YARN PARAMETERS INFLUENCING THE KNITTABILITY OF HIGH-GRADE SPUN YARNS

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Summary

The paper deals with the properties of high-grade spun yarns most influencing the processibility on circular knitting machines. On the basis of laboratory and mill experiments, yarn thickenings are the most decisive faults from the point of view of processibility. The paper contains suggestions for practically limiting the number of faults.

Introduction

The relation between the properties of yarns and fabrics, furthermore the prediction of the expectable functional performance and the characteristics of fabrics have long been discussed in the knitting industry. A problem of major importance is the type of the test method for determining the suitability of a given yarn for a given purpose under given conditions.

Actually, requirements of a reasonable material management raise two aspects imposing expedient yarn tests:

— *processing of yarns of lower quality than required* leads to higher material consumption (more wastes) and generally, to a lower efficiency, while only part of the products meets the requirements;

— *use of yarns of higher quality than needed* makes the goods, more costly than necessary, and eventually demands more from the spinning mill than necessary, to the detriment of efficiency.

Results of yarn tests and qualifications made both in mills and recently, in our laboratory are only valid to restricted ranges. (Generally valid limits for yarn properties cannot be set up because of differences in final uses.) Confrontation of an adequate number of part results would offer a better insight into relations between yarn properties, processibility and fabric

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characteristics permitting to more precisely formulate the technical parameters of the knitting yarn best fitting a given purpose.

In our present work spun yarns applied in fine cut circular knitting machines (E 28) has been investigated. In addition to our measurements, manufacturing experiences at the Habselyem Knitting Mill Co. have been made use of.

The types of yarns tested

The test yarns and fabrics are listed in Table 1. From among the yarn components, hare wool is novel, contained in four products. The beard-hair, suitable for spinning, exhibits rather high thickness variations [1], and hare wool is thicker than angora wool. Low density (0.94–1.3 g/cm^3) of hare wool causes segregability in yarn blends making it difficult to knit. This explains the higher irregularity of yarns containing hare wool compared to other types of yarns (see later). The elongation of hare wool (30–40%) does not impair processibility. However, in finishing, it has to be taken into consideration that it

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		
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)	14.3	70
F	6	80% PES—20% hare wool (pastel, PFV)		
G	7	85% PES—15% hare wool (white, Gross)		
H	8	100% PES		
H	9	100% PES	11.8	85
K	10	100% PAC (hygroscopic)		
furthermore without fabric sample the following yarns:				
L		100% PAC	14.3	70
M		100% cotton	11.8	85
N		67% PES—33% cotton		

is more susceptible to chemicals and dyed in blends it becomes more pastel than common wool [2].

The Habselyem Knitting Mill blends hare wool of about 20% with polyester. Special literature reports on several components in blended yarns with hare wool [3]. In the recommended yarns, the hare wool proportions is generally lower than usual in this country:

85% PAC—15% hare wool,
82.5% PAC—10% wool—7.5% hare wool
80% PAC—10% wool—10% hare wool
70% PAC—15% wool—15% hare wool
42% PAC—43% PES—15% hare wool
40% PAC—40% PES—15% hare wool and 5% Viscose.

(The majority of the listed yarns are produced in count Tex 25.)

From among the yarns tested the 100% PAC yarn K of Bayer is another interesting structure. It is featured by water absorptivity similar to that of cotton and wool favourable both for processing and for use as apparel goods. (Water absorptivity of hare wool is 30–40%, while under identical conditions that of cotton is 45–50%, and that of wool is 40–45%). Another advantage of this yarn is its low density (0.9 g/cm^3), while that of "conventional" Dralon of polyacrylnitril is 1.18, and surpassed only by polypropylene from the more important fibres. Also, its water retention (30–40%) exceeds that of Dralon (5–12%). All these properties result from the longitudinal, tolular (capillary) structure of fibres contained in yarn K [4].

A further interesting yarn among the yarns tested is yarn N of lower pilling tendency. (According to a witty analogy [5]: "To learn to live with pilling is somehow similar to learn to live with rheumatism, since both are incurable but both can be rendered more bearable and less painful".)

Also prevalence of yarn peculiarities in fabrics has been examined. The synthetic fibre content of the yarn types tested varied between 33–100%, as usual [6].

Yarn tests

Choice of the tested yarn properties

Processing of spun yarns on fine cut knitting machines is known to be more problematic than that of silk yarns. Due to their structured differences, strength, surface of yarn body, the arising other properties and variability of all the characteristics differ considerably from those of silk and affect knittability. According to manufacturing observations and research experiments [7, 8, 9, 10], and factors or procedures affecting most favourably processing conditions are as follows:

— uniformity in yarn count and in breaking strength,
— adequate yarn cleaning,
— relative low number of yarn twist (in the range of knittability),
— adequate paraffination,
— cut of knitting machine matching linear density of yarn.

For instance, under the above conditions, the requirements for 100% cotton yarn Tex 15 are:

— maximum standard deviation of Uster mass irregularity: 17%;
— standard deviation of the breaking force: maximum 15% (minimum specific breaking force of 10 cN/tex);
— maximum number of faults due to yarn cleaning: 4/10 000 m;
— maximum yarn twist: 840/m;
— paraffin content 0.2–0.3% of the yarn mass.

Respect of the ranges above [7], resulted in favourable processing conditions and fabrics of good quality on a circular knitting machine gauge 20.

According to other research results [8], the knittability of yarns is most affected by the coefficient of friction. Among faults the number of breaks caused by naps changes significantly in dependence of the coefficient of friction: for $\mu=0.13$, and $\mu=0.27$, 2–7% and 38%, resp., of the faults originate from naps. This fact puts paraffination and yarn cleaning on the top of the list of knittability factors. With increasing yarn count attenuations come to the foreground from among formal irregularities [11].

Also other research works refer to friction [9] and to yarn faults [10] as yarn characteristics fundamental for the processibility of spun yarns.

The experiences referred to induced us to perform, in addition to the strength and friction properties the following tests on the yarns:

— for determining formal irregularities, Uster unevenneses, thin places, thick places and nap number have been counted fault values in the Uster Classimat and Peyer Digimat systems determined;
— for investigating the quality of yarn surface, number of twists was counted and abrasion resistance tested;
— in order to obtain information on some fabric properties elongation and elastic characteristics of the yarns were determined.

Mass irregularity and formal faults

In tests made in a Zollweger-Uster instrument at 100 m/min yarn speed, 5 min testing time, 100% sensitivity and 1.0 m/min diagram speed, yarns exhibited the irregularity values shown in Fig. 1.

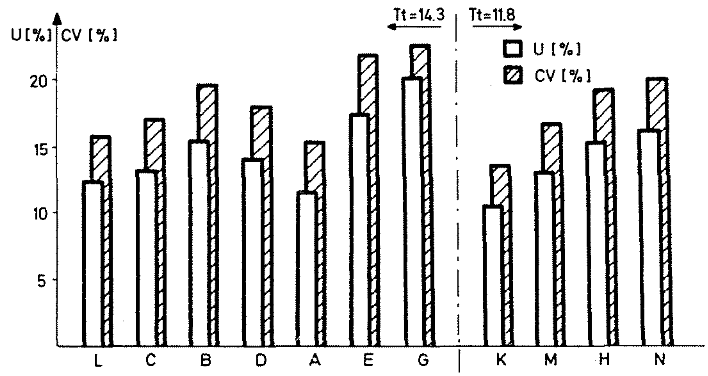


Fig. 1. Mass irregularities in tested yarns

Yarn grading according to the Uster Statistics method showed most of the tested yarns to belong to the 50% average quality or lower irregularity domain.

This limit is exceeded by hare wool yarns and yarns B, H, N and the U percentage of yarn G is too high to be graded according to the Table.

Also standard deviation, of the CV percentage shows a high irregularity for the same yarns with excessive U%.

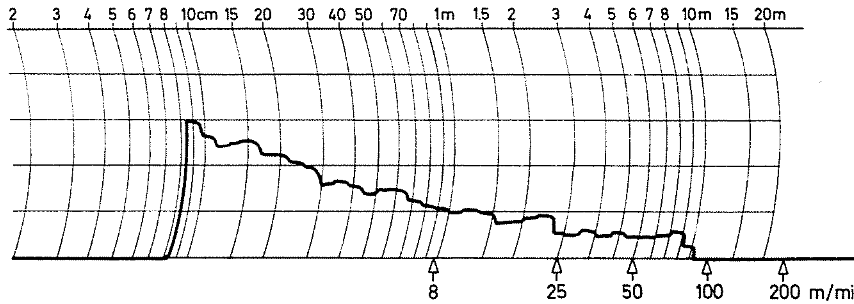
Spectrograms (Fig. 2) show periodically repeated fault peaks to be absent.

Occurrence of formal faults of yarns is shown in Fig. 3. In accordance with the high count of the yarns, the number of thin places is higher by orders than that of thick places. Averages cover a rather extended range of variations: while average $92.4/10^3$ m frequency of thin places in the best yarn K is made up from $24–160/10^3$ m values, the average value of $1161/10^3$ m for the poorest yarn B results from measured data of $820–1422/10^3$ m.

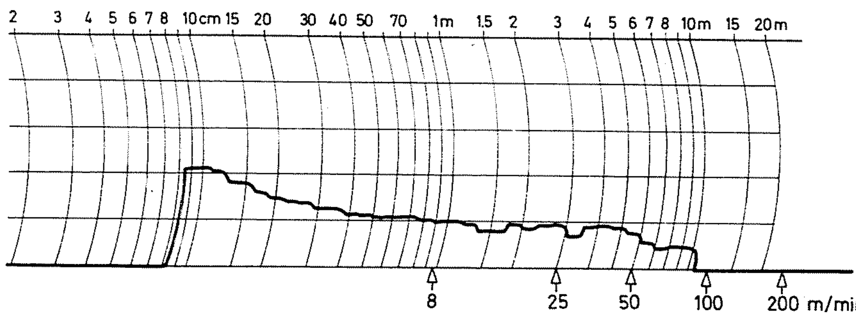
Comparison of Figs 1 and 3 shows the quality order of yarns to be the same from the aspects of either the U percentages or that with respect of the number of thin places, — the most frequent among the formal faults.

The frequencies of thick places and of naps create a different order of succession; from both points of view, hare wool yarn is the worst.

The yarns were tested by the Uster Classimat method, too. The fault content over a yarn length of 100 km is summed up in Fig. 4. (The legend of symbols is the following: the figures mean thickness increase referred to nominal diameter. 1, 2, 3 and 4 indicate yarn thickness increase frequencies of 100%, 150%, 250%, over 400%, respectively. Letters preceding the figures denote the thicken yarn lengths A, B, C, and D denoting fault lengths of 0.1–1 cm, 1.0–2 cm, 2.0–4 cm, and over 4 cm, respectively.



Yarn E
14.3 tex (Nm 70/1) 80 % PES - 20 % hare wool
U = 16.0 % CV = 20.0 %



Yarn M
11.8 tex (Nm 85/1) 100 % combed cotton
U = 13.1 % CV = 16.7 %

Fig. 2. Spectrograms

Also diagrams in Peyer-Digimat yarn grading system — though of a different scale — show hare wool yarn to be the poorest from the aspect of any thickness deviation. (Some characteristic diagrams are given in Fig. 5, the characteristic yarn faults are shown in Fig. 6.) For the other yarns the order of succession does not fully agree with that from the Classimat test for the total of fault values. Table 2 shows Peyer and Classimat gradings, in the latter the diameter deviations being separately indicated.

The results of the two test methods show the best agreement for the faults in the thickest yarn sections as illustrated in Fig. 7.

In view of the deviating results obtained by the different test methods, only knitting experiences could lead to a conclusion on which of the tested yarn

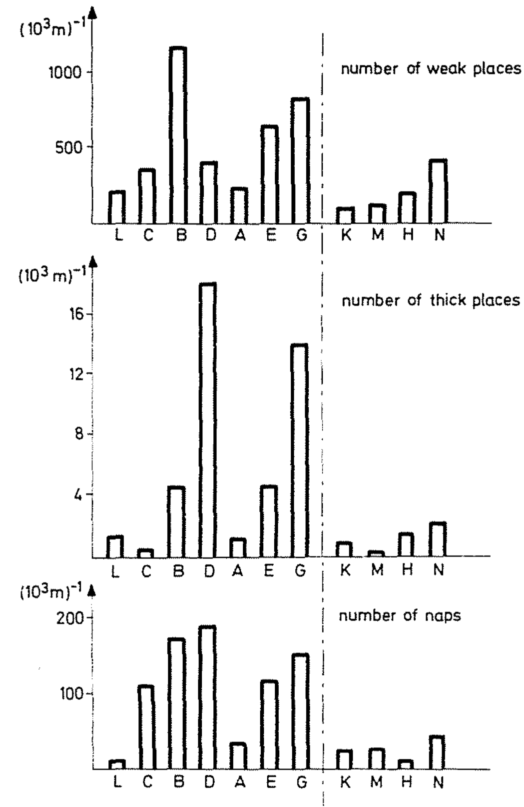


Fig. 3. Frequency of yarn faults

faults affect processing, and to what extent; hence, what is the testing and grading method best suiting the yarn grading. (The distribution of each fault type in a given yarn agrees with the results obtained by other, similar tests [12].)

Breaking force

The yarn breaking forces have been determined in a Zellweger-Uster automatic yarn breaking instrument under standard conditions. The average values of breaking forces are represented in Fig. 8.

It is interesting to see the significant deviations in the frequency distributions of breaking force values F. The two extremes are represented by diagrams of the 100% cotton yarn and of the 100% PES yarn (Fig. 9). The

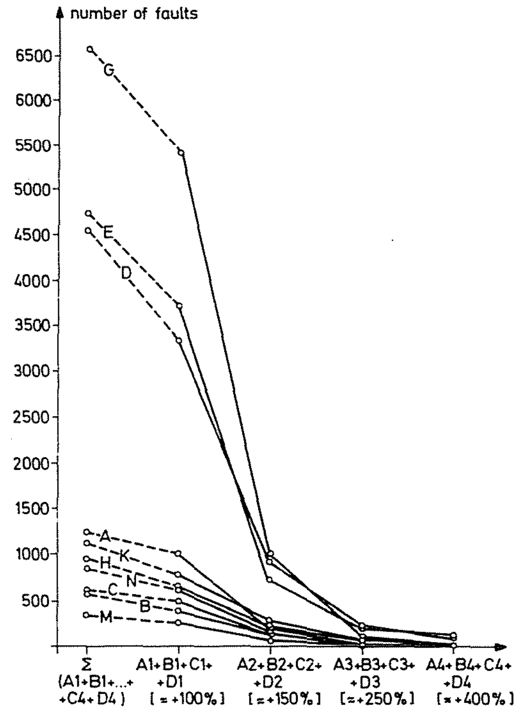


Fig. 4. Fault content by the Classimat test

distribution typical of the 100% cotton yarn, closely approximates the Gaussian curve, while that of the PES yarn is quite scattered. Uncertainties in the latter curve induced us to repeat the measurements, leading again to a multi-peak distribution curve, testifying the yarn breaking force to change actually to this extent.

Also the three types of hare wool yarn exhibited significant deviations both in the frequency distribution and in the average value of the breaking force (Fig. 10).

Average breaking force values F (Fig. 8) and fault content values (Fig. 4); are not related breaking force of hare wool — poorest from the aspect of fault content, — is among the highest. This points to the fact that faults (thin and thick places) in yarns are not such as to cause unambiguously weak places. Thus, formal irregularities do not reduce the breaking force of freely clamped-in yarns under test. In processing, however, yarn surface contacts deflecting and loop forming units, and in that case formal faults already reduce the strength, as seen from our processibility data (see later).

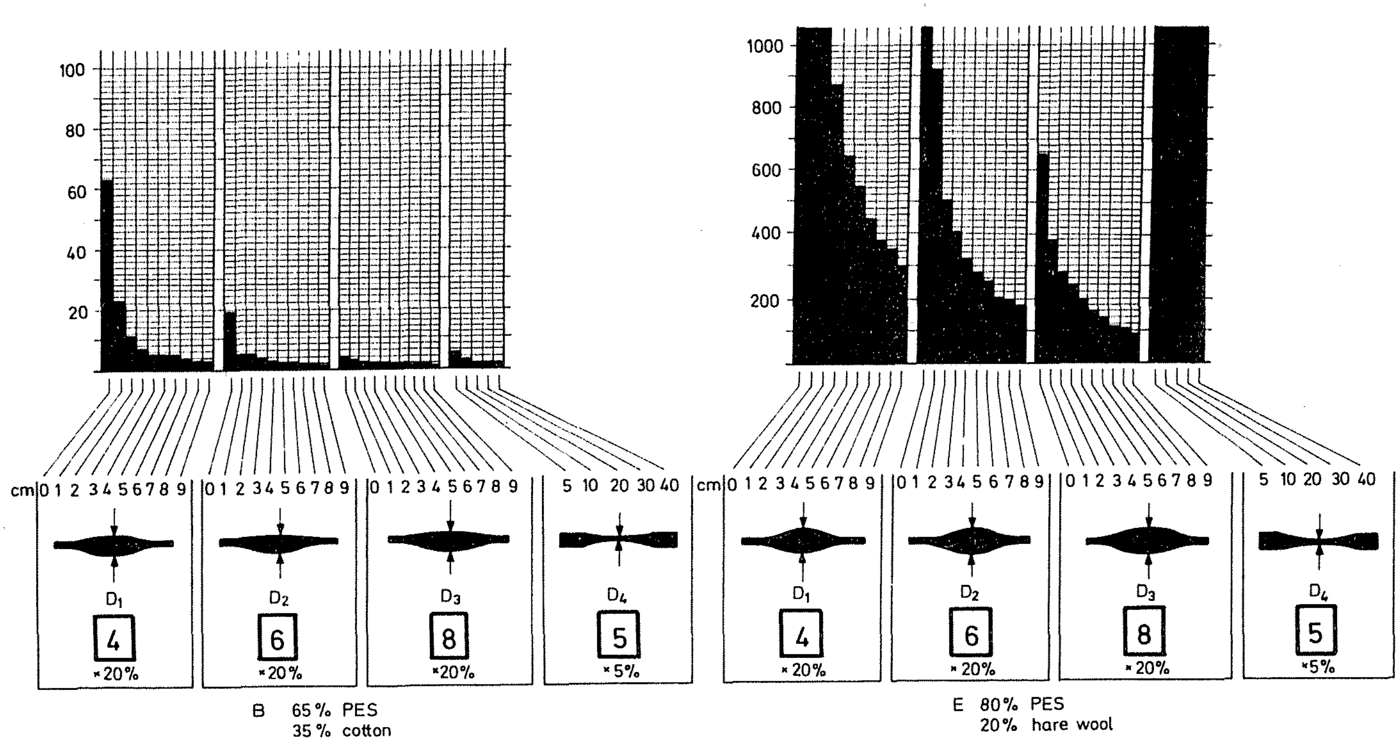


Fig. 5. Fault content by the Peyer test

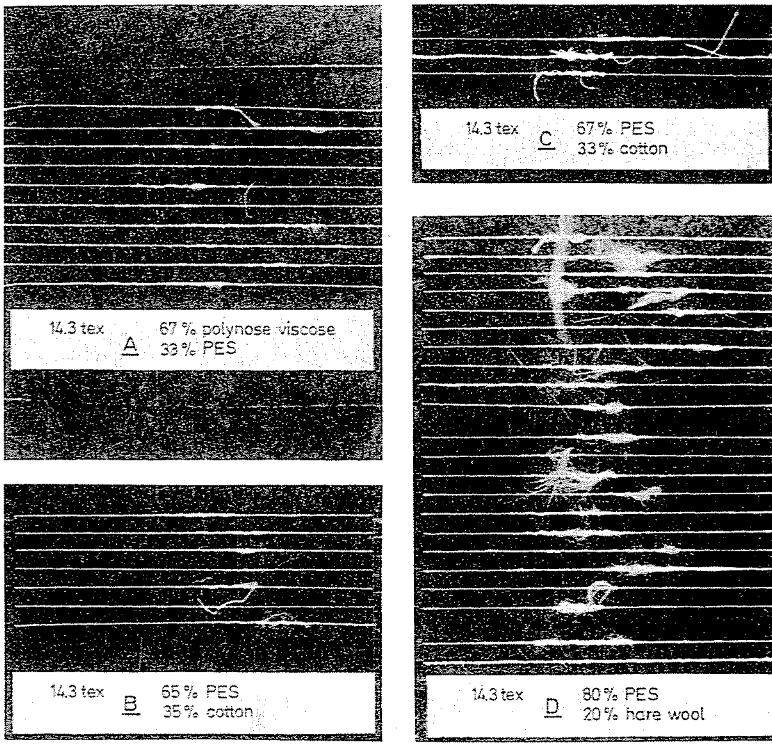


Fig. 6. Characteristic yarn faults

Twist

Since the knittability of a yarn is also influenced by its flexibility, the tested yarns were compared also for twist. Twist was tested by a tension sensing method (MSZ 3224-60) with 50 mm clamping length and 5 mN/Tex preloading. The average twist counts are in a rather narrow range: 900–1000/m, by 5% lower for yarn G, and by 5–15% higher for yarns C, H, N. The observed twist unevennesses are comparatively small and are unlike to disturb the processing.

Coefficient of friction

The coefficient of friction for the test yarns was determined in a Rothschild R-1182 instrument, carrying the yarns over an oxyde ceramic roller at a contact angle of 180°, at 100 m/min running speed, and 70 mN input yarn

Table 2

Grading of yarns by fault content

Yarn	Peyer Digimat (according to 8 × 20% thickenings)	Uster Classimat Σ	4*	3	2	1
K	8	5	9	5	4	5
C	6	8	4—5	9	9	8
B	9	9	10	8	8	9
D	2	3	2	1	2	3
A	10	4	8	6	6	4
E	1	2	1	2	3	2
G	3	1	6—7	3	1	1
M	5	10	4—5	10	10	10
J	7	6	6—7	4	5	6
N	4	7	3	7	7	7

(1: the poorest; 10: the best)
* A4 + B4 + C4 + D4, the other numbers similarly

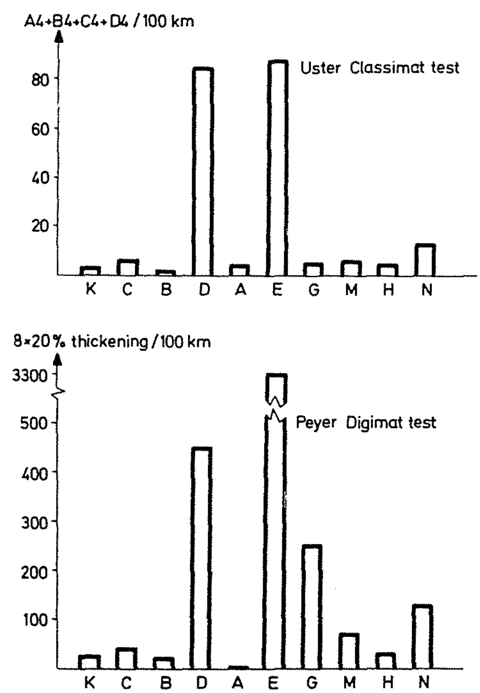


Fig. 7. Distribution of the grossest faults in either of the two grading systems

force. Yarns are seen in Fig. 11 to exhibit rather different friction coefficients. In virtue of the relationship shown in [8] to exist between friction and fabric faults, factor $\mu > 0.3$ (in yarns A, B, E, M, N) impairs knittability.

At the same time, there are a number of precedents [13] of the undisturbed processing of yarns of such friction values, confirmed also by knitting experience at Habselyem Knitting Mill.

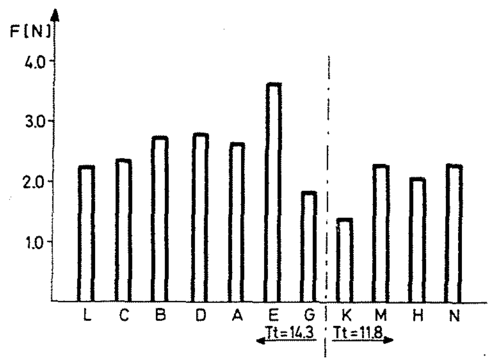


Fig. 8. Average breaking force values

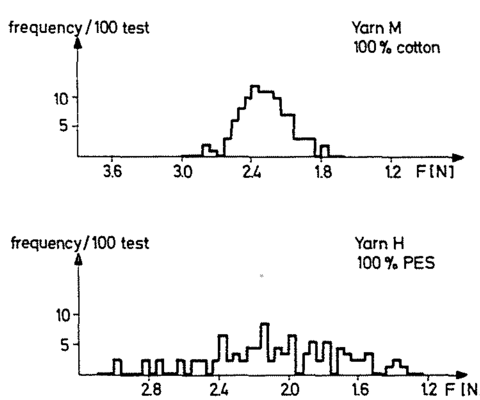


Fig. 9. Distribution of the breaking force for cotton and PES yarns

Elongation, elasticity

In addition to determining ultimate elongation values of yarns in breaking tests, separate measurements have been carried out for comparing elongation values under identical loads, and for determining the changes in elongation properties after fatigue.

Such measurements were made on a group of test yarns using a breaking-fatigue tester type Zwick 1604 (made in the FRG) at the Department for Textile Technology and Light Industries, Technical University, Budapest.

The measured breaking force values agree with those in Fig. 8., pointing to the reliability of the applied measuring methods and instruments. Since the breaking force values ranged from 1.4 to 3.8 N for the fatigue tested

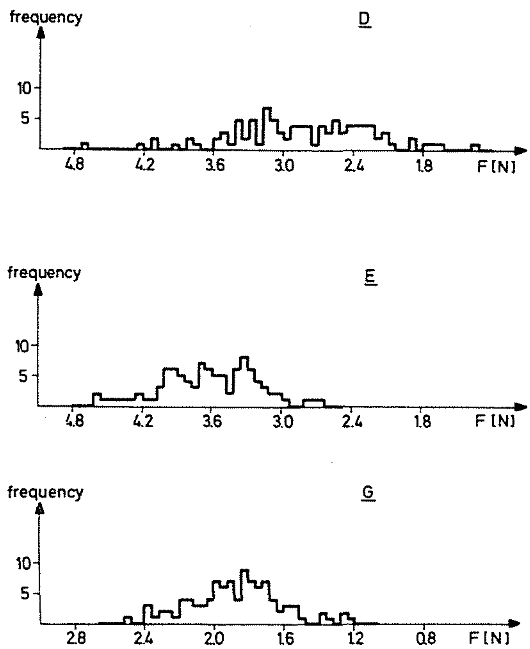


Fig. 10. Distribution of the breaking force for hare wool yarns

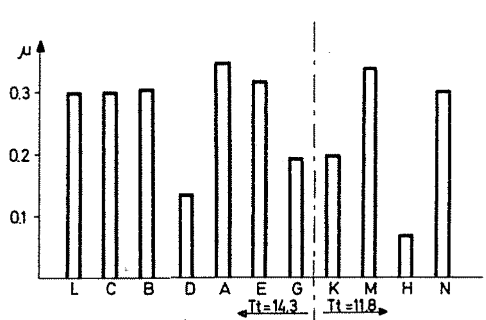


Fig. 11. Coefficient of friction

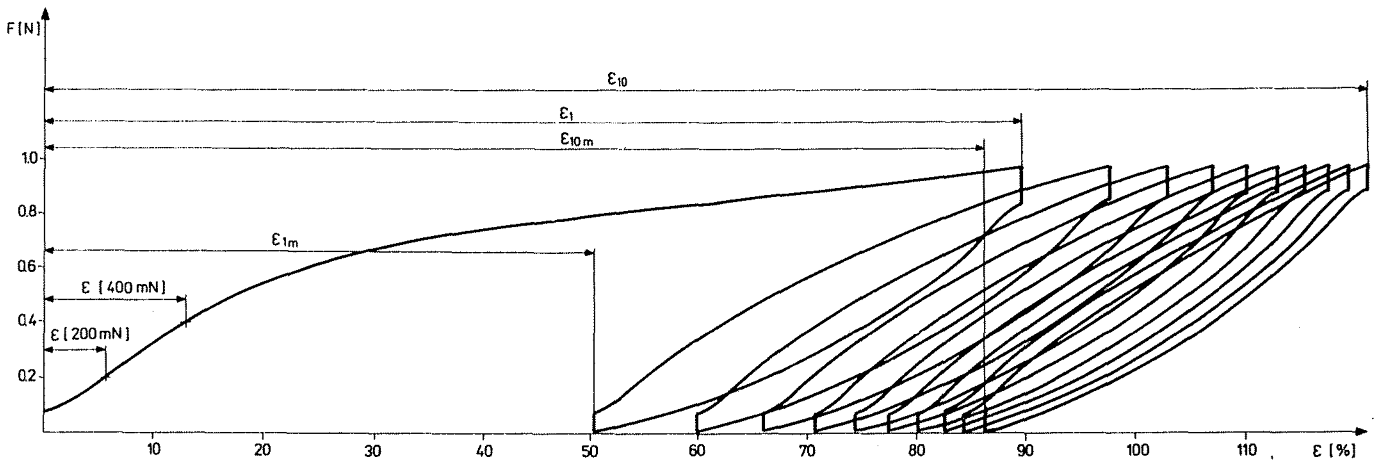


Fig. 12. Fatigue diagram of a yarn of high elongation

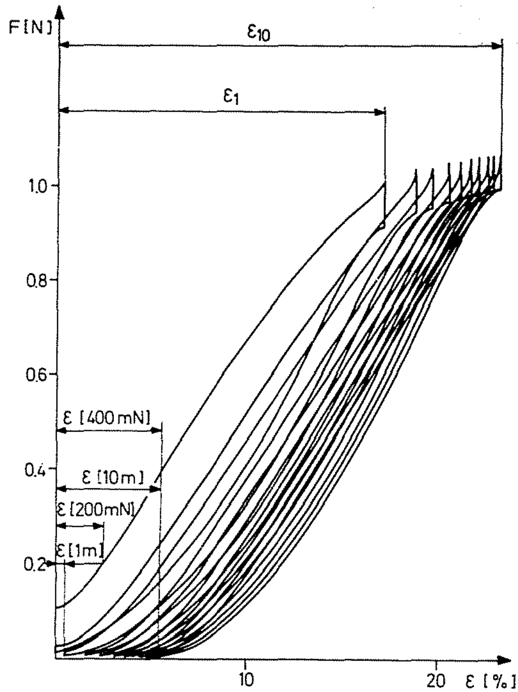


Fig. 13. Fatigue diagram of a yarn of low elongation

yarns (Fig. 8) a has been chosen as uniform upper limit load of 1 N in all the yarn fatigue tests. The tests consisted of 10 cycles, with perfect unloading after each cycle. 10 measurements were made on each bobbin.

The considerable deviations observed in the fatigue processes are shown in Figs 12 and 13 for yarns K and A, respectively.

Elongation values for different loading conditions and cycle numbers (Fig. 14) show that for identical loads the elongation values measured in the first cycle ($\varepsilon_{1(N)}$) are determinant for those after the tenth cycle ($\varepsilon_{10(1N)}$). (To ease comparison, measuring points belonging to different yarns have been connected; the dotted lines indicate that in the section between the points the diagram is not interpreted.) The almost parallel course of the lines shows the first cycle to be determinant. Clearly, elongation values in the first cycle vary by less than 15% — except yarn K (18–32% for the different yarns) and the total elongation values measured after the tenth cycle are, in general, by 25% higher, also for yarn K, than those after the first cycle.

Since elongations due to any force effect can be read off the diagrams, the influence of quite small loads on elongations have been compared. Elongation

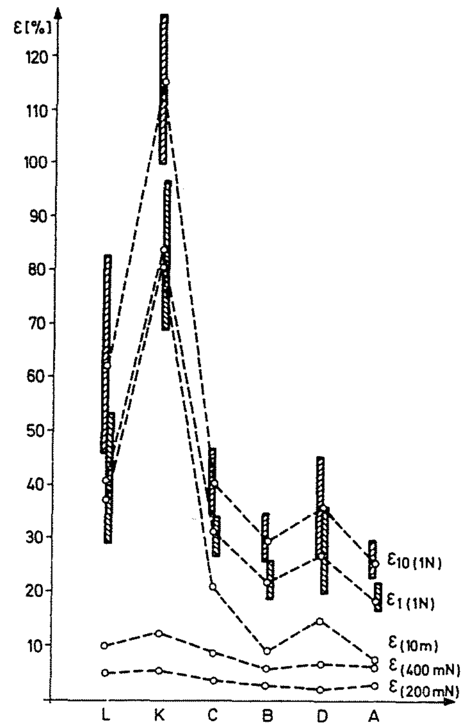


Fig. 14. Yarn elongation values

values measured in the first fatigue cycle with 200 mN load generally remain below 5%, and for 400 mN below 10%. (Also in these cases, the elongation of yarn K somewhat exceeds the given limits.) Under small loads the elongation values of different yarns show only quite minor deviations.

Analysis of the individual values shows the elongation tendency of the yarns to vary considerably also within each yarn type. The measured minima and maxima of ε_1 and ε_{10} are seen in Fig. 14. From among the yarns of almost identical mean elongation tendencies, hare wool yarn values ε_1 and ε_{10} vary the most, — one and a half times or twice as much as the other ones.

Yarn elasticity has been calculated as:

$$r = \frac{\varepsilon_{10} - \varepsilon_{10m}}{\varepsilon_{10}} 100\,(\%)$$

the difference between the total elongation measured after the tenth cycle (ε_{10}) and the residual elongation (ε_{10m}), i.e. the combined momentary and delayed elastic elongation components, referred to the total elongation. Also of yarn types of identical nominal count it can be said — also from the point of view of residual elongation — that the extent of total elongation in the first cycle is determinant, its 40–65% will be the residual elongation value after the tenth cycle. (The higher the ε_1 %, the higher its proportion transformed into residual elongation after the tenth cycle. This is valid also for the thinner yarn K of high elongation tendency, where the residual elongation almost equals the total elongation in the first cycle.)

The calculated values of yarn elasticity show exactly the reverse order of yarns (Fig. 15) as the elongation tendency: the yarns A, B of low extensibility are of the highest elasticity.

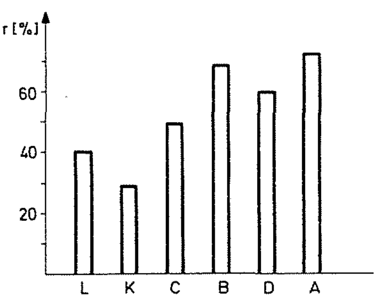


Fig. 15. Yarn elasticity

Resistance to bending

The flexibility of the yarns was measured on a test instrument developed at the Research Institute for Textile and Apparel Technic of the Technical University Dresden [14] during a study trip. The measurement principle consists in determining the force necessary for bending the clamped-in yarn by the inductive sensing of the deviation of a plate-spring or by using a strain gauge.

Figure 16 contains the measurement results. In view of the high scatter of the measured values, particularly of the enormous deviations between the lowest and highest bending force values, the results obtained can only be considered as informative, comparative data. Accordingly from the yarns tested, yarn K, showed the lowest resistance to bending this yarn — of low count — has, however, to be treated separately. From among the yarns of identical counts, yarn A is the stiffest, and yarns C and B the most flexible ones. (Again, this experiment could only affect one group of yarns.)

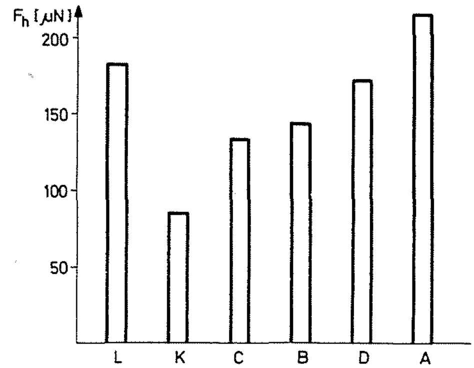


Fig. 16. Resistance to bending

Wear

The abrasion resistance of yarns may be expressed by the number of abrading cycles up to yarn break. The test was made in an instrument developed at the TKI (Research Institute for Textiles, Hungary). As abrading element a guide of a tricot machine was applied. The ultimate number of abrading cycles was chosen as test characteristic.

The measurement results are represented in Fig. 17. Tendencies to wear of different yarn types differ significantly. Variations may be significant even within one and the same yarn type in some cases (e.g. yarns B, H) by 200% about the average. Yarns of identical counts (Tex 14.3) can be divided into three classes of wear: the best is yarn B, the worst is yarn G, the others being in the mid-range, with a maximum deviation of as low as 60 cycles.

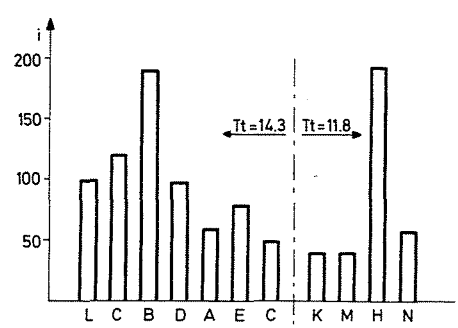


Fig. 17. Abrasion resistance

Relation between the measured yarn properties

One group of the yarn properties (irregularity, fault content, breaking force) primarily affect processibility, while the other characteristics tested (friction coefficient, extensibility, elasticity, bending and abrasion resistance) also affect the wearing and handling properties of the products.

Conclusions

— The distribution of mass irregularities in yarns (U%) is similar to that of the frequency of thin places.
— The numbers — even the maxima and minima — of thin places, thick places and naps follow a different order for each yarn type.
— The rate of mass irregularity is little influenced by yarn count.
— The distribution of fault content much more differs between yarn types than does the mass irregularity.
— Yarn grading systems (Uster, Classimat, Peyer) rank yarns differently according to fault contents, fault classes and mass irregularities. An exception is the fault class of the highest bulging excess for which the Classimat and Peyer systems give an almost identical yarn succession system.
— Yarn irregularity and breaking strength are in no random relation.
— The elongation tendency (the elongation caused by the same force effect, rather than the ultimate in almost the opposite value) ranks the yarns in almost the oppositive as the breaking force.
— Under identical stresses, yarn elongation and elasticity are in a strict (reversed) relation.
— Coefficient of friction, breaking force and elasticity do not determine separately the abrasion resistance of the yarn.

Influence of yarn properties on the number of knitting faults

Test yarns were industrially processed to fabrics by single-bed interlock knitting, — fabric 9 by interlock knitting, — on gauge 28, 30″ diameter, 48 feeds Textima and 72 feeds Jumberca interlock machines. The knitting faults in the fabrics produced at comparatively low (13–16 rev/min used in the knitting mill) are shown in Fig. 18 [15]. The monthly average of faults on 100 m^2 of fabric

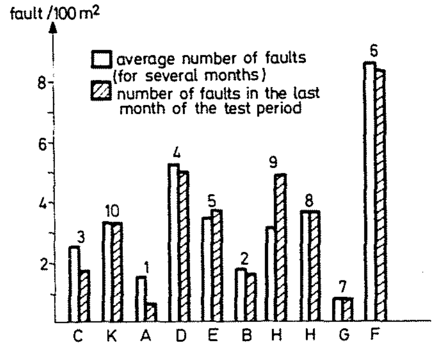


Fig. 18. Average number of knitting faults, and knitting faults in the last month of manufacture

surface, are shown in blank columns. Since in certain cases of introducing a new product, the monthly fault numbers do not vary around the average but gradually decrease with time, the fault data of the last evaluated month have also been indicated (shaded columns). Monthly fault contents of the tested fabrics show the number of faults in fabrics produced from yarns C and A (during the 7 to 9 months of observation period) to gradually and considerably decrease. For fabrics 5 and 8 also manufactured and observed during several months this tendency is absent. In our opinion, this phenomenon can be attributed to the variable yarn quality or/and to the empirical adjustment (or not) of knitting machine setting.

The quantity of faults — provided machine settings are correct — is influenced by yarn quality and fabric structure.

In general, the test fabrics were produced in single interlock knitting, except interlock fabric 8. Accordingly, only the number of faults reflects the influence of yarn quality and machine setting.

Out of the two yarn counts the lower grade ones (Tex 14.8, Nm 70) are closer to the optimum recommended in [9] as favourable for knitting (for 28 cut machines the knittability of the cotton-type yarn Tex 18.4 can be considered as the most favourable, within the range of Tex 14.8–22.8 yarns are easy to knit). Thus, the relatively high fault content of the fabrics knitted from yarns K and H, the highest after those made with hare wool, is also related with the yarn count (Tex 11.8, Nm 85), less adapted to machine gauge requirements.

From among the circular knitted fabrics made of yarn Tex 14.3, the fabrics 6 and 4 (containing yarns F and D) show excessively high fault content, followed by fabric 5 (knitted from yarn E).

There is a minimum number of faults in fabric 7 made of yarn G. Confronting this yarn order of succession with that of the measured different yarn properties the frequency of knitting faults agrees with the gradations of the Uster Classimat test for the frequencies of the highest thickness excess fault class (A4 + B4 + C4 + D4), and of the Peyer test for the thickest yarns (Table 1). This is also true for the other fabrics made of yarns Tex 14.3 (C, B, A) and of a low fault content in the range of 1.5 to 2.5/100 m^2.

Our test results have demonstrated no relationship to exist between mass irregularity (U%), number of thin places, naps (Figs 1 to 3) and the frequency of knitting faults. The same is true for the breaking force of yarns (Fig. 8) and for the coefficients of friction (Fig. 11).

For fabrics relatively easy to knit the number of faults, elongation tendency and the elasticity of yarns are of a similar order (of course only for fabrics ranked by yarn faults into the same range of knitting faults!). The fabrics with lower number of faults show a lower elongation tendency (Fig. 14) and higher elasticity (Fig. 15). The bending resistance is irrelevant for the frequency of processing faults (Fig. 16).

The fault frequency found in tests and the manufacturing experience of technicians are in good agreement: better yarn quality (uniform yarn thickness) is generally accompanied by bobbins of better quality. Hare wool fabrics of high fault numbers caused the multiple of usual needle breaks more winding faults, thus requiring more labour time in knitting; while fabric 7 produced at a low fault frequency from hare wool yarn was appreciated by the technicians: "no winding-off in advance of upper yarn layers from bobbins is necessary facilitating processing at less waste and fewer needle breaks than in knitting other yarns containing hare wool". (Remind that this yarn type contains only 15% of hare wool.)

From all these tests it follows unambiguously that the influence of yarn quality is the most decisive for the fault frequency. Within the limits of mill conditions — fabric type and density are of a light effect, after machine settings have been favourably adjusted (see lots processed at gradually improving fault frequency data in Fig. 18). It was found that from among the yarn properties, the number of thick places registered by the Uster-Classimat or the Peyer Digimat yarn grading is system in the closest relation to the frequency of knitting faults.

Thus, in order to achieve easy processing:

— in the case of the Uster Classimat test, the sum of faults in fault classes A4 + B4 + C4 + D4 should not exceed 10; while

— in the Peyer Digimat test, the number of faults in the thickness zone 8 × 20%, should not be higher then 200 (see Fig. 7).

The above limits could serve as grading levels in yarn acceptance tests and mills should require home spinners to supply yarns cleaned to such an extent (even if at some overcharge, since processing of yarns of improved quality increases significantly the output [16]).

Final conclusions and suggestions

The described research was spent on relating different properties of high-grade spun yarns, and on determining the yarn characteristic most influencing the processibility.

Investigations permitted to draw the following general conclusions:

1. The Uster test determining the mass irregularity of yarns ranks them according to the most frequent faults. In the case of fine count yarns this is proportional to the number (frequency) of thin places. Knitting faults and machine stillstands being caused by thickenings in yarns, bulge rather than by thin places, yarn grading by U% — for such thin yarns — does not agree with the order of knittability of yarns. Thus, in the count range of the yarns tested, the Uster unevenness measurements are inadvisable for yarn grading.

2. The results of the Uster Classimat (and also of the Peyerfil Digimat) yarn grading systems show a close relationship with the processing experiences and the knitting faults. Rather than by the total number of faults, knittability is affected by values in fault classes A4 + B4 + C4 + D4, indicating the frequency of the largest yarn thickenings (in the Digimat system the frequency of 8 × 20% thickenings). Accordingly, as yarn grading for predicting yarn knittability (or in complaints on yarn quality) indication of the number of faults in the class, of maximum registered by either of the above test methods is recommended.

3. On the basis of the yarn stock tested, the Uster-Classimat test gave 10 as combined fault limit in fault classes A4 + B4 + C4 + D4 for easily knittable yarns; same was a value below 200 in the fault class 8 × 20% according the Peyerfil Digimat test.

4. For processing yarns of lower grade than above in circular knitting machines, it appears expedient to purchase yarns cleaned to the extent suggested above. Other research [16] proved yarn price increases to be compensated by improved fabric quality and knitting efficiency.

5. Knittability is little affected by the breaking strength and the coefficient of friction of yarns compared the fault content — within the range measured for the yarns tested — thus they cannot be recommended to be tested as factors of yarn grading.

6. Since knitting faults can also be attributed causes of fabric structure and machine setting, we suggest to indicate optimum machine setting data (including height of the dial, knitted-in yarn length at 2–3 feeds, and setting of the fabric takedown spring) in the technology description of fabrics. Furthermore, it appears practical to regularly inform yarn inspectioners and yarn testers on the course of knitting faults.

7. Should it not require extra administration, it is suggested to file faults according to origin (faults, stillstands counted in special heading of blanks).

8. For determining the knittability of yarns it is suggested — in addition — to knit a fabric sample on a small-diameter, one-feed, yarn analyzer circular knitting machine. This method would consume few bobbins to determine how minor yarn faults — irregularities, actually not hindering the knitting process — would disturb the development of a uniform loop structure (fabric appearance), thus the fabric quality.

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