

# Thinsulate™ INSULATION

expert advice



## The Physics of Insulating

### The technology of warmth

#### What makes Thinsulate™ Insulation so effective?

It's all in the fibers.

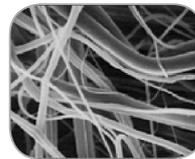
#### Insulations work in two ways:

- 1 By trapping air. The more air trapped, the more efficient the insulation.
- 2 By reflecting back the body's radiant heat.



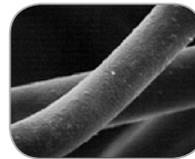
The unique microfibers of Thinsulate™ Insulation are about ten times smaller than the fibers of other synthetic insulations, which mean they're much more efficient at trapping air and more effective at keeping you warm and comfortable.

It also means more fibers can be packed into the same space, where they can reflect back more of the body's radiant heat.



#### Thinsulate™ Insulation

The fibers of Thinsulate™ Insulation are fine, making them ideal for trapping insulating air and reflecting back the body's radiant heat.



#### 6-denier hollow fiber

The fibers in 6-denier polyester are much thicker and not nearly as efficient at trapping air or reflecting back body heat.

### How your body uses and loses heat



Scientists have found that the human body sitting at rest consumes 4.7 kilocalories/hour/square foot of body surface area and transfers this energy into heat.

When thinking about heat loss, it is important to remember that heat loss is affected by:

- Body temperature
- Outside air temperature and wind speed
- Distances between the insulation fibers
- Thickness of insulation
- Fiber size

**3M**

### Effect of activity level

The insulation required by an individual to maintain comfort is markedly affected by activity level. This factor must be considered when choosing a garment for a particular activity.

### Staying warm

Thermal comfort is achieved by balancing three factors:

- Rate of heat production by your body
- Insulation value of your clothing (Clo)
- Environmental temperature

Of those three, it's easiest to alter the insulation value of your clothing. To do this we need to understand how, exactly, insulations work.

The unique microfibers of Thinsulate™ Insulation are about ten times smaller than the fibers of most other synthetic insulations, which means they're much more efficient at trapping air and more effective at keeping you warm. It also means we can pack more fibers into the same space, where they can reflect back more of the body's radiant heat.

Neither repeated machine washings nor dry-cleanings markedly affect the performance of Thinsulate insulation. Tests have shown, in fact, that Thinsulate insulation's average "Clo" (a measure of the ability of an insulation to keep you warm) remains relatively unchanged even after repeated cleanings.

Thinsulate insulation is the smartest choice if staying warm is important to you. When you compare equal thicknesses, the original "warmth without bulk" Thinsulate insulation offers almost one-and-one-half times the warmth of down, and twice the warmth of other high-loft insulation materials.

### Thermal comfort – Clo defined

Human thermal comfort is the state of mind that expresses satisfaction with the surrounding environment, according to ASHRAE Standard 55.

Most important for thermal comfort is the so called "operative temperature".

This is the average of the air dry-bulb temperature and of the mean radiant temperature at the given place in a room. In addition, there should be low air velocities and no 'drafts', little variation in the radiant temperatures from different directions in the room, the humidity has to be in a comfortable range, and the air temperatures in a heights of 0.1m above the floor should not be more than 2°C lower than the temperature at the place of the occupant's head. Also the temperatures should not change too rapidly - neither across the space nor with time.

In addition to environmental conditions, thermal comfort depends on the clothing and activity level of a person. The amount of clothing is measured against a standard amount that is roughly equivalent to a typical business suit, shirt, and undergarments. Activity level is compared to being seated quietly, such as in a classroom.

This standard amount of insulation required to keep a resting person warm in a windless room at 70°F (21.1°C) is equal to one Clo. Clo units can be converted to R-value by multiplying Clo by 0.88 and R-value can be converted to Clo by multiplying R-value by 1.136.

### Normal Clo values

Nude person Clo = 0.0

Typical business suit Clo = 1.0

### Clo values are additive

Summing the Clo values of individual components will approximate the total system Clo.

### Determining effective Clo

Total Clo is estimated by adding the Clo values of the components and correcting for surface area, fit, and air layer effects. This procedure was developed by the American Society of Heating, Refrigeration and Air conditioning Engineers.

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