BASE HEATING FOR PROPAGATION: FLEXIHEAT

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INTRODUCTION

Flexiheat is the trade name for low voltage electrically heated mats, distributed by Foil Engineering, Ltd of London. They operate at a safe 24 volts, and generate 14 watts for each 300mm length of foil element. The elements consist of aluminum or nickel foil, laid out in an intricate winding pattern, similar to the original printed circuit boards which revolutionised the electronics industry. For horticultural use, the elements are mainly aluminum foil, and the electrical connections consist of cold copper tails soldered onto a pair of foil busbars, running down each side of the active heating element. The resultant mat is then encapsulated between two layers of polyester film, making it impervious to moisture or chemical fluids.

Each mat has a total width of 380mm, with a foil width of 350mm, including the two busbar strips. The active heating section of the element in the centre is 250mm wide, and designed to form a complete circuit module every 600mm. Table 1 shows how the wattage per square metre can be varied by overlapping the busbar strips, or the busbar strips can overlap the active heating area, but the active heating sections must never overlap each other, as this could cause overheating.

Table 1. Flexiheat mats heat output. (28 watts per 600mm complete circuit module at 24 volts; 14 watts every 300mm run.

Equivalent Wattages			
120 watts/m^2	over	380mm	plastic width
129 watts/m^2	over	350mm	foil width
151 watts/m^2	over	300mm	overlap
181 watts/m^2	over	250mm	active sheathing width

MAIN ADVANTAGES

Low voltage safety. The mats operate at 24 volts, reduced from the main voltage of 240 volts, through a transformer.

Even heat distribution. The overall heat pattern achieves improved efficiency in propagation, without relying on a large bulk of sand to provide the heat transfer to the seed trays. However, if full benefit is to be obtained from the Off Peak "Economy 7" tariff, some form of thermal storage is recommended. As with any heat source, there is still the difficulty of obtaining an efficient heat

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transfer to the compost if polystyrene based trays are used, and these should be avoided if possible.

Simple installation. Mats can be rolled out onto an insulated bench, and just covered with capillary matting, or laid into an insulated sand bed.

Mobility. Flexiheat mats can be easily rolled up again for storage if required.

Sterilisation. Steam sterilisation is easy, as the foil is resistant to temperatures of up to 120°C. It will also withstand most known chemicals used in sterilisation.

Long life. Although the mats are waterproof and the encapsulated foil virtually indestructible the life span can be extended considerably if a sheet of heavy gauge polythene is laid over them, or they are enclosed in a polythene sleeve before covering with sand. This provides additional mechanical protection from any pieces of sharp grit, and more important, prevents the mats from becoming submerged in any liquid fertiliser or chemical fluids, which could cause corrosion of the electrical connections.

Where mats consisting of three or more complete element modules are used, any mechanical damage causing a break in the foil elements will result in the current finding an alternative route via adjacent arms. Thus any loss of heat will be restricted to one or as many arms of the pattern that may be damaged. This will be largely compensated for by a slight increase in heat output by the remaining arms.

INSTALLATION

Root zone warming is only one factor affecting plant growth, and the use of low voltage matting does not excuse the system from the basic rules. It is impossible to list here the environmental requirements of all plant species, but whatever type of heating system is chosen, it must be capable of maintaining a temperature range of between 12° and 25°C. Table 2 lists just a few typical environmental regimes.

Table 2. Typical glasshouse environmental temperature regimes.

	Air temperature, °C		
	Day	Night	Root zone °C
Bedding plants	5–12	5–12	15–25
Nursery Stock	5–10	5–10	16–22
Ornamentals	15–24	15–24	18–25
Chrysanthemums	12–16	12–16	18–25
Lettuce	8–15	5–10	12–18
Tomato Cucumber	20	15–18	21–25

Insulation. It is now considered standard practice to insulate propagation beds and benches; this has the potential of obtaining up

to 50 per cent fuel economy.

The suggested procedure is to use 50mm expanded or extruded polystyrene boards. When expanded polystyrene is used, the boards must be wrapped and sealed in polythene. If the beds or benches are narrow then the insulation can be reduced to 25mm on the sides and ends, thus avoiding too much loss of effective bed area.

Where the insulation boards butt up against each other, they should be taped together with 50mm wide self-adhesive cloth tape; this makes a surface for the heated mats that cannot drift apart. The heated mats themselves can also be anchored in position with the same type of tape, prior to covering with sand or capillary matting.

Drainage. In the majority of cases, sloping the polystyrene surface will provide adequate drainage; alternatively drainage channels can be provided along the centre or on both sides of the beds by leaving a gap between the polystyrene board to enable water to drain between them.

Laying the mats. Having established a firm, thermally insulated, base of polystyrene boards, the mats are then unrolled, stretched flat, aligned as required, and then anchored down with tape. If a continuous polythene sheet is used as a cover, this can be tucked in all around the insulation boards. If the mats are to be enclosed in polythene lay-flat tubes this should be of sufficient length to tuck in at both ends.

The mats are delivered to site in the required lengths to match the size of bed or bench, complete with a transformer of a suitable size to match the total electrical load. There is no reasonable limit to the width of bench or bed, but each mat must not exceed 9.6m in length. This means that in long benches or beds the mats are supplied in sections, with the terminations butting up to one another.

All terminations and connections are clearly marked, but it is recommended that the services of a qualified electrician be used to install circuits to the transformers, and connect the mats and thermostat.

Various wattages per sq m can be obtained by careful overlapping of the mats, but any pair of overlapping busbars must always be connected to the same terminal, and for this reason each matching busbar connection is marked with a yellow tab.

When overlapping, busbars can of course overlap busbars, and busbars can even overlap the active heating area, but on no account must active heating areas overlap each other.

CONTROLS

Accurate temperature control is best provided by a thermostat, and it is recommended that this should either be of a capillary type or an electronic type (Table 3). Also, to enable the thermostat to

function correctly, it is important that the entire remote bulb or sensor is inserted horizontally into the sand bed or rooting medium. The temperature readings will be inaccurate if only part of the sensor is inserted, or left hanging in free air.

Table 3. Soil warming applications, Energy loadings W/m^2 and type of controls[1].

Soil warming applications	Energy Loading, W/m^2	Recommended Control
Cold frames	55–65 in the south 65–70 in the north	Thermostat control or Restricted hour dosage
Propagation	60–100 in heated houses	Thermostat control
Benches	80–150 in unheated houses	preferred
Heated propagation	60–100 in heated houses	Thermostat control
Beds or floors	80–150 in unheated houses	preferred
Within the greenhouse	80–170 for restricted hours	
Mist propagation beds	170 Minimum	Thermostat control only

[1] See Electricity Council Technical Information Sheet AGR9

If it is decided to operate "Restricted Hour" working, careful consideration must be given to the thermal capacity of the bed, and a possible increase of the energy loading per sq m. In order to obtain maximum use of cheap night rate electricity (Economy 7) a suitable time switch must be included.

CAPITAL COSTS

The capital cost of the heated mats complete with termination is at present (September, 1987) £3 per linear metre run, but it is usual to purchase complete kits, comprising of a suitable size transformer, contactors, and a capillary type thermostat, depending on the size of the installation. Larger installations cost progressively less per sq m, hence:

Size 500 watt kit suitable for 3m^2 — £100.00
Size 1200 watt kit suitable for 8m^2 — £200.00
Size 400 watt kit suitable for 14m^2 — £300.00
Size 2700 watt kit suitable for 17m^2 — £340.00

ELECTRICITY COSTS

Electricity use under thermostatic control will vary from 0.6 kwh per sq m per day to 2.5 kw h per sq m per day, depending on the differential between air temperatures and the thermostat setting and it is recommended to make as much use as possible of the Economy 7 tariff which offers units at 1.90p for 7 hours between 22.00 and 09.00 G.M.T. against 5.85p for units used during the day.