EVALUATING THERMAL BLANKET MATERIALS FOR GREENHOUSES

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Thermal blankets are materials so constructed and installed in greenhouses that they can be moved over the crop zone at night and stored out of the way during daylight hours. The blanket materials that can be used vary from polyethylene film to exotic fabrics. Thin lightweight materials offer little resistance to conductive heat flow. Heavy thermal blankets are made of materials with measurable resistance to conductive heat flow.

It is not possible to predict the thermal resistance of a material. Each must be tested and the resistance calculated. A standard testing method used for all samples allows comparisons. Full scale testing in a typical greenhouse operation provides additional performance data.

Radiative properties are transmission, reflection, absorption and emission. A good reflector is a poor absorber and a poor emitter. A good absorber is a poor reflector and a good emitter. All properties are functions of the temperature of the radiating source. An ideal material would have a highly reflective surface facing the plants, and a surface with low emissivity (high reflectivity) facing the outer greenhouse cover. An aluminized surface with no protective coating has a high reflectivity and low emissivity. "A black surface has a low reflectivity and a high emissivity."

A modified guarded hot box was used in tests at Penn State University to provide data on heat loss through the thermal blankets. Ninety four samples were tested. There were many thin materials among the samples and several laminated products. Materials with surfaces highly reflective to longwave radiation had higher thermal resistances than materials such as clear polyethylene film (it is transparent to longwave radiation from plant leaves). Permeable materials had lower resistance than similar, nonpermeable materials. The values obtained from the tests include surface resistance, material resistance and radiative property effects. Values for several materials are given in Table 1. Table 2 gives

Table 1. U values for selected materials tested in the modified hot box at Penn State University, vertical heat flow upward.

Material	U Factor BTU/hr/sq.ft./°F
D. S. Glass	1.04
4 mil, clear polyethylene	1.19
6 mil, black polyethylene	0.95
Tyvek, gray/black:	
Grey to warm air	0.59
Black to warm air	0.81
Foylon XA-2410	
Al to warm air	0.51
White to warm air	0.58
Technifoam Al	0.09
Air cap, small bubble	0.59
Air cap, large bubble	0.53
Simshade Aluminum/black	
Al to warm air	0.73
Air separated double polyethylene film	0.50

overall heat transmission values for several thin materials installed in a single glazed glass house.

Table 2. Overall heat transmission values for thin thermal blanket installed in three glass greenhouses.

	Heat Transmission Value BTU/ft^2-hr-°F	Heat Loss Reduction[1]
Mobile air curtain (double layer polyethylene film)	0.68	20%
Stationary air curtain (aluminized polyethylene tubes)	0.54	36
White-White spun bonded polyolefin film	0.51	40
Grey-White spun bonded polyolefin film (lightweight)	0.56	34
Clear polyethylene film	0.45	47
Black polyethylene film	0.48	44
Grey-White spun bonded polyolefin film (heavyweight)	0.43	49
Aluminum foil-clear vinyl film laminate	0.40	53
Aluminized fabric	0.39	54[2]
Black vinyl-aluminum foil laminate film	0.63	26
Double layer spun bonded polyester (tobacco shade cloth)	0.53	38

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[1] *Compared to single glass for the same greenhouses for nighttime heat loss.*

[2] *Average of four years of test data.*

Insulative value, durability, ease of handling, storage volume, and cost influence the choice of material for thermal blankets. Materials should fold or pleat easily to reduce storage volume. Heavy thermal blankets may have to be rolled for storage because they will not fold easily.

The problem of condensate collection in the top of deployed blankets has not been solved satisfactorily yet. Permeable materials avoid water ponding but lose heat faster because of the permeability. One solution would be to slope the blanket to direct water to edges that have drains.

Materials that have a woven fabric base should have good tear strength, fold easily and maintain surface quality. Some problems that have occurred include disintegration of some spun-bonded materials, toxic chemicals dissolving out of surface treatments, reflective surfaces peeling and flaking, and films becoming brittle.