FABRIC COMFORT

Important fabric properties for maintaining thermal comfort:

(i) Air permeability

(ii) Water or moisture vapor permeability/transportation

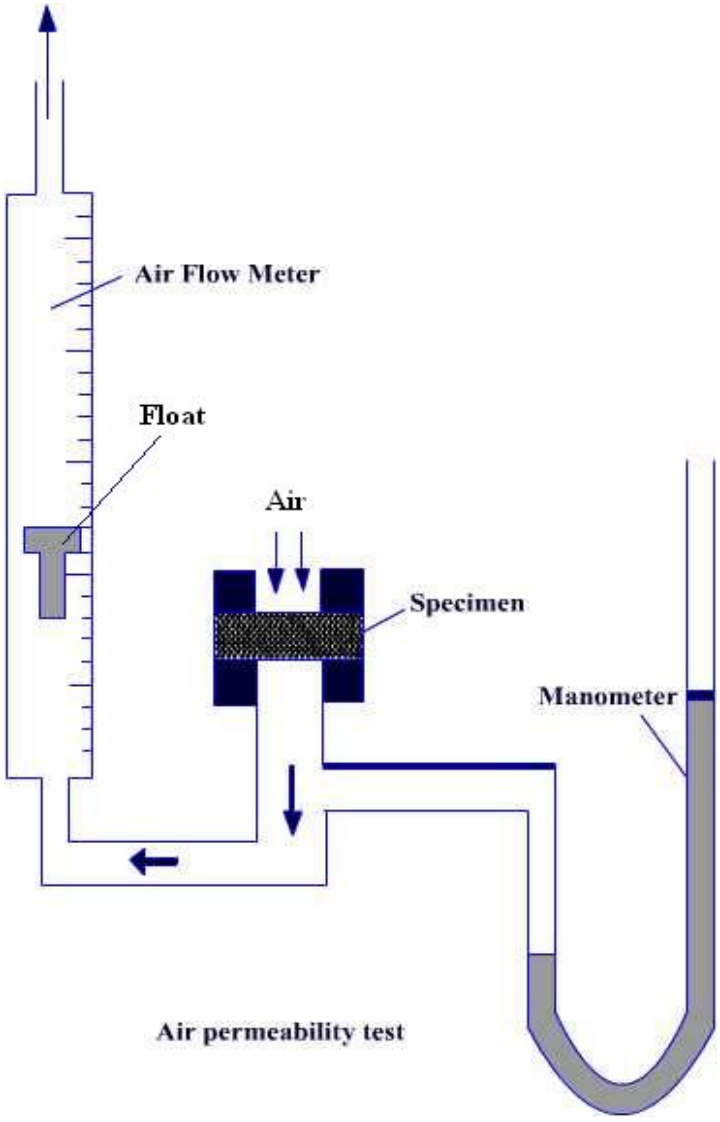
(iii) Heat transmission

I. Air permeability:

It is a measure of how well a fabric allows the passage of air through it.

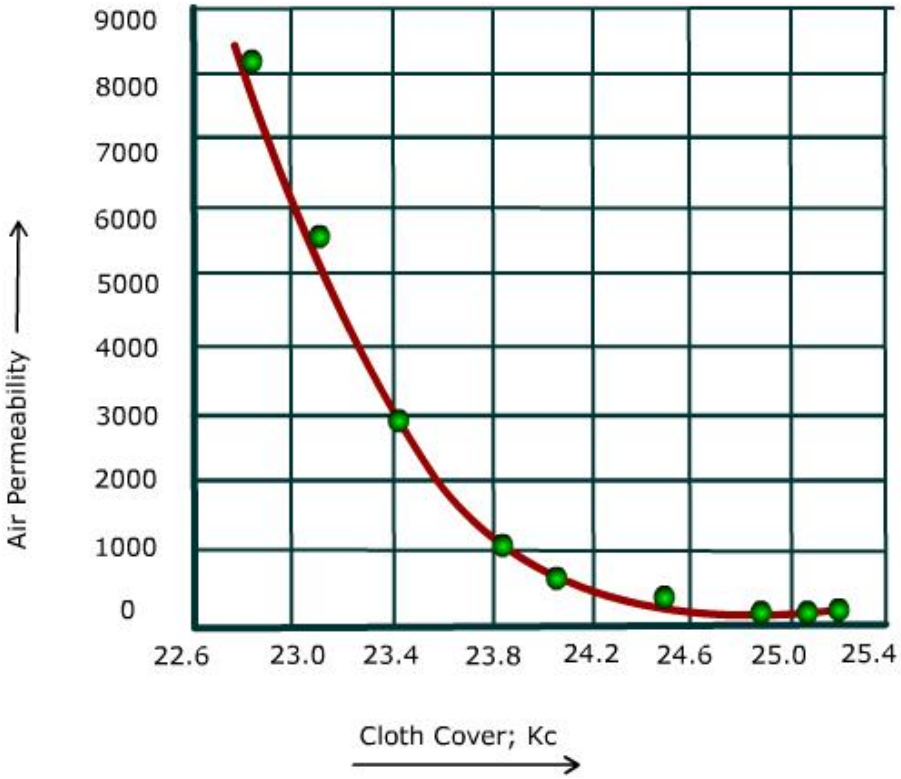
Apart from apparel comfort, it is also important for a number of fabric end uses.

e.g. Industrial filtres, tents, sail-cloths, parachutes, air bags etc.

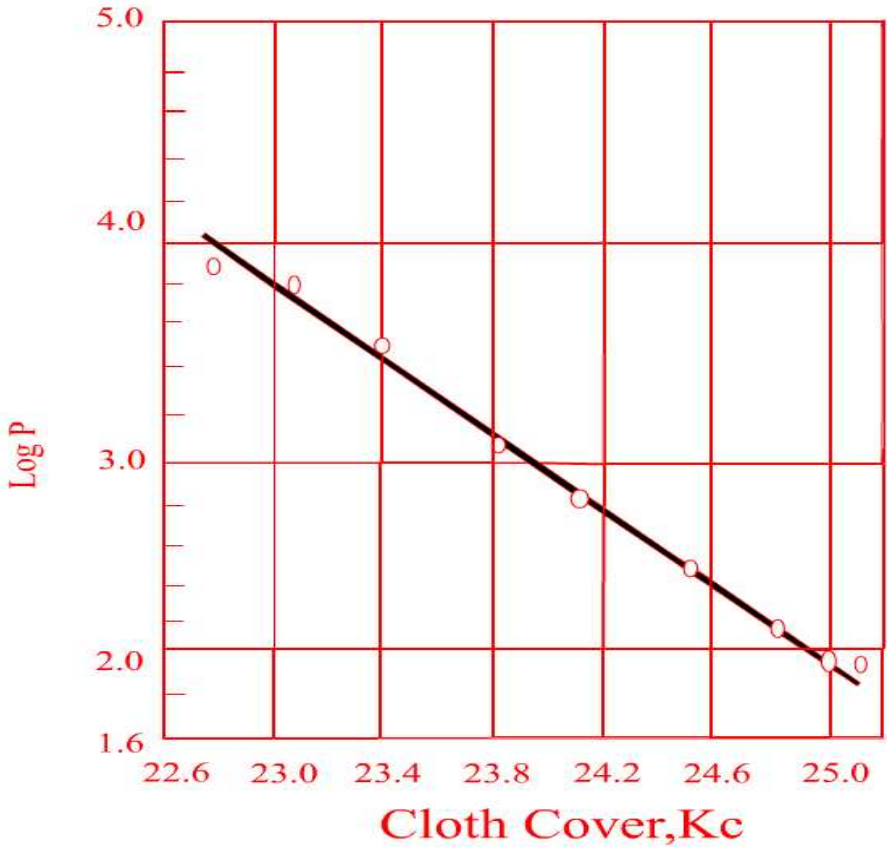


Air permeability test

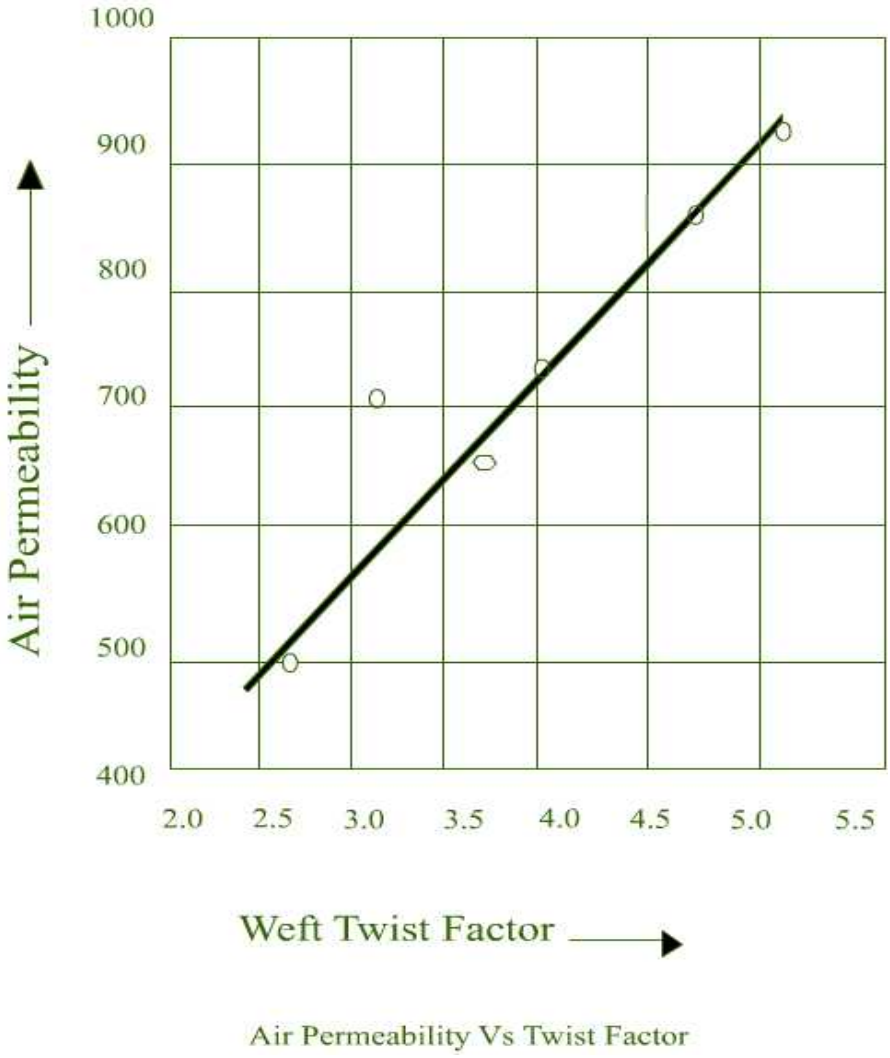
" ***Air permeability"-*** The volume of air (in cc) which pass in one sec through 1 cm^2 of fabric under a pressure head of 1 cm of water.



Air Permeability vs Cloth Cover



Cloth Factor vs log P



Air Permeability Vs Twist Factor

Air Permeability:

It is described as the rate of air flow passing perpendicular through a known area under a prescribed air pressure differential between the two surfaces of material.

It depends on,

- Type of Yarn
- Fabric structure
- Fiber parameters

Air Resistance:

Time in seconds for unit volume of air to pass through unit area of fabric under unit pressure difference. It is the reciprocal of air permeability.

$$Rt = R_1 + R_2 + R_3 + \ldots\ldots\ldots + Rn$$

Fabric Cover:

Air permeability is most highly correlated with minimum pore size, but was also significantly correlated with mean flow pore size measurements and with calculated values of theoretical porosity and also percentage fabric cover area.

n = number of threads per unit area, s =1/n= distance between threads

The ratio d/s represents the fraction of spacing, s, covered by projection of thread

Similarly, percentage fabric cover area can be expressed by,

$(n_1d_1+n_2d_2-d_1d_2n_1n_2)\times 100$

II. Water / moisture vapour transport:

Perspiration is an important mechanism which the body to uses to lose heat as its temperature starts to rise.

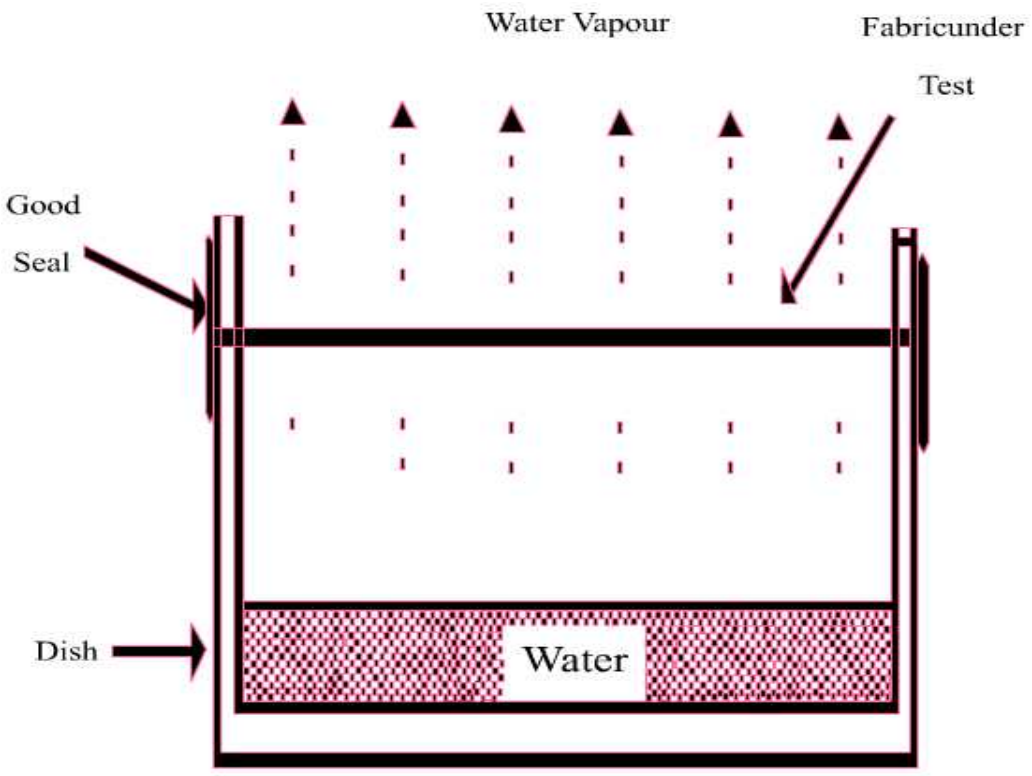
Perspirations are in two forms:

(a) ***Vapor form*** - Passes through the air gaps between yarns in fabric

(b) ***Liquid form*** - Occurs at higher sweating rates and it wets the clothing which is in contact with the skin.

Measurement techniques:

i. Water vapour Permeability:



The Water vapour permeability test

The specimen under test is sealed over the open mouth of a disc containing water and placed in standard testing atmosphere.

- Total wt. at start is taken (W_0).
- After specified time, the weight of setup is taken as W_t.
- The rate of water vapor transmission is calculated from the difference in W_0 and W_t [water vapor permeability (WVP)]
- When the ratio with a standard reference sample is calculated, we get water vapor permeability index

B. S. method:

10 mm air gap between fabric and water surface, specimen dia. 96 mm, sealed with PVC tape

WVP (g/m^2 / day) = (24 × M) / (A × t),

Where, M = W_0 - W_t

t = time between weighing, hr

A= Internal area of disc, m^2

WVP index= [(WVP) f / (WVP) r] × 100

(WVP) f =WVP of test fabric,

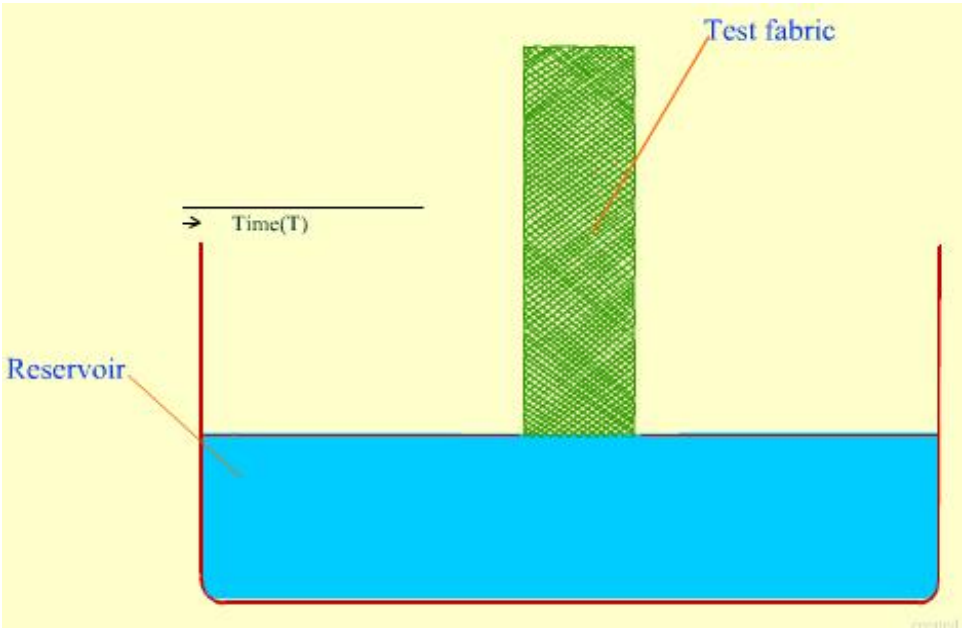
(WVP)r =WVP of reference fabric

(ii) Moisture transport:

***Wicking Test (longitudinal)*:**

- Strip of fabric is suspended vertically with its lower edge in a reservoir of distilled water
- The rate of rise of the leading edge of the water is monitored.
- This gives direct indication of the wickability of test fabric.

Click on Image to run the animation



Mass of water taken up by fabric -Take the difference in weight after wicking and dry fabric sample –Then express

- as a % of mass of the " *L*" length of fabric

- Wicking is by using the mechanism of capillary transport :

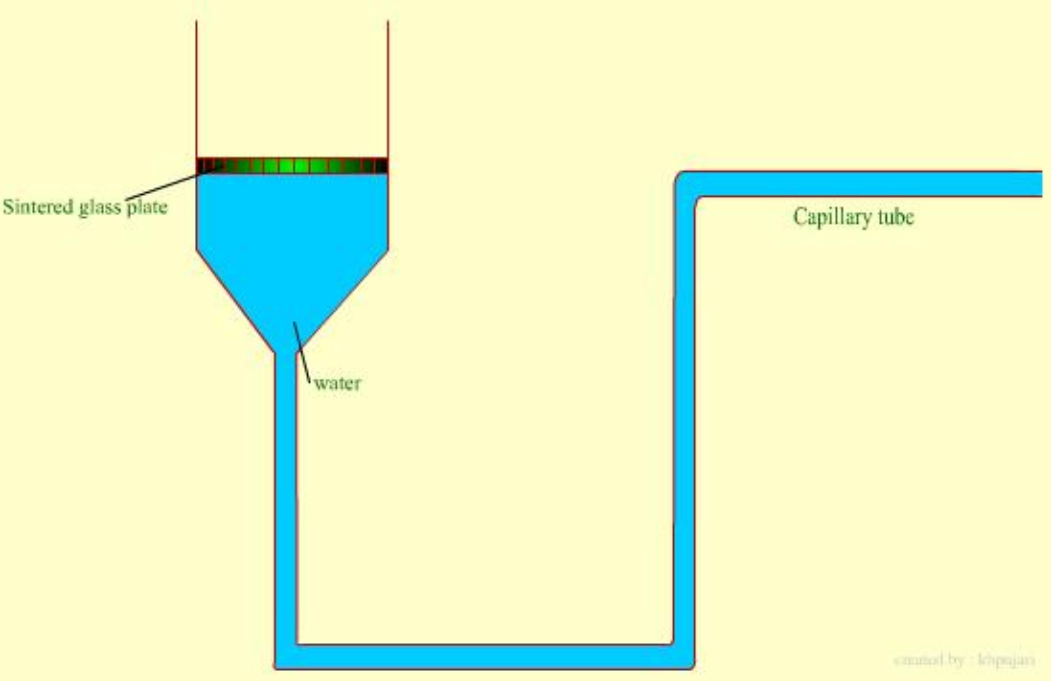
  I. The ability of fabric to do this is dependent on the surface properties of the constituent fibers and their total surface area.

  II. The size and no. of the capillary path through the fabric, i.e., capillary network

***Transverse wicking*:**

- Transmission of water through the thickness, i.e. perpendicular to plane of fabric.
- Close to actual transportation of liquid perspiration.
- Difficult to measure.

Click on Image to run the animation



- The sintered glass plate is kept moist
- A fabric sample, placed on top of the sintered glass plate can draw water depending on the wicking power.
- Water level should just touch the bottom surface of fabric, not flood it.
- The rate of water absorption is measured by the movement of the meniscus along the long horizontal capillary tube.
- *Weight is required to be placed, to have contact but creates problem*

III. Heat transmission:

- Human body temp. 37^{0}C(approx)
- In most climates body temp is greater than external environment.
- The *metabolic heat + heat received by the body from external sources (Must be) = Heat loss from body*
- If these are not in balance then body temp will either rise or fall, leading to a serious threat to life.

A person feels comfortable when their is heat balance.

The mechanisms that allow the body to lose heat to the environment to maintain the heat balance are;

1. ***Conduction*:** By direct contact (e.g. body in contact with any cold object)
2. ***Convection*:** By a moving fluid (liquid or gas) [e.g. air in contact with body takes away heat]
3. ***Radiation*:** By electromagnetic waves. Cloth acts to reduce
   - ☑ radiation loss by reducing the temperature difference
   - ☑ between the body and its immediate surroundings
   - ☑ as the clothing effectively becomes the immediate surroundings.
4. ***Evaporation:*** BY evaporation of sweat through the cloths.

Hot + Dry - Good

Hot + Humid –Problematic