THE VENTILATION CAPACITY OF THE STRATIFIED KNITTED FABRICS

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ABSTRACT

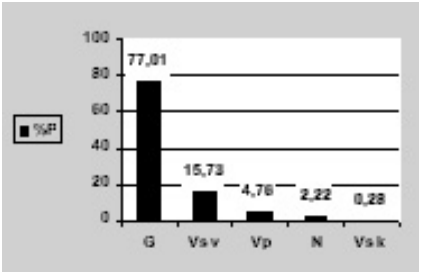
The sport garments used for intense physical activities must have characteristics that will assure the comfort of the user, as well as the desired level of performance.

Air permeability is one of these characteristics, best to define the knitted garments. For knitted fabrics, the value of air permeability is determined by: the structure of the knitted fabric; the nature and the type of the row materials (the yarns); the finishing process.

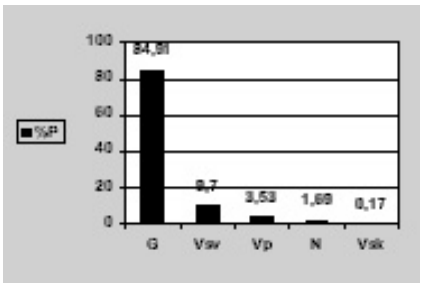
Key Words: Air permeability, double layer knitted fabrics, porosity, volumetric coefficient.

1. INTRODUCTION

Double layer knitted fabrics are a particular case of patterned structures, characterized by the existence of two layers, connected using different structural elements. There are many classification criteria of these fabrics [1 ,2]. The two layers can be connected through: stitches (made of one single yarn or plated), tucks, warp or weft yarns or fleecy yarns. If such fabrics are used for garments worn during intense physical effort, then the take over and the transport of perspiration from the skin surface is done through the "diffusion layer" or "conductive layer" (PP, PES, PA) to the "absorbent layer" (natural fibers), where it is slowly evaporated.



The inner conductive layer quickly transfers the liquid perspiration toward the exterior absorbent layer, mostly due to the capillary effect. An adequate choise of fibers and yarn cross section diameters for both layers will optimize the effect.

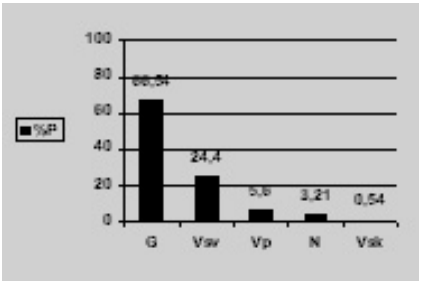


Double layer knitted fabrics made of natural and synthetic yarns are used to produce garments with a large range of thermal adjustment. These garments are comfortable and pleasant because of the dry feeling. Due to their thermal insolative properties which vary in a smaller degree when the body is in rest, the double layer knitted fabrics made of yarns of different natures avoid the post physical activity cooling, specific to the cotton garments. Such a garment has full contact with the mosturing skin, becoming a wet covering that will make the body lose heat through a slow, but permanent moisture process.

2. EXPERİMENTAL RESEARCH

The knitted structures were produces on a circular knitting machine- MULTICOMET 48 (Textime). The diagonal arrangement of the 40 patterning butts of the selectors imposed patterns with width up to 40 wales (submultiples included).

The fabrics were made of bleached 100% cotton yarns, Nm 54/1 (relief yarns) and 200/64x1/40 s dtex polypropylene yarns (ground yarns). The same machine was used to poduce two single fabrics, one with Nm 54/1 bleached cotton yarns and the other with 200/64x1/40 s dtex polypropylene yarns. The fabrics were considered witness samples [3].



The bleaching of the cotton yarns eliminated the possible problems that could have appeared during finishing (mostly due to the polypropylene behaviour at high temperatures).

The structural variants are as follow:

a. Relief jacquard vertical colour strips. V_1 -double layer fabric, with missing needles both in cylinder and dial; pattern width: b_f =19 (cylinder) and b_s =17 (dial); number of missing needles per pattern: 1 needle in cylinder and 3 needles in dial

At each complete machine revolution H=S/z pattern lengths produced, where S=48-number of system (feeders); z-number of systems (feeders) required to produce a complete pattern length (h). For V_1 fabric h=1, z=2, H=24. V_2-double layer fabric with pattern width $b_f = b_s$=8, h=1, z=2, H=24.

b. Single relief jacquard. For these fabrics, the front layer contains stitches made of polypropylene ground yarns, according to a pattern. The relief yarns float at the back of these stitches.

V_3 variant: $b_f = b_s$=10, h=12, H=4;

V_4 variant: $b_f = b_s$=20; h=12, H=4;

V_6 variant: $b_f = b_s$=20, h=24, H=2.

The variants are different due to the pattern width (b) and length (h).

c. Double relief jacquard. It is the case of V_5 variant – pattern width $b_f = b_s$=40 and pattern length h=16. As a structural characteristic, both relief yarns form stitches on all needles, including the one that produced front stitches made of ground yarns. Therefor, the relief yarns no longer float at the back of ground stitches and the pattern is better emphasized.

The porosity and the volumetric coefficient were determined for all fabrics and the results are presented on Table 1.

Table 1. The values of porozity and volumetric coefficient

Variant No.	P_z, [%]	G_v, [%]
V_1	79.72	45.24
V_2	78.85	52.08
V_3	80.72	48.30
V_4	76.21	63.29
V_5	81.50	53.47
V_6	82.07	33.78
M_1	74.32	-
M_2	77.85	-

The volumetric coefficient G_v is defined as:

$$G_v = 1/\delta_v \text{ x100, [\%].}$$

The value for the volumetric coefficient are in the following interval:

$$G_v = 33.78\% - 63.29\ [\%.]$$

The air permeability was studied using a direct quantity P_a, that expresses the volume of air passing through an area unit in a time unit, at a certain pressure difference. The measurements were done at a pressure difference of 50 Pa, the equivalent of 5 mm water colon, corresponding to air speed v=8-10 m/s. The existing data on air permeability usualy respect these conditions [STAS 5902-70]. The values were determined using an ATL-2 (Metrimpex) apparatus, measuring the air flowq, [l/h], that passes through each knitted fabric, at a pressure difference existing between the two layers. The values, together with the ones calculated for air permeability P_a [m^3/min x m^2] are presented in Table 2.

Table 2. The values of air permeability

Variant No.	q [l/h]	Pa [m^3/min. m^2]
V_1	5500	46,7091
V_2	5400	45,8598
V_3	5700	48,4076
V_4	5300	45,0106
V_5	5900	50,1061
V_6	6000	50,9554
M_1	7100	60,2972
M_2	> 8000	> 67,9405

V4 fabrics has the lowest value for air permeability, due to the lowest porosity and the highest volumetric coefficient (high fabric density). Because of its high porosity, the V6 fabric is the one with the biggest value for air permeability, even if it has also the highest thickness value .

For the witness fabrics, the highest air permeability was obtained for M2 fabric, due to its higher porosity (the polypropylene yarn is made of continuous filaments and it is texturated), even though it is thicker than M1 fabric. The main factors influencing the values of comfort characteristics for the analysed fabrics are the structural parameters, determining the porosity, together with the nature, the type and the finishing of the yarns.

The porosity determines the variation of air permeability. This variation is also illustrated by the equation used for the mathematical model this thermophysiological characteristics: y8= b0 + b1Pz (y8= b0+ b1x7).

CONCLUSION

The lowest value for air permeability was found for the V4 fabric due to its smallest porosity and its highest volumetric coefficient. Because its higher porosity, the M2 witness sample fabric presented a higher air permeability compared to the M1 fabric (the value Was influenced by the that the polypropylene yarn is made of continuous filaments and is textured), even though the M2 fabric is thicker.

The data obtained using the statistical – mathematical model for air permeability in the case of the double layer knitted fabrics conclude that if we want such a fabric with a higher air permeability than we have to enhance its porosity (the two quantities are directly related). The main ways to vary the porosity of knitted fabrics are trough:

- the structure and the type or row materials (yarns);
- the structure of the knitted fabric;
- the finishing process.

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