Water Permeability

Absorbability:

It is the ability of a fabric to take up a liquid. It is a term related to the warmth of a fabric. If a fabric is permeable to air but does not absorb water, evaporation of perspiration takes place from the skin and the skin temperature falls. This is the phenomenon which occurs when nylon fabrics are worn. If the fabric absorbs the perspiration, however, the evaporation takes place from the fabric and not from the skin. Therefore, chilling does not occur.

The following are the ways in which water can pass through a fabric:

1. By wetting the fabrics, followed by capillary action which brings the water to the other side.

2. By the pressure of water, forcing it through the opening of the fabric.

3. By the combination of the above two sections.

Shower proof:

To treat textile materials in a manner to delay the absorption and penetration of water. The fabrics retain a degree of permeability to air. If a fabric is made in which there were no openings between the yarns, the cloth might still allow water to pass, if the water wet the fibres. This happens in closely woven canvas cloth. If a fabric of ordinary weave is made of fibres which had been chemically treated so that they would not be wet by water, the cloth would allow much of the water to roll off without penetrating. But if the water gathered in a thick layer on the cloth of if the water stuck the cloth with much force, it would pass through the openings. This is the case in the shower proof fabrics.

Water Proof:

To treat textile materials, e.g. with fats, waxes or rubber to prevent the absorption of water. The additions may be physical films or coating or may be physically combined. Fabrics treated with such substances have low degree of permeability to air. The following are the examples of water proof fabrics

a) Rubber in ordinary raincoats
b) Bitumen in tarpaulin
c) Waxes in some tent cloth
d) Plastic coated fabrics

Water Repellent:

It is a state characteristic by the non-spreading of a globule of water on a textile material. A water repellent fabric is one that will reset absorption and penetration of water for a given period of time, depending upon the length of exposure and the force of water.

Note: A garment is labelled as **shower resistant** will provide protection from light rain but will be penetrated by a heavy rain after 15 minutes. A garment labelled as **rain resistant** will provide protection for a few hours of exposure in a moderate rain.

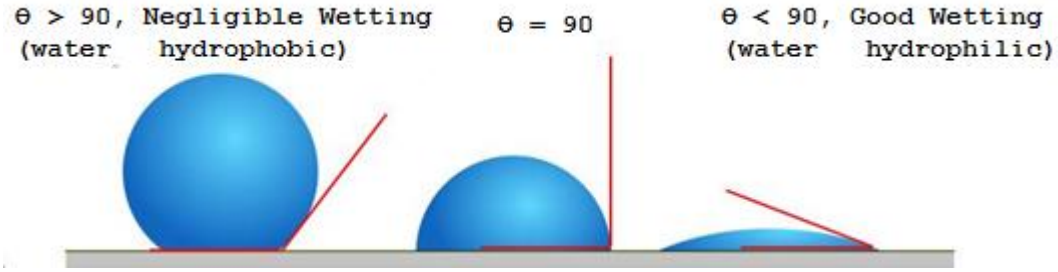
A garment labelled as **storm resistant** will resist water penetration for many hours. There will be an external material in water proof fabrics other than the yarn surface but in the shower proof and water repellent fabrics, wetting will take place after certain interval.

Difference between water proof and water repellent:

Topics	Water proof	Water repellent
Pore in the matl	Filled	Open
Air permeability	Small or nill	Large
Water or vapour permeability	Small or nill	large
Characteristics of goods	Resistance to passage of water even under hydro static head	Resistance to water and rain and spread of water but permits water under hydrostatic head.
Fabric outlook	Fabrics are stiff and not pliable	Fabrics are pliable and are not different from untreated fabrics.

Water retention:
This is the moisture remaining in and on a material after a specified mechanical treatment.

Wettability:
According to British Cotton Industry Research Association (B.C.I.R.A) A drop of water (or sugar solution) is placed on to the specimen fabric which is mounted horizontally. The time taken for the contact angle to drop to 45° is noted. The reciprocal of the time taken is called the wetting velocity or wettability.



Contact Angle (θ):
The angle between the solid surface and the tangent to the water surface as it approaches the solid, the angle being measured in water.

Wetting Time:
The wetting time can be described by a test developed by Baxter and Cassie. A fabric stripe is immersed in water of 20 ° c. Then it is withdrawn from the water at a speed of 8 mm/min. At the start of the test a large receding contact angle is seen but after some time the angle is to decreased to 90 degree. This time is noted by a stop watch. This time taken to decrease the angle to 90 degree is called the wetting time.

Methods of testing

1. **The wetting time test.**
2. **The spray test.**
3. **The drop test or drop penetration test.**
4. **The Bundesmann test.**
5. **Shirley hydrostatic head test.**

1. The Wetting Time Test:

In this test, a strip of fabric is lowered in a trough of water and is removed from the water surface from one end of the trough. Distilled water at 20° c is used and the speed of withdrawal of fabric is maintained at 8 mm per minute. In the beginning of the test, a large contact angle is seen and after some time it reduces. The time is noted using a stop watch when the angle drops to 90°. The time to drop to 90° is called the **wetting time**.

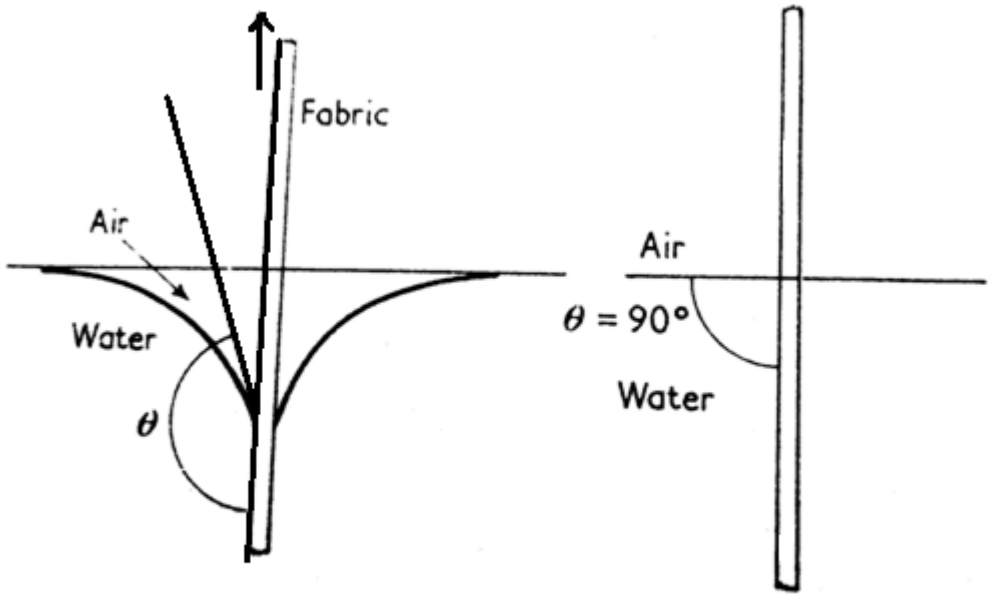


Fig: the wetting time test

This is a very useful method to assess proofing efficiency of fabrics. But for cotton, the method is not so popular, hence other methods are to be considered. The wetting time test is useful for heavy wool cloth.

2. The Spray Test

Construction:

In this test a small-scale mock rain shower is produced by pouring water through a spray nozzle. The water falls on to specimen which is mounted over a 6″ diameter embroidery hoop and fixed at an angle of 45°.

Working Procedure:

To carry out the test, 250 cm^3 of water at 70°F are poured steadily into the funnel. The distance from the bottom of the spray to the centre of the fabric is 6″. After spraying has finished the sample holder is removed and the surplus water removed by tapping the frame six times against a solid object, with the face of the sample facing the solid object. The tapping is in two stages, three taps at one point on the frame and then three times at a point diametrically opposite.

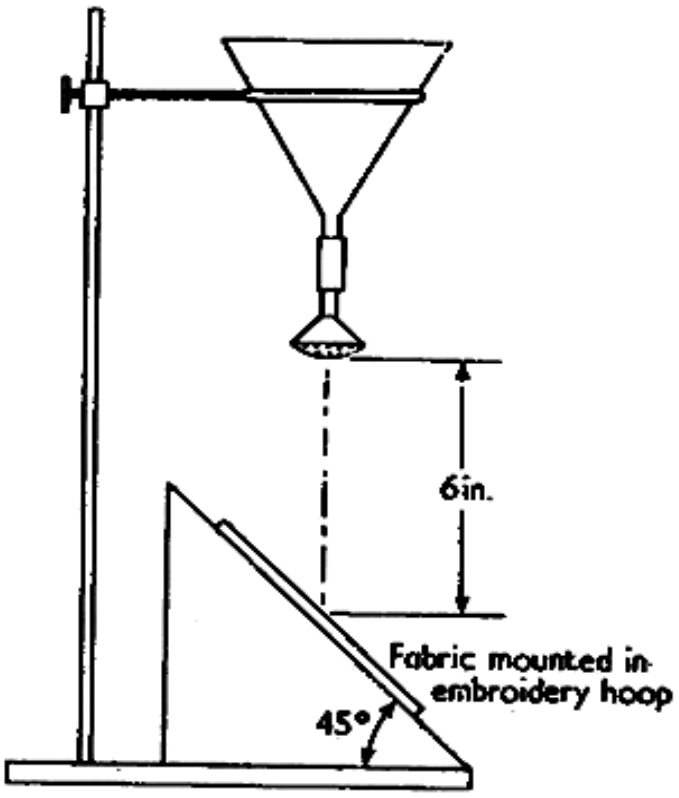


Figure . The spray test

The assessment of the fabric's water repellency is given the **spray rating**. After the removal of the surplus water is accomplished the fabric surface is examined visually by matching against the rating chart of photographs.

The ratings (AATCC) are as follows-

100→No sticking or wetting or wetting of the upper surface.
90→Slight random sticking or wetting of the upper surface.
80→Wetting of upper surface at spray points.
70→Partial wetting of whole of upper surface.
50→Complete wetting of whole of upper surface.
0 →Complete wetting of whole of upper and lower surfaces.

Five tests should be made and the nearest rating assigned to each, since no interpolation is allowed, i.e. a rating for a specimen cannot be 75. The mean of 5 ratings is reported.

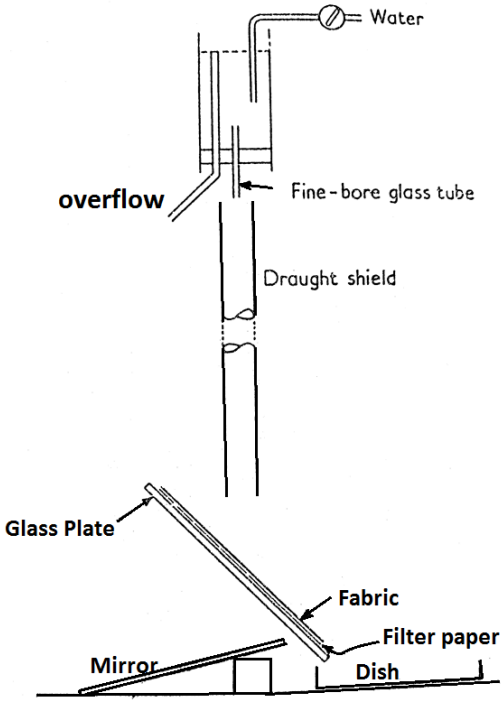
ISO rating ranges from 0 to 5.

3. Drop Penetration Test:

In the initial of wetting, the drops of water pearl of the fabric and after some time the pearling stops, the water enters the pores of the fabric, and becomes wet. Therefore, the drop penetration test is to count the number of drops required to penetrate the fabric to the inner side when all the drops fall on the same spot.

Description:

A fabric sample is clipped onto a glass plate with a piece of filter paper sandwiched between glass and fabric. The frame holds this assembly at an angle of 45° directly under the drop forming apparatus. The drop forming apparatus is a fine bore glass tube to produce a certain number of drops per minute of given size, with a constant head of water so that the size of drop and time of dropping are constant. To ensure that the drops fall onto the same spot, a draught shield is used.



Working:

With the specimen in position the water supply is started and drops begin to fall on the fabric. The end point is reached when the filter paper shows the sign of water. This can be noted on the mirror placed underneath the specimen. The time is measured with a stopwatch. Then water which penetrates the specimen is collected and the time taken to collect 10 cc under specified condition is observed to the nearest second.

Various methods are used to determine the end point with greater precision. The filter paper may be impregnated with a chemical which changes colour when wet e.g. cobalt chloride turns blue or the water can be tinted.

The size of the drop, rate of dropping, height of drop and other dimensions may be changed according to the purpose.

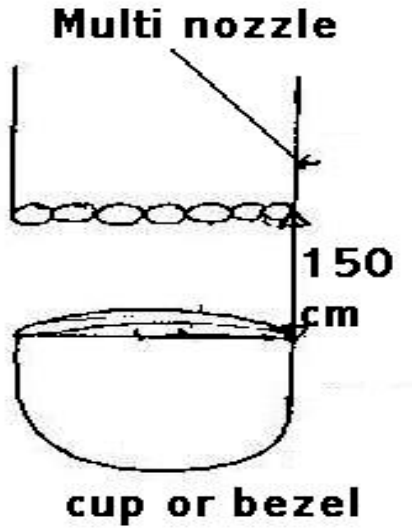
4. The Bundesmann Tester

The Bundesmann tester is quite different from two tests, viz, sparay, drop penetration and they are not satisfactory, when fabric are used as a rain coat. The wearer of the fabric walks in the rain continuously exposing fabric for heavy shower and at the same time rubbing because of the movement of the limbs of the body coming into contact with the other side of the fabric. The agitation makes more amount of water to enter the fabric which is not tested in shower proof. The Bundesmann tester satisfies this condition.

Description:

The Bundesmann Test:

Fabric speciments are mounted over a special cups or bezels and subjected to a shower of water from a multi-nozzle drop producer. Water which penetrates the fabric is collected in the bezels and measured. The water which is retained by the specimen is also measured.



The shower producer is mounted 150 cm above the four bezels. The bezels are mounted on an assembly rotating slowly at 5 rpm. As the fabric circulate in the shower of water, special wipers inside the bezels rub the underside of the specimens in order to reproduce the rubbing action mechanically which occurs in practice. This rubbing action will help the water to penetrate the fabric.

After a 10 minutes shower of controlled severity, the specimens are removed and two values determined.

Penetration:

The water collected in each of the bezels is measured and the mean volume calculated to the nearest milliliter.

Absorption:

From the weight of each specimen before and after the test, the % of water retained by each specimen is calculated as follows-

$$\text{Absorption} = \frac{\text{Weight of water absorbed}}{\text{Original wt of the specimen}} \times 100$$

The mean of the four results is calculated and reported to the nearest 1%.

Points must be considered during testing:

- Temperature of water = 18℃ - 20℃
- pH of water = 6-8
- Rate of flow = 62-68 ml/min per bezel
- Drops to be uniformly spaced and the fabric to be conditioned for at least 24 hours in a standard atmosphere.
- Specimens to be weighted in an airtight container
- Surplus of water to be removed by six sharp shakes.

5. The Penetration of Fabrics by Water Under Pressure

The Pressure required to force water through fabric may be determined and the ability of a fabric to do a particular job can be assessed using the hydrostatic head test.

Hydrostatic Resistance

It is the resistance of fabrics to the passage of water under pressure when the force is applied at right angles to the plane of the fabric.

Description:

The specimen holder consists essentially of a double chambered cell. The internal diameter of the inner chamber A is 5 cm. Circular specimens are clamped between rubber gaskets over the orifice.

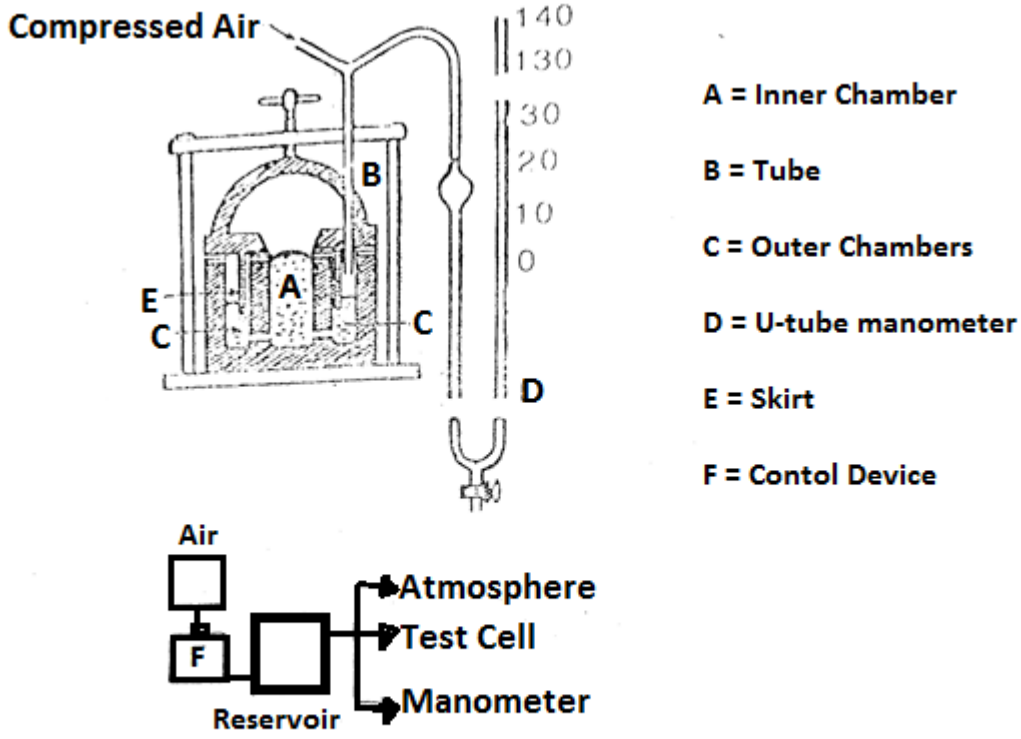


Fig: The hydrostatic head test

Compressed air is passed to the outer chamber C through a tube Brand displaces the distilled water in the outer chamber into the inner chamber.

By that way, water is forced up against the specimen. The clamp is provided with a skirt E to prevent the air leakage across the specimen outer chamber to inner chamber or to the atmosphere. Tube B is connected to a U-tube manometer and the pressure of water against the fabric can be noted on a scale mounted on the arm of the manometer tube.

The air supply is drawn from a reservoir of 3 liters capacity. This reservoir is fed through a flow control device F from a source with pressure ranging from 4 to 20 psi. The flow control device is designed

so that it can be set to give the required rate of increase of pressure of 10 cm of water per minute. The rate of loading will be within the specified limits of 10 ± 0.5 cm per minute up to the limit of the instrument. The max head attainable is 150 cm of water.

Procedure:

Circular specimens 6 cm in diameter are out from the fabric to be tested, using a template. The test cell is rinsed with distilled water and filled to approximately 0.3 cm of the top. The inner rubber gasket is thoroughly dried and a test specimen is placed over the orifice and Tightened with a clamp.

Then a control tap is turned to position no 1 to communicate the air supply, manometer and the test cell. The pressure on the under surface of the specimen is allowed to increase at the specified rate of loading until water appears at third place in the specimen, the control tap is immediately turned to position no 2 to allow the air supply and the test cell to discharge to atmosphere. But the manometer retains at the pressure at which breakdown of the test specimen occurred. This value can be noted.

The hydrostatic head can be noted from one arm of the U-tube manometer to the nearest 0.5 cm of water. Then the control tap is turned to position no 3 to discharge the monometer to atmosphere.

Then the test specimen is removed, the used water thrown away, fresh distilled water is poured into the test cell and the operation is repeated for eight samples and the main value is calculated.

The Water Percolation test:

After being tested in the hydrostatic head apparatus, the samples may be immersed in water for 24 hours and then subjected to a head of 100 cm water. The amount of water which percolates through the fabric in the first 500 sec is collected and measured. The percolation may be expressed thus:

Percolation = w / 3.92 ml/1000 sec at 1 m water head

Where, w is the weight of water in grams collected from four specimens in 500 sec.

This type of test is suitable for measuring the performance of fabrics intended for use as tent cloth, water buckets, etc.