts for between twenty and forty per cent of the total direct production costs. An increase in the efficiency of a greenhouse heating system has a significant effect in reducing production costs.

Air temperature is the most important controllable factor that has a fundamental effect on plant development, yield and quality. Each crop type has its ideal air temperature. For much of the year UK external temperatures are below optimum for most greenhouse crops and so there is considerable scope for space heating. To maximise the effectiveness of heating it is essential to have an efficient control system. Poor control of air temperature wastes fuel.

Electricity is a refined fuel and therefore more costly than coal, oil or gas for large-scale heating. For smaller greenhouses run at relatively low temperatures (frost protection only) the lower capital cost coupled with convenience, efficiency and low maintenance requirement make electric heating more competitive with other fuels.

Cleanliness, adaptability and ease of control make electric heating suitable for well insulated structures such as packing houses, potting sheds and offices and for the more specialist applications such as seed drying and heat treatment of flower bulbs. Electric soil warming can provide a highly effective and convenient means of maintaining optimum root temperatures for propagating benches or frames. There is evidence to show that soil warming can make economies in space heating by facilitating a reduction of minimum air temperature without impairing crop performance. Soil warming is the subject of a separate Technical Note.

Equipment for horticultural heating is subjected to more rigorous conditions than in the office or home being exposed to watering, high humidity and possibly corrosive sprays. It is important to use equipment designed and made to suit these conditions.

Choice of Heating System

Design Temperature Requirements

The crops to be grown in a greenhouse determine the required temperature regimes. The crop requiring the highest air temperature will determine the maximum capability of the heating system.

Heat Input Requirement

Having decided upon the highest temperature regime required the maximum heat input can be calculated and this determines the size of the heating system. The five principal factors which need to be taken into consideration are:-

a) type of structure to be heated (thermal transmission coefficient or U value)

b) size (area of glass or plastic covering)

c) geographical location

d) the maximum difference between inside and outside temperature (DT)

e) air infiltration (escape of heated air).

Heating Systems

Oil, natural gas or solid fuel heat the majority of commercial greenhouses. Electricity is employed to operate the heating systems through fans, pumps and control systems. Only where its convenience is of value, or frost protection may be needed, is

Farm Energy Centre, NAC, Stoneleigh Park, Kenilworth, Warwickshire CV8 2LS
Telephone: 024 7669 6512 Fax: 024 7669 6360 Email: info@farmenergy.com Web: www.farmenergy.com

electricity directly used for heating. Applied correctly, electrical heating systems can provide some cost effective solutions to heating in greenhouses as in the following examples.

Bivalent (Part Load) Electrical Heating

Electrical boilers sited immediately adjacent to their heating task can operate usefully in parallel with fossil fuel central boilers (gas, oil, solid fuel). All or part of the heating load can be taken under the following typical circumstances:

a) additional boiler capacity is required as a result of expansion of the growing area;

b) turn down on the existing boiler system is insufficient to match the much reduced summer load, or can only meet this demand with a very low system efficiency;

c) the majority of the heating load coincides with off-peak electricity periods.

Two types of electrical boilers are available: flow boilers and storage boilers.

Flow boilers are simple efficient heaters and are largely maintenance free. Unlike fossil fuel boilers, they do not suffer from efficiency losses when used intermittently or at less than full output. They are compact and can often be located conveniently alongside the heating load.

Storage boilers have the advantage, in addition to being efficient, of heating water at times of low energy cost by making maximum use of off-peak tariffs.

Tubular Heaters

The only tubular heaters recommended for horticultural situations are waterproof aluminium types because of the wet and corrosive conditions in the greenhouse. The aluminium tubes are normally 50mm in diameter and are available in lengths of 0.6m-4.5m. They are best fixed singly or in tiers of two, three or more tubes around the walls of the house. The lowest tube should be about 100-150mm above the soil level to provide a sufficient gap for effective air circulation while taking up the minimum space.

Where tubes are fixed under solid benches there should be a gap of 75-150mm between the back of the bench and the wall to allow warm air to circulate freely upwards. The electrical loading for tubular heaters is generally 196W per m run of the tube, but a 255W per m type is also available and can be used where wall space is limited.

Fan Heaters

Fan heaters used in greenhouses generally operate by drawing air over a bank of heating elements; the warmed air is blown out into the surrounding space where it mixes with ambient air raising the temperature to the required level. Care must be taken in siting fan heaters to ensure sufficient mixing takes place and streams of hot air are not directed onto the plants causing stress and damage. Heaters are placed on the floor or can be suspended from the superstructure. Fan heaters with thermostats provide a simple frost protection system. For the smallest house heaters start at 1.8kW and larger units range from 2kW to 15kW. Fan heaters are useful in storerooms and offices where there is only an occasional need for heat.

Transparent plastic perforated tubes or ducts can be used to ensure a more uniform distribution of warmed air. Size of ducting and the pattern of perforation vary according to house requirements. The tubing is available in diameters from 180mm to 700mm but 250mm is the most popular size. These tubes can be fitted around the house, suspended under benches or can lie on the soil or pathways. Suitable electric heaters rated at 4, 6, 12, 16 and 20kW are available.

An advantage of this system is that in warm weather the heating element can be switched off. Air drawn in from outside and blown through the tubes provides a degree of fresh air movement around the plants.

Radiant Heaters

QLL (quartz linear lamp) heaters are particularly good for spot heating in open or draughty conditions such as potting benches of check-outs of nursery shops. They are very responsive and waste no energy in warming up or cooling down.

Controls

A prime feature of electrical heating systems is their efficiency and ease of control; an appropriate temperature controller is an essential part of the system.

Energy Efficiency

Good housekeeping is the least cost measure to reduce heat losses. Check that vents and doors close properly and seal well; then ensure that they are kept closed unless opened for a specific purpose. Gaps and holes in the greenhouse fabric e.g. where cables or pipes pass through should be sealed and repaired because all the small leaks together cause a significant heat loss. Heat losses can also be reduced by thermal insulation using transparent materials such as 'bubble sheeting'. Application of such materials will cut down light transmission and may be counterproductive in terms of plant growth, but small greenhouses can benefit from insulation applied to north facing walls.

Thermal screens drawn across the house at nightfall save energy by trapping warm air beneath them and reducing heat transmission through the roof. On a smaller scale horticultural fleece drawn across benches and beds with soil warming will help conserve heat. Fleece can also be used to give a degree of frost protection in unheated houses.

Pipes carrying steam or hot water and which are not intended as heating surfaces should be well insulated and any damaged insulation should be repaired. The thicker this insulation, the better it is. Thermostat sensors should be kept clean and shielded from both direct sunlight and cold draughts. Heating controls should be calibrated regularly and computer controlled programs checked to see that they are as intended.

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