THERMAL PROPERTIES

Thermal Properties:

The behaviour shown by a textile material when it is subjected to heat is known as thermal property. Followings are the thermal properties of a textile material-

- Thermal conductivity
- Glass transition temperature
- Melting temperature
- Thermal expansion
- Heat of wetting or heat of absorption
- Heat setting

- **Thermal conductivity:**

Thermal conductivity is the rate of transfer of heat in calorie along the body of a textile material by conduction. Higher conductivity of a material indicates that the heat will pass through the material very easily.

Woolen dresses are comfortable to wear during winter season due to its lower conductivity and cotton dresses are comfortable to wear in summer season because of its higher conductivity.

Typical values of thermal conductivity for some fibres:

Fibre	***Thermal conductivity ($mWm^{-1}K^{-1}$)***
Cotton	*71*
Wool	*54*
Silk	*50*
(Above thermal conductivity of fibres with a bulk density of 0.5 gm/cm^3)	
PVC	*160*
Cellulose acetate	*230*
Nylon	*250*
Polyester	*140*
Polyethylene	*340*
Polypropylene	*120*

- **Glass transition temperature:**

The temperature up to which a textile material behaves hard as like glass and after which it behaves soft as like rubber is known as glass transition temperature and it is expressed by Tg. The range of Tg lies between -100^0 C to 300^0 C.

Factors influence the Tg value of polymers:

- Higher the flexibility of chain bond, lower will be the Tg value.
- Composition of ring structure in molecular chain raises the value of Tg.
- Bulky side groups raise the value of Tg.
- Flexibility of side groups decreases the value of Tg.
- Tg increases with molecular weight upto 20,000.
- Polarity of side groups increases the value of Tg.
- Co-polymers have lower value of Tg than homo-polymers.
- Increase of orientation restrict the chain movement and increase the value of Tg. (Tg of undrawn polymer fibre is 110^0C whereas Tg of fully drawn polymer fibre is 150^0C)

❖ Melting temperature:

The temperature at which a textile material melts is known as melting temperature and it is expressed by Tm. At melting temperature a polymer losses its identity and change into viscous liquid. It losses its strength and some molecular weight at melting temperature. Cellulose and protein fibres decompose before melting.

Typical values of T_g and T_m for some MMF:

Fibre	*Tg (^{0}C)*	*Tm (^{0}C)*
Nylon-6	*50*	*215*
Nylon-6.6	*50*	*260*
Polyester	*69*	*260*
PVC	*81*	*310*
PAN	*97*	*314*
Rubber	*-73*	*36*
Cellulose tri-acetate	-	*300*

❖ Thermal expansion:

Thermal expansion is the increment of length of a textile material after heating. Thermal expansion is measured by co-efficient of thermal expansion. Co-efficient of thermal expansion can be defined as the fractional increase in length of a material due to rise in temperature by 1^0 C.

$$\text{Co-efficient of thermal expansion} = \frac{\text{Increase in length}}{\text{Initial length of a textile material}}$$

❖ Heat of wetting or heat of absorption:

When textile materials absorb water they show their ability to leave off small amount of heat which is known as heat of wetting or heat of absorption.

If 1 gm dried material is completely wetted, then heat in calorie/gm involved in that material is known as heat of wetting.

❖ Heat setting:

Heat setting is the process of stabilizing the form, size and dimension of the material by drying and cooling in successive dry and wet condition.

For manmade fibre, heat setting process must be done to keep the dimension of fabric during further heat treatment. Usually, spandex or elastane is heat set at 180-200^{0}C based on different brands. After heat setting material becomes able to keep its dimensions up to setting temperature. Heat setting is usually done by hot air or steam flow treatment.