Heat-Wet Property Test of PTFE Membrane Fabrics

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Abstract

PTFE is short for poly tetrafluorothylene, PTFE membrane is a kind of micro porous breathable membrane, and now widely used in apparel and textile industry.Testing the thermal and water-vapour performance of PTFE membrane laminated fabric can indirectly reflect people's feelings in actual wearing. This paper selected 8 kinds of PTFE membrane animated composite fabrics, tested and discussed its air permeability, water resistance, thermal resistance, Water-vapour permeability index and wicking height, the results showed that PTFE membrane composite fabrics have good heat-wet comfort ability.

Keywords: PTFE membrane, laminated composite, thermal resistance, Water-vapour permeability index, Heat-wet Comfort ability

1. Preface

PTFE membrane laminated fabric is also known as the "breathing" functional fabric, which has been widely used in outdoor sports, health protection, military clothing etc.With the improvement of science and technology, people put forward higher request son clothing function and comfort, so we set about from the human body comfort aspects, it may has a realistic significance for design and produce the PTFE membrane laminated fabrics.

2. Experiments

2.1 Sample Selection

10 pieces of PTFE laminated fabric was selected as the experimental samples, and numbered for 1-8 # respectively, each sample from the outside to the inside composition are: 1 # for polyester + PTFE membrane +warp knitting fabric, 2 # for polyester + PTFE membrane+ warp knitting fabric, 3 # for polyester + PTFE membrane+ warp knitting fabric, 4 # for polyester + PTFE membrane+ warp knitting fabric, # 5 for polyester + PTFE membrane + warp knitting fabric, 6 # for polyester + PTFE membrane, 7 # for polyester + PTFE membrane+ warp knitting fabric, 8 # nylon + PTFE membrane + warp knitting fabric, the sample specifications shows in table 1.

Table 1: Sample Specifications

Sample Number	Thickness（mm）	Weight （g/m^2）	Latitude Density （radical/10cm）	LongitudeDensity （radical/10cm）
1#	0.618	221.3	320	282
2#	0.436	185.8	340	220
3#	0.506	185.9	310	190
4#	0.386	127.7	420	360
5#	0.448	159.4	284	184
6#	0.200	1.146	385	330
7#	0.456	2.206	215	215
8#	0.442	1.778	260	350

2.2 Experiment Content and Procedure

The cloth was humidifying in flabby condition for 24 hours. Before cut out, the samples were evenly arranged in more than 150 mm from edge area, avoid fault and fold which may influenceexperiment results.

(1) Air permeability

Adopted standard GB/T5453-1997 [1],choose YG461 - □automatic air permeability tester (Ningbo textile instrument factory), the test area was setas 20 cm^2 and test differential pressure was 100 pa, each sample selected different parts and test for 10 times, thencalculated air permeability.

(2) Water resistance

The fabric encountered a hydrostatic pressure when water through it, this kind of resistance is hydrostatic pressure. According to the standardGB/T4744-2013[2], we used YG825E digital water permeability tester (Ningbo textile instrument factory) for experiment.Under the condition of the standard experiment, the outside of sample contacted with water, recorded the hydrostatic pressure value at the moment when three water drops appeared in the opposite.

(3) Thermal resistance

R_{ct} always short for thermal resistance. According to standard ISO11902 [3], and use YG606G type thermal resistance of textile wet resistance tester (Wenzhou DaRongtextile Instrument Company). each fabrics were cut out 3 piece samples of specifications for 515 mm * 515 mm,the sample placed face up when test, the experimental parameters Settings are: experimental board surface temperature is 35 ℃, the climate chamber temperature is 20 ℃, relative humidity is 65%, air velocity is 1 m/s, test 3 piece of samples one by one, then take the average.

(4) Water-vapour permeability indexi_{mt}

$i_{mt}$is the ratio of thermal resistance and water-vapour resistance, its value between 0 to 1, and dimensionless, it can calculated by formula 1:

$i_{mt}= S\cdot R_{ct} /R_{et}$ (formula 1)

Among them: S = 60 pa/K,R_{ct} is thermal resistance, R_{et} is water-vapour resistance.

(5)Capillary effect

According to the standard FZ/T 01071-2008 [4], choose the instrument YG871 capillary effect tester (Ningbo textile instrument factory).Each fabric cut three samplesLatitude and longitude respectively, the sample is about 250 mm long, not less than 30 mm wide.

3. The Experimental Results and Analysis

3.1 Air Permeability

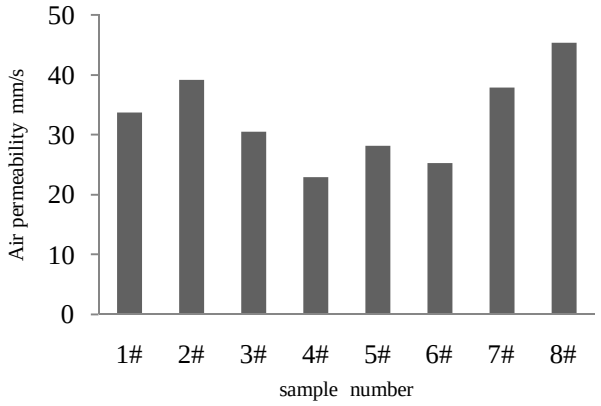

Fig.1 Air Permeability（mm/s）

Air permeability is a kind of performance when air through the fabric, expressed by the vertical airflow through the sample rate under the prescribed conditions. Fig.1 is air permeability rate of 8 kinds of PTFE membrane, it can be seen that each fabric has certain permeability, of which 8 # is excellent, 1 #, 2 #, 3 #and7 #are the second place,4 # and 6 # are the lowest. This have some correlation with the outer fabric, weaving technology, density and thickness, 8 # is nylon three-layer composite fabric, the Latitude and Longitude Density of outermost fabric is small, the weight is light, which has good permeability.But4 # and 6 # bothforpolyester three layer composite fabrics, the table 1 shows that its density is larger, this may affect air permeability.

3.2 Water Resistance

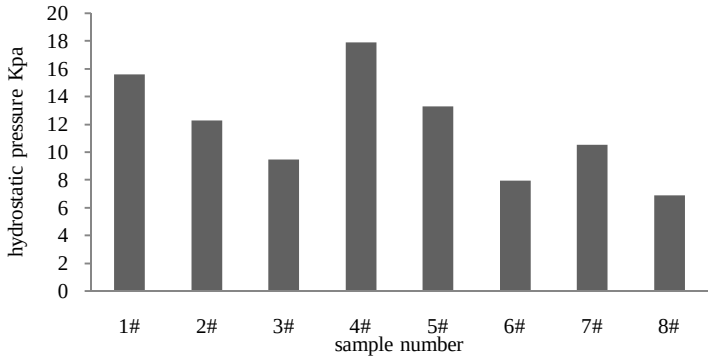

Fig.2: Hydrostatic Pressure（pa）

The table2 shows that water pressure resistance of all the samples were greater than 50 KPA, based on the standardGB/T4744-2013, we can have a conclusion that all samples of waterproof performance are excellent.It has close relation with the special structure of PTFE membrane, PTFE membrane pore diameter is 0.8- 4.8 um, the diameter of the water vapor is 0.0004 um, and the diameter of the minimum water molecules (mist) is 20 um[5], this kind of space structure determines the water vapor can pass through the membrane and water molecules cannot, so that the fabrics not only have certain waterproof performance but alsohas Air permeability andwater-vapour permeability, thus can be dispersed human body water-vapourtimely in the process of movement.

3.3Thermal Resistance$r_{ct}$and Water-Vapour Permeability Indexi_{mt}

Table 2: R_{ct}（m^2·K/W）and i_{mt}

Sample	1#	2#	3#	4#	5#	6#	7#	8#
R_{ct}	0.0295	0.0417	0.0312	0.0281	0.0278	0.0219	0.0157	0.0128
i_{mt}	0.428	0.585	0.380	0.430	0.294	0.241	0.144	0.144

From table 2, it Can be seen that: Thermal resistance of 8 kinds of fabrics in order from big to small is:2#、3#、1#、4#、5#、6#、7#、8#，And the order of water-vapour permeability index from small to big is:2#、1#、4#、3#、5#、6#、7# and 8#，2 # has the biggest thermal resistance and the smallestwater-vapour permeability, and the heat preservation performance is the best, which is suitable for winter sports fabrics; 7# and 8# have the best water-vapour permeability and the smallest heat preservation performance, made them are more suitable for summer fabrics.

3.4 Capillary Effect

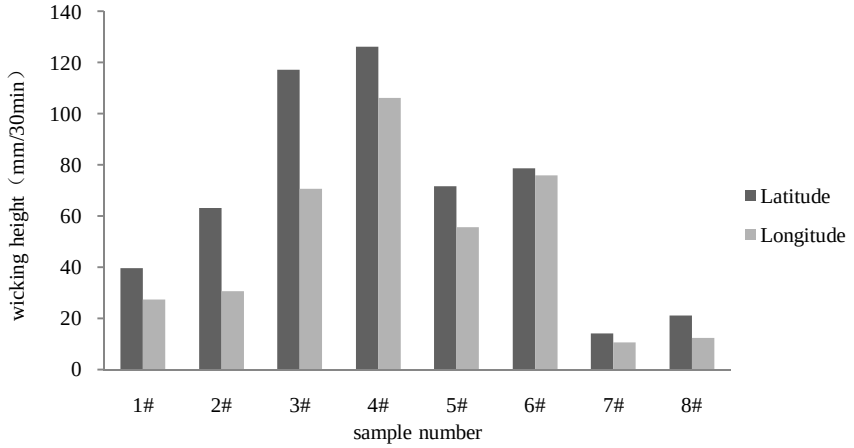

Fig.3: Wicking Height（mm/30min）

Capillary effect is the ability of fiber transfer water-vapour. Wicking ability is a part of the water-vapour transfer performance [6], usually water transfer along the surface of the fiber, wicking ability has often depends on the surface properties.From Fig.3, we can see that the wicking ability ofPTFE membrane lamination fabric is great difference, wicking abilityof 4 #is the best, 3 #, 6 #, 5 #, 2 #, 1 #, 8 # are worse one by one, and 7 # is the worst.The difference are highly correlated with the outermost fabric structure performance.4 # and 7 # both for polyester fabric, but the outermost fabric Latitude and Longitude Density of 4 #is maximum, closely packed between fibers, thus water molecules pass quickly, while Latitude and Longitude Density of 4 #is minimal, thickness and weight are big, hindered the transformation of water molecules.

Wicking ability can transfer Sweat from fiber surface to the outer surface of the garment and evaporates into the air, this nature is particularly important for training sports fabrics such as running outfit.

4. Conclusions

From this paper，we can see that PTFE membrane three-layer laminated fabrics are thicker than two layers, but the innermost layer has low effect on heat -wet comfort ability, which is closely related to the performance of the outermost fabric.

PTFE composite membrane fabrics have excellent waterproof performance, at the same time it also canexport air and water-vapour to the outside of clothes, good maintain the microenvironment between human body and clothing, prevent bacterial growth and increase wearing comfort.

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