INFLUENCE OF THE PROPERTIES OF HIGH COUNT SPUN YARNS IN THE CHARACTERISTICS OF CIRCULAR KNITTED FABRICS

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Summary

The paper deals with the main properties of fabrics made of Tex 11...15 count pure cotton, cotton-type blended yarns and synthetic spun yarns. The characteristics of fabrics mentioned, knitted on 28 cut circular knitting machines are compared experimentally.

It can be stated that within the range tested, from the point of view of extension, elasticity, pilling tendency and abrasion resistance of the fabric, the influence of fabrics structure is higher than that of the properties of yarns of similar function. However, dimensional changes in washing and hygroscopicity depend to a higher extent of the characteristics of the raw material processed.

In the course of the experiments the measurement of hygroscopicity was completed with a test method approaching more fully the actual stresses.

Introduction

In our previous work (1) we investigated the properties of high count spun yarns which influence their processability. We have found that these are primarily the frequency of yarn thickening, viz. the grossest faults which can be discovered with the help of yarn testing systems based on yarn cleaning (Uster-Classimat, Peyer Digimat). Within the range tested, neither the breaking stength of yarns nor their coefficient of friction proved to be responsible for the deteriorating processability.

In our present paper we investigate the yarn properties influencing fabric properties. Table 1. contains the main data of yarns and types of fabrics tested. The fabrics were made by the "Habselyem" Knitting Mill in large scale production on 28 cut 30″ diameter Textima, and Jumberca interlock circular machines, respectively, in single face interlock, while fabric No. 9 in interlock knitting.

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Table 1

The types of yarns and fabrics tested

Yarn	Fabric	Composition of yarns	Linear density	
			Tt	Nm
A	1	33% PES-67% Polinose Viscose	14.3	70
B	2	65% PES-35% Cotton		
C	3	67% PES-33% Cotton		
D	4	80% PES-20% hare wool (white, PFV)		
E	5	80% PES-20% hare wool (grey, PFV)		
F	6	80% PES-20% hare wool (pastel, PFV)		
G	7	85% PES-15% hare wool (white, Gross)		
H	8	100% PES	11.8	85
H	9	100% PES		
K	10	100% PAC (hygroscopic)		
and the following yarns without fabric sample				
L		100% PAC	14.3	70
M		100% Cotton	11.8	85
N		67% PES-33% Cotton		

Tests on fabrics

Main fabric characteristics

The technical description of the fabrics (in a grey and finished state), furthermore the data of our own laboratory measurements on the main fabric characteristics (in a dry, relaxed state) are given in Figs 1 and 2. The square meter mass of the fabric types made of identical count yarns and the same knitting types changes only within narrow limits. This is due to the fact that in finishing, the specific mass generally increases (except in the case of fabric 2 and of those made of yarns Tex 11.8) and after relaxation of the fabric the process of covering continues. The course and stitch wale densities change considerably in finishing (Fig. 2). In the course of the relaxation process generally only minor changes occur in density, and in a major part of the fabrics course density, and in the rest of the fabrics stitch density becomes fully stabilized after finishing. (Only in the case of fabric 1 made of yarn A can a change in course-wise density be observed, which, however, later becomes fully relaxed and then again a change in the opposite direction follows.)

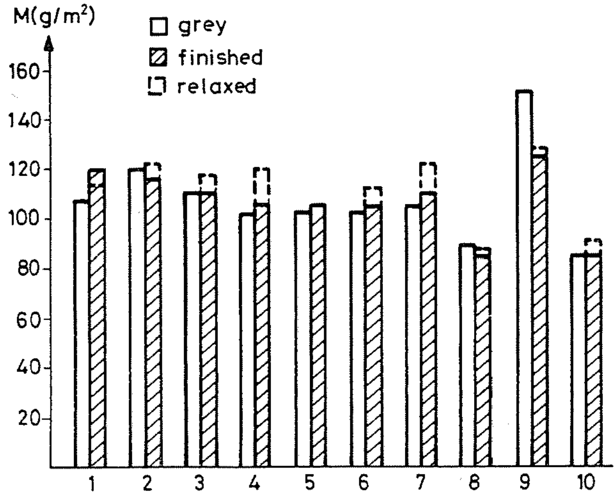


Fig. 1. Square meter mass of grey and finished fabrics

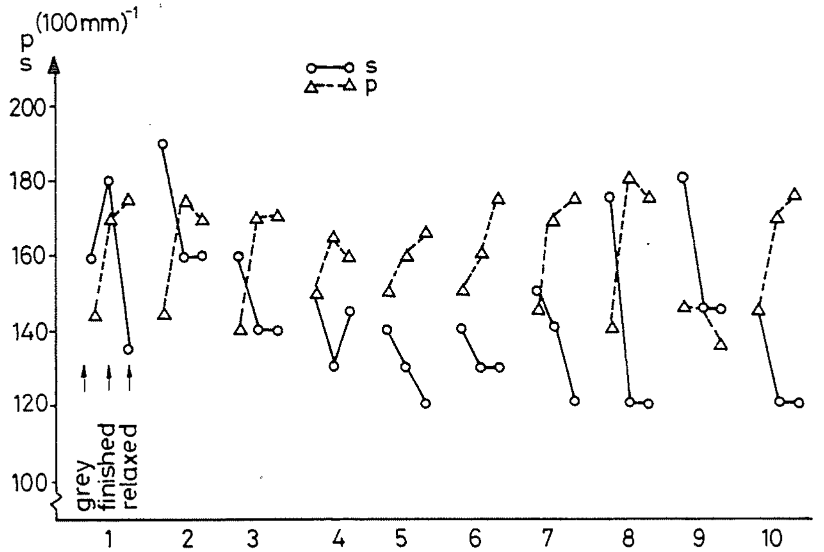


Fig. 2. Density values of grey, finished and relaxed fabrics

The density ratios of the fabrics in the relaxed state deviate substantially from and do not follow the statement valid for cotton (2), according to which with increasing stitch length course density decreases and stitch wale density increases. In view of the fact that during knitting, fabric take down influences the deformation of stitches taking place after stitch formation (2). Furthermore in order to be able to repeat the technology, it appears practical to include in the technical descriptions of fabrics both the data of fabric take down, and that of the setting height of the dial, since stitch length can be controlled more conveniently with the aid of these than with that of the stitch cams (3).

The relationship between the properties of fabrics made of different types of yarns having different density ratios and similar square meter mass, as well as the factors influencing the said properties can be determined from our further investigations.

Elongation and elastic properties

The fabrics were tested in finished and relaxed states, using partly Grab's breaking method in single cycle, and partly repeated loads.

The force-elongation diagrams obtained with the first method (MSZ 101/7—73) using a Kralik—Gillemot type horizontal fabric braking instrument on samples of 100 mm width, clamping in the 50 mm width, show, within the individual fabric types, nearly the same forms. (Figure 3 f.i. illustrates 3—3 diagrams on Fabric 1 taken up in course and wale direction.) Comparing the values of the coefficients of yarn variation, it is to be seen that the variations in the values of the force-elongation of the yarn contained in the structure of the knitted fabric — as a consequence of the cooperation of the number of yarns — become compensated and no significant variations can be found in the individual fabrics.

Because of the deviations in the values of the breaking force, F_k, of the different fabrics (Fig. 4) their elongation at break (Fig. 5 ε_b) is also influenced by the strength of the fabric. Since the wearing stresses are far from approaching the value of the breaking force, and the force-elongation diagrams are not linear, we have compared the elongation tendency of the fabrics at identical (50 N) loading force too, this latter being substantially lower than the breaking force. (Figure 3 shows the way how to read the diagrams, while columns $\varepsilon_{(50N)}$ illustrate the respective values.)

It can be seen that the elongation values at break of the fabric and the elongation values belonging to the loading force 50 N measured in the same direction are not of the same order of succession for the fabrics. Thus, the order of succession of the elongation values of wearing stresses cannot be substituted by the order of sucession of the values of elongations at break.

The highest values of elongation in course direction are shown by the fabrics composed of the three thinner yarns. This can be attributed to the fact that the density values of these types are not higher than those of the other ones

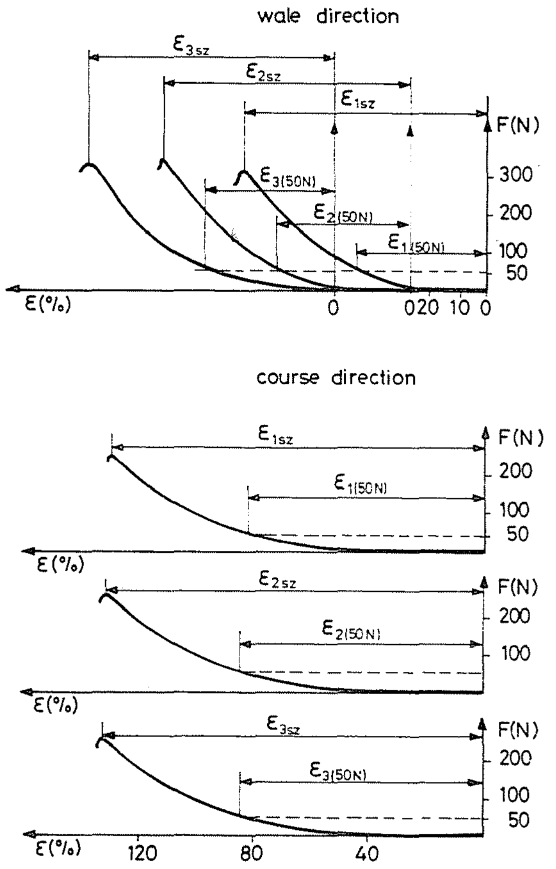


Fig. 3. Characteristic breaking diagrams

(see Fig. 2). In all single bar fabrics coursed density is higher than wale density, however, as a consequence of the 1/1 needle space construction, short yarn sections are introduced in course direction in the fabric, which, in the case of stresses acting in course direction, produce a stiffening effect. The joint result is that at identical loadings the elongation of most single face interlock fabrics is twice as high in course direction than in wale direction. An exception to this is Fabric 2 showing the lowest elongation in course wise direction, but its course wise density is the highest of all the weft knitted types (this being by 20. . .30% higher than those of the others).

In the interlock fabric structure (Fabric 9) there are no yarn sections of course wise direction; that is manifested in the highest elongation in course direction as compared to all other fabrics.

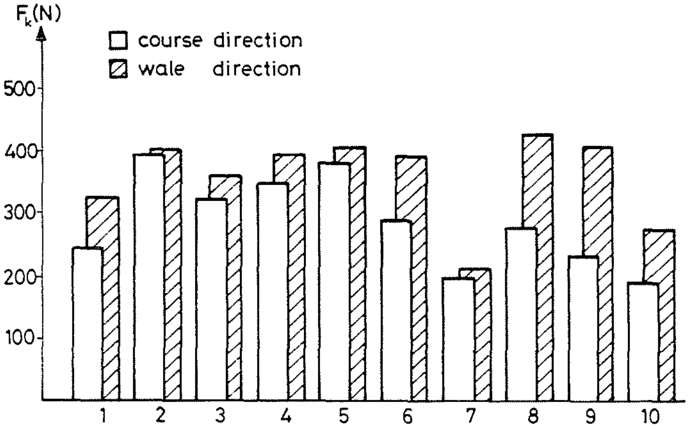


Fig. 4. Breaking strength values of fabrics

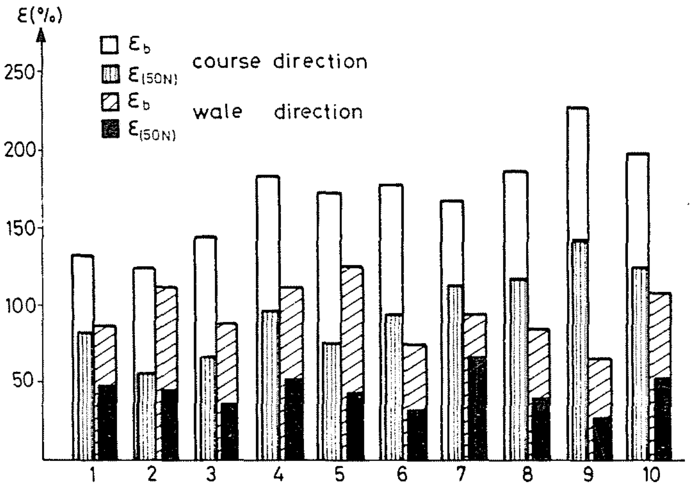


Fig. 5. Elongation at break and elongation of fabrics at a loading force of 50 N

From a comparison of the elongation values of the yarns and those of the fabrics it can be seen that in the case of identical loadings the yarn elongation appears considerably dampened in fabrics and only the high deviations are reflected in the elongation of fabrics (see the high elongation of yarn K and that of the respective Fabric 10). The fabric type and the stitch density exert higher influences and are more determinant on fabric elongation than the effect of minor deviations in yarn elongation. In order to achieve a lower elongation tendency the so-called fabric types of low elongation are to be preferred and should, at the same time, a low square meter mass be desirable, then single face fabric variants have to be chosen. (According to our experience (4) in addition to the above it is more advantageous to include in the fabrics sections of missing loops — as done in the single face interlock fabrics tested — than to apply tucking.)

In the other part of our investigations we determined fabric elongation by repeated fatigue tests. On a Textenser instrument, type TKI, 10 cycles of loading and deloading were performed continuously. This was followed by a one minute (deloaded) interval and then the fabrics were loaded again in order to be able to determine residual elongation. Preloading (F_{es} and F_{ep}) varied for the different types of fabrics, its value is a specific one, in which the number of stiches in the cross-section of the fabric in the given direction, (n_s, and n_p), furthermore the yarn count (Tt) are included:

$$F_{es}=n_s\,Tt\,0.5\ (\mathrm{mN})$$

and

$$F_{ep}=n_p\,Tt\,0.5\ (\mathrm{mN})\,.$$

In the loading cycles the upper limit of the force is ten times as high as that of preloading:

$$F_s=10\,F_{es}\,,$$

$$F_p=10\,F_{ep}\,,$$

and the lower limit is twice as high. Figure 6 illustrates a characteristic single-cycle and an enduring force-elongation diagram. Relating the full elongation occurring in cycles 1 and 10 (according to the notations of the Figure ΔL_1 and ΔL_{10}) to the clamping length the present elongation ε_k is represented in Fig. 7.

On basis of the fatigue test it can be seen that full elongation is substantially increased by repeated loadings; the elongation occurring in the first cycle increases by 10...50% after the tenth cycle. Relating the elastic elongation (the difference between full elongation and residual elongation, in Fig. 6 (ΔLm_1 and ΔLm_{10}) to the full elongation, the elastic factor of the fabric ε_{rk} obtained in this way (Fig. 8) changes already far less in the course of repeated loadings. It has also to be considered that from point of elasticity the behaviour of the fabrics in course and wale direction is the same and there is no significant difference between the different types of fabrics. When compared to the elasticity values of yarns it can be seen that the deviations shown in yarn elasticity are not to be found in the fabrics at all.

From the point of wearing comfort the flexional resistance and the drape of the individual types of fabrics are of interest. Figure 9 shows the bending factor W of the fabrics, established by fabric tests carried out on a Drape Tester.

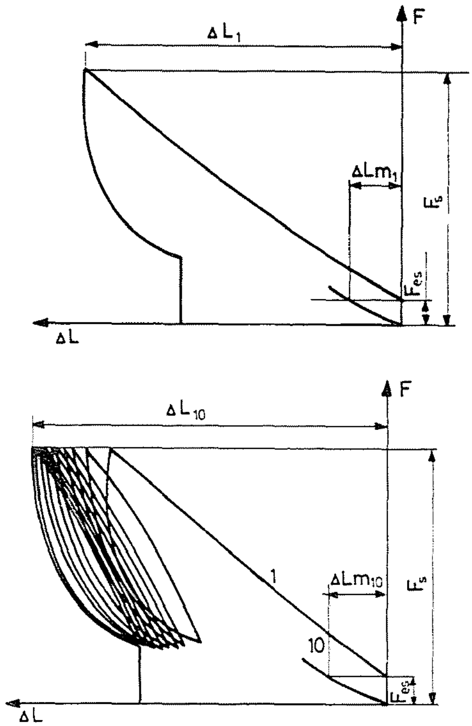


Fig. 6. Diagrams of single-cycle and multi-cycles enduring tests

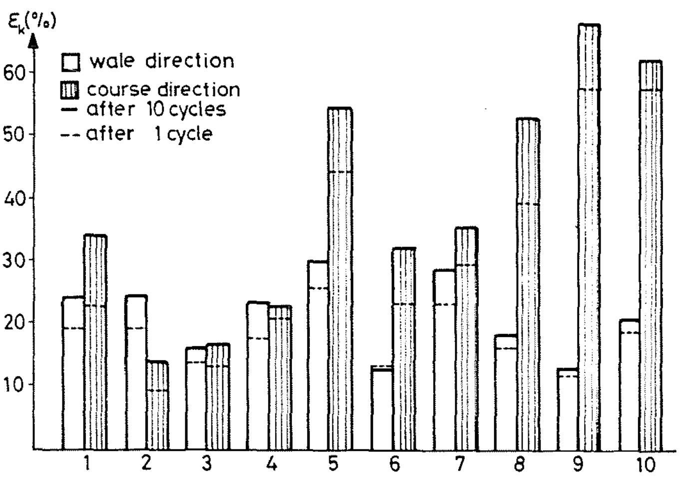


Fig. 7. Changes in fabric elongation under repeated loadings

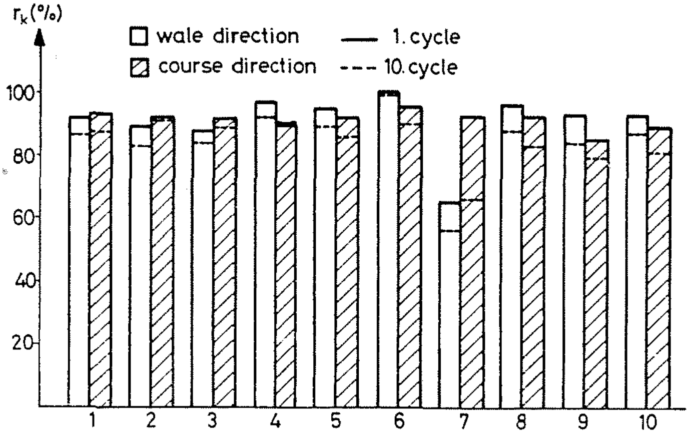


Fig. 8. Fabric elasticity

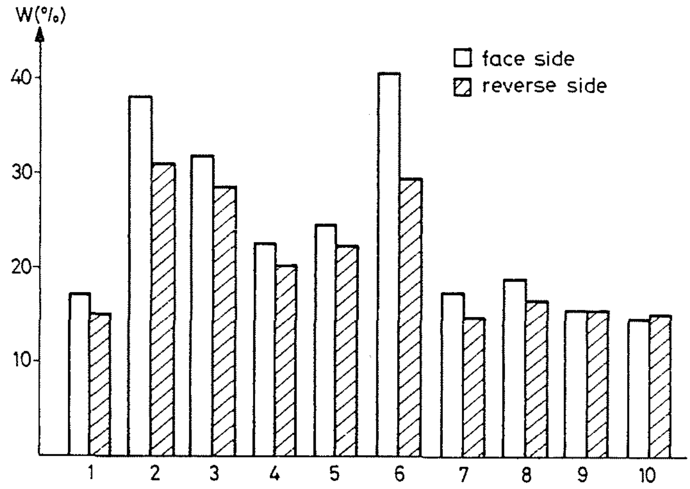


Fig. 9. Bending factor (drape)

From the characteristic of the interlock fabric 9 it follows that the tendency to draping on its face and back side is the same while in the case of the other fabrics the bending factor is generally higher for the face side. From this versatility it also follows that the drape of fabrics is considerably influenced by their structure. (The softer fabric has the lower W value.)

No close relation can be found between the properties of yarns and fabrics (yarn elasticity, yarn rigidity, coefficient of friction (1), respective fabric drape). It is clear that the coefficient of friction measured by the test method described is not identical with the friction acting within the yarn body and the measurable friction of yarns on yarns. Nor can the highly scattered measuring results of yarn flexibility give an adequate basis for comparison. Thus, the influence of yarn properties cannot be established by the standard test methods. The effect of the lower density of fabrics made of the thinner yarns is reflected in their lower bending factor.

Dimensional changes during washing

Figure 10 gives one of the basic factors of the easy care property of fabrics, viz. the dimensional change ($\delta\%$) during washing. (The test was carried out according to standard HKSZ 7/1977 applied by the "Habselyem Knitting Mill".) The majority of the test fabrics shows nearly the same dimensional changes in course and wale direction, and the values obtained do not exceed 4% in that group of fabrics. Since wet relaxation is largely influenced by the raw material, (i.e. the fabric stability) it is evident that the highest dimensional change occurs in Fabric 1 knitted from the lowest (33%) Polyester content yarn "A" (exceeding the permitted shrinkage). In Fig. 10 the fabrics are represented in the order of increasing Polyester content. Apart from minor deviations the Figure demonstrates fairly well the same order of dimensional changes during washing, supporting the previous statement.

The dimensional changes in the test fabrics after washing are practically not influenced by the square meter mass of the fabrics of different yarn, types, viz. by the cover of the fabric, this is demonstrated by the quite low dimensional changes in Fabric 8 of cover factor 10.5, further in Fabric 10 of cover factor 10.8.

From among the yarn properties the coefficient of friction, yarn elasticity and yarn elongation may presumably influence dimensional changes during

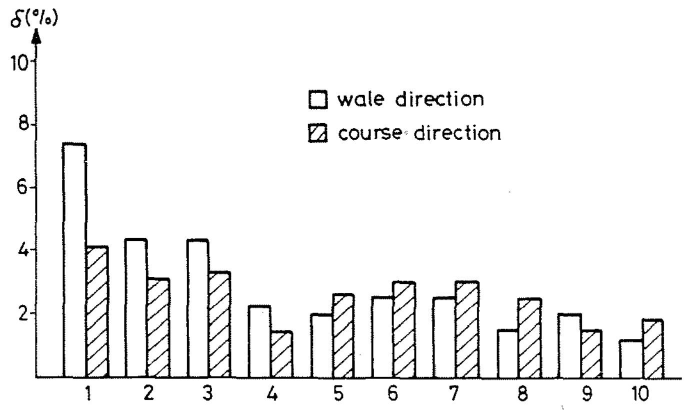


Fig. 10. Dimensional changes in washing

washing. On the basis of our investigation it appears that a lower friction coefficient and a higher yarn elongation produce lower dimensional changes, while between yarn elasticity and washing shrinkage there is no relation at all. In our opinion the primacies of a comparatively high synthetic fibre content and that of a proper heat setting procedure are supported by the above.

Pilling tendency, abrasion resistance

In order to determine the pilling tendency of the test fabrics, a test was carried out according to Hungarian standard KERMI MSZT 203—74, on a Pilltester, at 60 rev/min, with 2 N loading force and choosing the most complicated path of movement for the abrading unit of the test instrument. Figure 11 gives the number of pills developed after 5, 10, 20 and 30 min testing time, while the samples treated are indicated in Fig. 12.

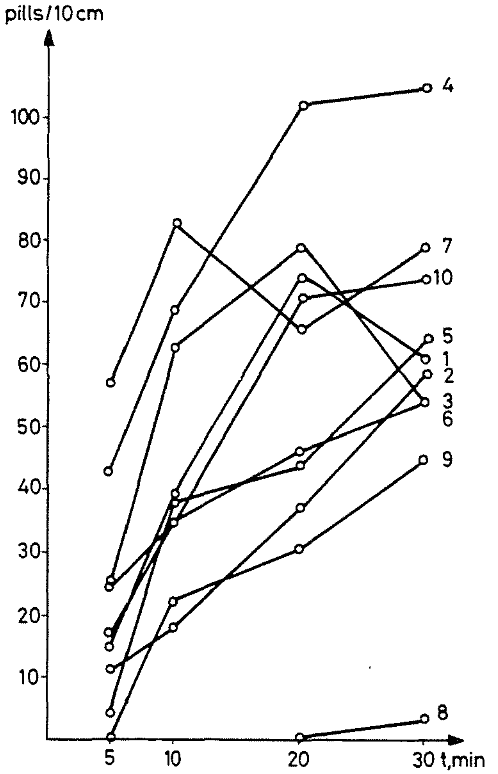
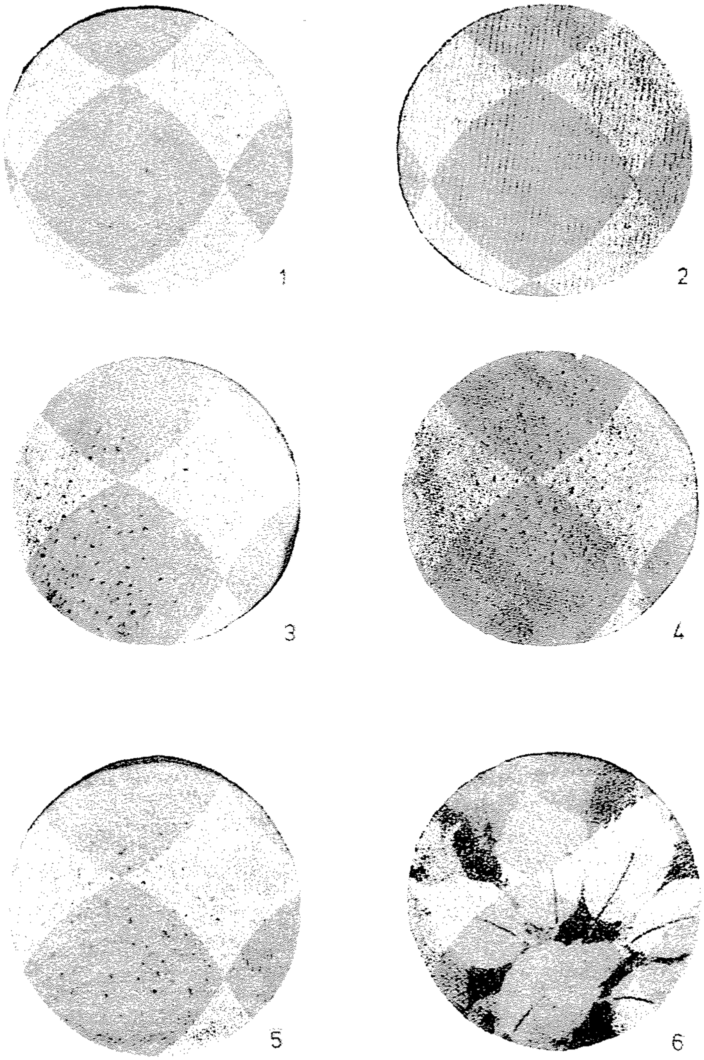


Fig. 11. Pilling tendency

The curves belonging to the fabrics are not at all parallel, in some of the fabrics pilling develops progressively, in the others the rate of pilling decreases depending on the testing time. The more, part of the pills developed previously on the surface of some fabrics — as a consequence of the abrading effect — disappear and the number of the remaining pills actually decreases on the fabric surface.



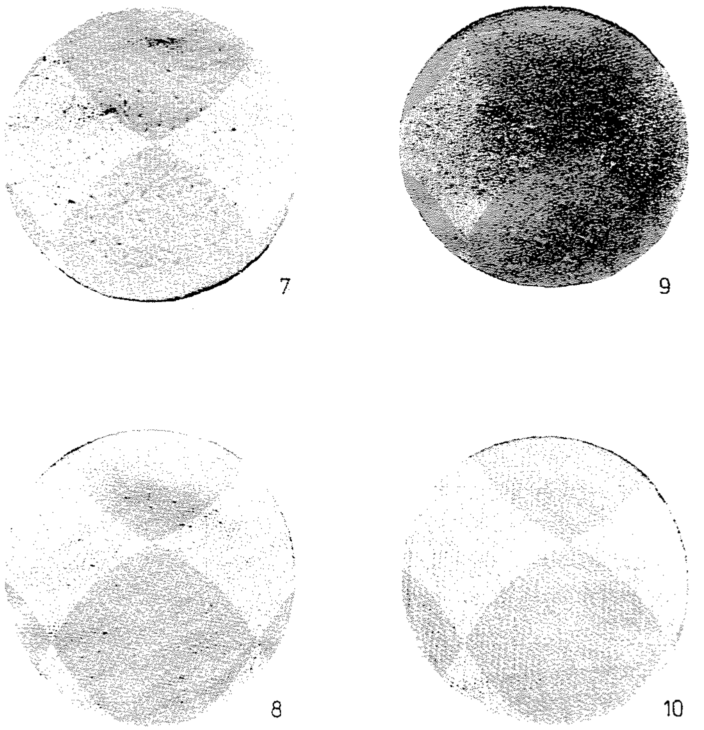


Fig. 12. Abraded fabric samples (on 2 pages)

A logical relationship can be found between the results obtained for the fabrics tested, and the surface properties of the raw material, the fibre strength, the density (cover) properties and the fabric type.

The data for twist and the properties of the raw material reflect clearly this assumed relationship: Fabric 8 and interlock Fabric 9 that show the least pilling, are knitted from a thin, 100% Polyester yarn with the highest twist number (1133.9/m) among all test yarns. Fabrics 4 and 7, due to an abrasion process of 30 min., show the highest pilling content. These two fabrics also have the comparatively lowest twist number: 905.3 and 856 t/m, respectively.

The influence of the raw material can be seen clearly on the pilling diagram. Fabric 10 made of the 100% Polyacril yarn K, shows a high pilling tendency. It would be worth-while to make experiments with the recently developed Hoechst Acryl yarn of considerably reduced pilling tendency, as shown by the diagram of comparison in Fig. 13 (5). (The grades of pilling on the ordinate of the Figure were established in Reutlingen.) In the relevant technical

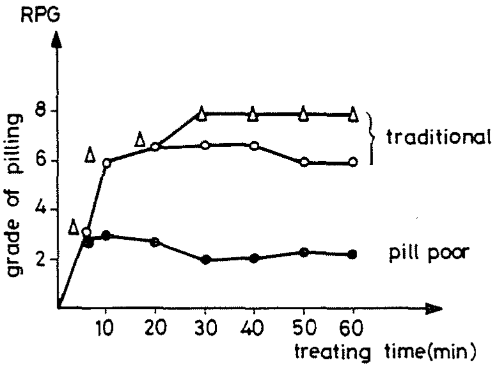


Fig. 13. Comparison of "pill-poor" Acryl with other yarns

literature PAN—PES blends of reduced pilling tendency are suggested for knitted fabrics in which the Acrylnitril component provides the bulky, wool like appearence of the yarn, while the Polyester one the property of shape retention. Reduced pilling tendency Polyester yarns are also offered by Enka (6) also worthy to test.

It is to be noted that pill formation the process in hare wool fabrics Type E is lower and may even decrease in the function of time. In this case hare wool fibres disappear to an increased extent, as a result of which the hair wool proportion decreases. It has to be mentioned, however, that this was not experienced in the case of yarns *F*.

Within the tested range the pilling tendency of the fabrics is not influenced either by the square meter mass or by the density characteristics. Thus, there is no sense to change the present order of magnitude of the fabric structure.

Comparing the test fabrics with the single face ICI fabric standards, the formers can be included in five classes:

5. (the best)	8
4.	9, 2, 1
3.	10, 3
2.	6, 4
1. (the worst)	5, 7

(The Hungarian KERMI standard gives three classes for grading fabrics, and two further intermediate classes with the notation 1—2 and 2—3, thus also a total of five classes are at disposal for grading.)

Testing the abrasion resistance is similar to measuring the pilling tendency. In our Laboratory we have measured the mass of fibres abraded on a Weartester at 60 rev/min of the abrading unit, in dependence of the treating time. We did not endeavour to establish the number of abrading cycles necessary for total wear (up to hole formation), as the above method is far from suitable for practical application. The test method of the abrasion resistance mentioned — similarly to pilling test — accentuates the advantages of a close fabric structure when processing identical yarns.

Though weighing on an analytical balance the abraded mass of fabric is not as objective a method as the automatic instrument registration of the measuring results it still enables to compare the fabrics. Thus, the diagram of the loss in the fabric mass (V) given in Fig. 14 shows clearly that the hair wool containing fabrics have a lower abrasion resistance (the worst amont them being Fabric 6 knitted of yarn F), while the further test fabrics have a practically similar, comparatively high abrasion resistance.

The results concerning the fabrics deviate considerably from the data obtained in the abrasion tests of yarns. The least resistance to the abrasion stress was shown by yarn K, while Fabric 10 knitted of that yarn was the one showing the highest abrasion resistance. Yarn E endured twice as many abrading cycles as yarn K till break whereas Fabric 5 made of the former yarn proved to be one of the poorest in respect to abrasion resistance. The results of the yarn abrasion tests are not only influenced by the extent of surface damages but also by that of the interlacing fibres, thus by the fundamental strength of the yarn. From this point of view, however, the best is yarn E, and the worst is yarn K, the breaking strength of which is 80% lower than of the former yarn. From

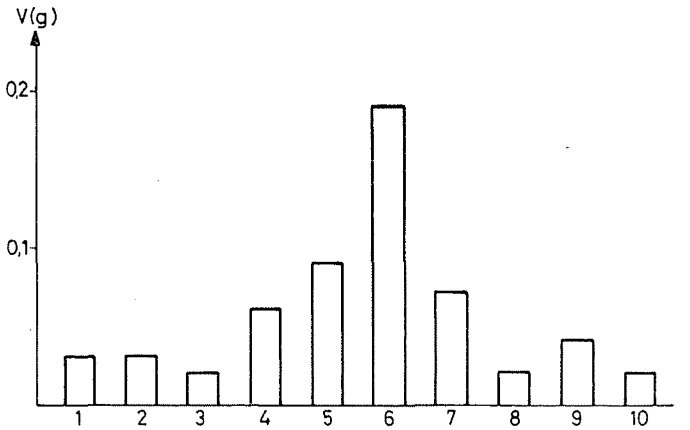


Fig. 14. Loss in fabric mass in wearing test

this it clearly follows that no relationship can be found between the results of the abrasion test of yarns and the abrasion resistance of the fabric surface. (Following this observation we established from the number of abrading cycles and the quotient of the breaking strength of yarns a factor, assuming that by taking into consideration both properties, a better relationship could be obtained with the abrasion resistance of fabrics. However, this factor did not prove to be adequate for the purpose, either.) Thus, it is no good to apply the above yarn abrasion test method, as no conclusion can be drawn from its results concerning the probable abrasion resistance of fabrics.

The abrasion resistance is not influenced by the cover and the elongation tendency of fabrics within the range of the test fabrics. It can be stated that the abrasion resistance of the test fabrics is in general good and hardly any deviation can be found among them except in the case of fabrics containing hare wool. (Presumably because of the minor deviations, it is difficult to find a relationship indicating a definitive influence exerted by one or the other factor of the yarn and fabric structure, respectively.

Hygroscopicity

One of the most decisive factors of wearing comfort is the fabric hygroscopicity. In our relevant experiments (MSZ 101/9) we have measured the absorption level of water in fabric stripes immersed in water, as a function of time. Figure 15 indicates the absorption level N of water in course, Fig. 16 that in wale direction (N, mm) and Fig. 17 gives the average value calculated from the moisture levels developed in individual sections of 5...10 minutes treating time

$$\left(N = \frac{N_1 + N_2 + N_3 + N_4 + N_5 + \frac{N_6}{2}}{6}\right).$$

The curves represented in the function of time — in general — do not cross each other, thus the order of succession of fabric of hygroscopicity is practically identical at any point of the treating time. From the shape of the curves it can be seen that the speed of moisture absorption decreases gradually with the time, during the first five minutes the fabrics absorb generally 50% of the total water quantity taken up during the complete testing time of 30 min. Considering that the ratio of moisture absorption in course and wale direction does not change with the testing time, a treatment of 5 minutes seems to be sufficient for determining the characteristics of the hygroscopic property of fabrics.

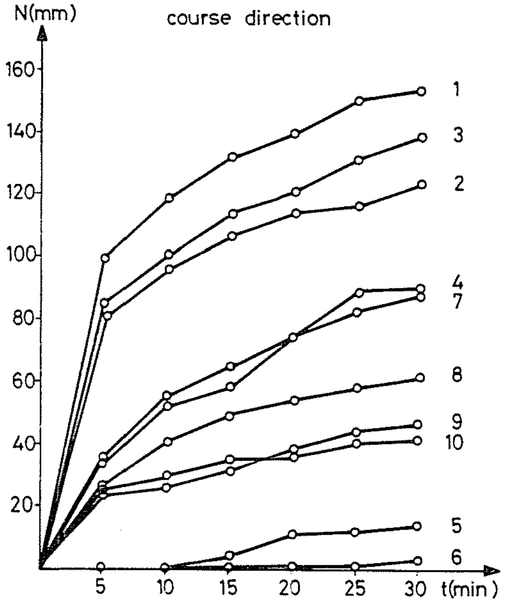


Fig. 15. Moisture absorption in course direction

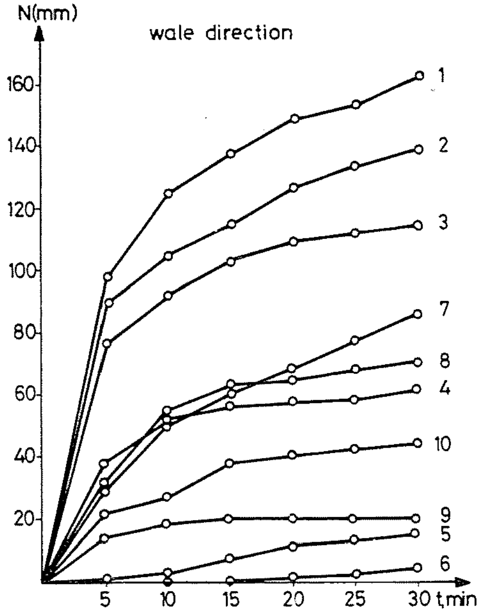


Fig. 16. Moisture absorption in wale direction

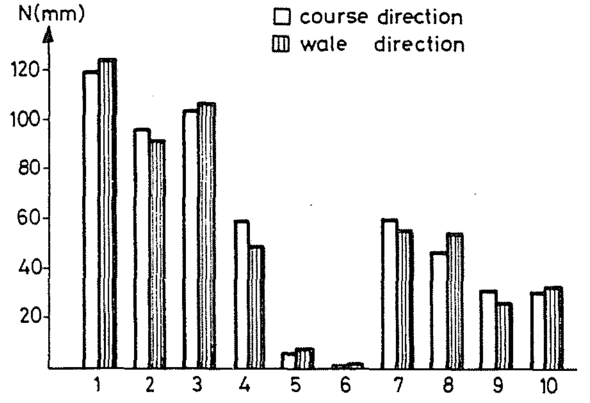


Fig. 17. Average level of water absorption

According to the measuring data the hygroscopic properties of the test fabrics show considerable deviations. The raw material of the yarns, the finishing process applied and the types of fabric all influence the hygroscopic properties.

From among the weft-knitted fabrics, No. 1 made of yarn A with the lowest (33%) synthetic fibre content shows the highest hygroscopicity since the other yarn component, viscose, has a good hygroscopic property. After that follow Fabrics 2, and 3 made of yarns B and C containing 33% and 35% cotton, respectively. As to the synthetic fibre content, from among the Hare wool yarns (80%, and 85% PES), the white ones follow the logical order of succession, while the hygroscopic properties of Fabrics 5 and 6 knitted from coloured hare wool yarns are considerably poorer than those of 100% Polyester or Polyacrylnitril, as their hygroscopicity is practically zero. There is no appreciable difference between the cover factors of the mentioned, hare wool fabrics; their square meter mass is about 10...15% lower than that of higher hygroscopicity hare wool fabrics.

The 100% Polyacrylnitril fibres of which the yarn is built up, is developed purposely to achieve good hygroscopicity (7) and it is considered as a special advantage that with this fibre no swelling occurs during the moisture uptake. (That is important because the transfer of water vapour taken up from the skin surface does not slow down through the textile, and the permeability remains unchanged.) For the wettability and speed of moisture transfer through textiles (the so-called spreading effect) — similar to the test method used by us — the diagrams shown in Fig. 18 were obtained for double face fabrics (7).

From the comparison with other fibre materials it can be seen that the hygroscopicity of the fabric of yarn K approaches that of cotton. (The low value

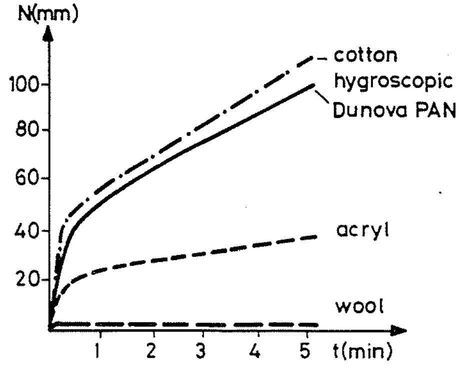


Fig. 18. Data from technical literature on moisture absorption

obtained for wool is due to the difficult wettability). The results were supported by wearing tests, too. According to literature the volatilization of the moisture taken up is fastest from fabrics composed of fibres of yarn K, because apart from the possibility of moisture flow from the interior of the fibre capillary towards the exterior skin (through skin groves), the inner structure of the capillary can easily transfer water to the fibre tips protruding from the fabric surface, and thus volatilization can take place simultaneously from several places. (According to research workers no such water transfer occurs from the interior of fibres to their tips in the case of cotton, Acryl, and wool fibres.)

The diagram in Fig. 17 does not reflect the advantages of the enumerated hygroscopic properties of yarn K concerning the fabrics tested by us: in Fabric 10 knitted from yarn K, the level of absorbed moisture is the same, in some cases it is even lower than in fabrics with a 100% PES content.

In wearing the actual stress consists of the absorption and volatilization of the moisture appearing on the fabric surface (and not in its cross-section) in the yarn ends. We have therefore completed our test method with a process in order to better approach the actual stress. — Test samples of $100 \times 100\ \text{mm}^2$ size, after their dry masses were determined, were placed for 20 minutes on a wet blotting paper. The water-uptake was determined in per cent with taking into consideration the measured wet and dry masses (M):

$$\text{water-uptake in } \% = \frac{\text{M wet} - \text{M dry}}{\text{M dry}}\, 100$$

The values N of the moisture taken up through the fabric surface are given in Fig. 19. The order of succession of the fabrics knitted from the thicker yarns is

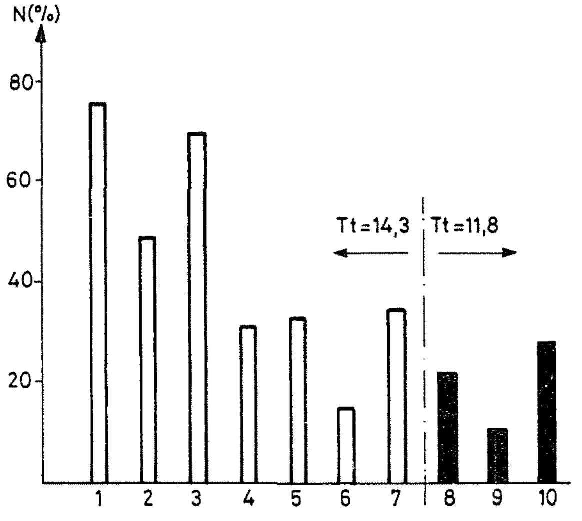


Fig. 19. Surface water uptake of the fabrics tested

similar to that obtained in the previous test. The Fabrics H (8, 9) made of yarns with a similar linear density as that of yarn K (100% PES) became less humid than Fabric 10. From the point of surface moisture uptake, the fabric knitted from yarn K is more favourable than those made of PES, however, according to these tests, its hygroscopicity does not attain the good hygroscopic properties of cotton and viscose fabrics.

Grading of the fabrics on the basis of tested properties

Similarly to the order of succession of the processed yarns, that of the test fabrics can also be determined depending on the characteristics measured (Table 2.)

The order of succession of the fabrics reflects well the extreme values, but in many cases there are hardly perceptible differences between the fabrics following one another, thus if cannot be seen to which limit some intermediate fabrics are situated nearer. — Therefore, a comprehensive and comparative characterization was also made in the following way: within the range of the measuring results of the tested properties the fabrics were graded in three groups, viz. in "low", "medium", and "high" value groups. This is shown in Table 3. On the basis of the properties considered previously.

Table 2

Order of succession of the fabrics

Tested property	1	2	3	4	5	6	7	8	9	10	Range of fluctuation (round up)
Elongation (Loading 50 N)											*1→10*
course	5	1	2	8	4	7	9	10	12	11	55–140%
wale	9	8	5	11	7	4	12	6	3	10	20–65%
Elasticity (after 10 stresses)											
course	6	1	3	2	7	4	12	8	10	9	90–65%
wale	7	11	10	3	4	2	12	5	9	6	100–55%
Drape (Bending down)											
face side	10	2	4	7	6	1	9	8	11	12	40–15%
reverse side	10	1	3	7	6	2	12	8	9	11	30–15%
Dimensional changes during washing											
course	12	9	11	2	6	7	8	5	3	2	1.0–4%
wale	11	9	10	5	3	7	8	2	4	1	1.0–9%
Pilling	8	7	6	12	9	5	11	3	4	10	0–105/10 cm
Weight loss in wearing	6	6	3	9	11	12	10	3	8	3	0–0.2 g
Water uptake											
course	1	3	2	6	11	12	5	8	10	9	0–120 mm
wale	2	4	3	8	11	12	6	7	10	9	1–130 mm

Table 3

Fabric	Elongation (10 cycles)*						Elasticity						Drape (flexibility)						Fastness to washing						Pill			Wearing			Water uptake					
	course			wale			course			wale			face side			reverse side			course			wale									course			wale		
	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉	〈	k	〉
		80÷120%			30–50%			75–85%			80–90%			20–30%			20–25%			2–3%			2–4%			10–70 db			0.05–0.1 g			40–80 mm			40–80 mm	
1		x			x				x		x		x			x					x			x		x					x			x		
2	x				x				x		x				x			x			x			x		x		x					x			x
3	x				x				x		x					x		x			x			x		x		x					x			x
4		x				x				x			x		x			x	x				x					x			x			x		x
5	x				x				x		x			x				x		x		x				x		x		x				x		
6		x			x				x				x			x		x		x				x				x			x		x		x	
7		x				x		x				x			x		x				x				x			x		x				x		x
8		x				x			x			x			x		x				x				x		x		x			x		x		
9			x		x				x			x			x		x		x			x				x		x			x			x		
10			x				x			x			x		x		x		x			x					x		x				x		x	

* The range belonging to "k" gives the average value of the property tested, 〈 the value lower than that, 〉 the value higher than that.

Conclusions

In the course of our experiments we tried to find an answer to the question which and to what extent the type of knitting and the fabric structure influence the characteristics (and thus the probable functional performance) of the fabrics.

On the basis of our investigations the following general conclusions can be drawn:

1. From among the fabric properties the tendency to elongation is much more dependent on the fabric structure than on the original elongation of the processed spun yarn. Elongation in a course direction can be decreased by introducing straight yarn sections in floating stitches (with missing.) In fabrics of low elongation no decrease in elongation can be achieved by tucking as with missing; and this has to be considered in design work. Decrease in yarn thickness, thus in fabric cover, leads to an increase in the elongation propensity. In the deviations of fabric elongation properties only the highly different yarn elongations can be perceived.

2. Between yarn elasticity and that of the fabric no relation at all can be found. The elasticity in course and wale direction of the types of fabrics tested were almost the same. Higher fabric elongation is accompanied by a lower elasticity tendency. Repeated loadings increase fabric elongation and decrease its elasticity, however, not to a great extent (by 2. . . 10%).

On the basis of the statements in points 1. and 2. testing the elongation and the elasticity of yarns is not considered to necessary, since from its results no conclusion can be drawn — only in highly extreme cases — for similar fabric properties.

3. Dimensional changes during washing are primarily dependent on the material composition. From this point of view a synthetic fibre content higher than 65% — in addition to the finishing method (heat fixation) applied, is sufficient to ensure that dimensional changes do not exceed 4% in either main direction, and this is valid even for fabrics of the lowest cover. In the case of identical material composition in fabrics of denser construction deformation will be naturally lower. The influence of the original yarn properties is small; with respect to the dimensional stability of fabrics low friction coefficient and high elongation tendency appear to be more favourable and the effect of yarn elasticity can be completely neglected (at least within the comparatively narrow range of the yarns of fabrics tested).

4. In the development of the pilling tendency of fabrics the type of fabric (its cover) furthermore the closeness of yarn body (number of twists) are of

paramount importance. Among the fabrics those of low elongation construction are much more favourable than those made by interlock knitting.

For decreasing pilling, from the yarns the Polyester ones are the best (helped by a comparatively high number of twists).

The highest pilling formation was found in the fabrics containing hare wool yarns, but also a low twist number exerts in such cases a detrimental effect. However, for lack of separate experiments no increase in the number of twists can be suggested, since a stiffening of the hare wool — PES yarns of high fault number may eventually lead to further processing difficulties.

If there is a possibility to obtain an experimental lot of identical yarn types with different number of twists it would prove useful to carry out comparative fabric tests.

The Polyacrylnitril yarn K also ranks among the yarns unfavourable in respect to pilling. It would perhaps be worth-while to carry out knitting experiments with "pill poor" Acryl and Polyacryl — Polyester blended yarns suggested in foreign literature (8).

5. Concerning abrasion resistance, the influence of fabric structure is decisive. Within the range of identical structure fabrics primarily those containing hare wool show the highest loss in mass, while the abrasion resistance of other type yarn fabrics is about identically favourable. Thus yarn property is a factor exerting influence. The usual wearing test of yarns is not suitable for estimating the abrasion resistance of fabrics. So far, no other reliable relationship between fabric abrasion resistance and yarn properties was found. Referring to foreign sources perhaps the possibility of decreasing the 20% hare wool content may be suggested.

6. In the development of fabric hygroscopicity the main part is played by the raw material. This was confirmed by our investigations, too. The best hygroscopic properties were shown by the fabrics of lower synthetic fibre content. The results obtained also depend on the test method. The moisture taken up through the fabric surface, i.e. the level of water taken up does not give the same order of succession for the PES — hare wool, and the 100% PES fabrics, viz. for those made of yarn K. The PES — hare wool fabrics are more favourable in respect to surface moisture uptake than to water uptake. The hygroscopic Polyacrilnitril yarn and/or fabric K is more favourable only from the point of view of surface moisture uptake than the 100% PES fabric knitted from identical linear density yarns.

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