OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.1[illegible]/1[illegible]
[illegible] June 1972

ORIGINAL: ENGLISH

Expert Group Meeting on New Techniques
of Yarn and Fabric Production

Manchester, United Kingdom, 19 - 22 June 1972

OPEN-END SPINNING OF SHORT STAPLE FIBRES 1/

by

S. Kroužík
Chief of the Spinning Research Department
Cotton Industry Research Institute
Ústí nad Orlicí, Czechoslovakia

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has been reproduced without formal editing.

id.72-3812

Contents

1. Introduction

The process of break-spinning, or open-end spinning, as a result the research efforts to increase spinning productivity, has made a true impact on the fibre-to-yarn conversion technology. An extraordinary feature of this process is that the open-end spinning machine is used in lieu of the ring spinning frame which has always been the most critical link in staple yarn production influencing the rest of the spinning machinery. For this reason, an increase in production rate at this stage is far more important than any output rise in the preceding operations. At the ITMA International Textile Machinery Exhibition in Paris in 1971, open-end spinning as a new progressive technology dominated the field of spinning. The exhibited thirteen machines based on open-end principle were a clear answer to all the pessimistic views forecasting commercial utilization of this system not sooner than after 15 years or more. Nowadays, there is no doubt that ring spinning, which played a dignified part in the mule spinning era and which has been gradually improving for more than eighty years, is retreating despite the endeavour of machine designers to retain its position.

2. Processability of various cotton varieties in open-end spinning

Before dealing with the applicability of cotton varieties to open-end spinning, I should like first to mention the effect of cotton fibre properties on the spinning performance.

2.1 Factors determining the cotton spinnability

The main factors determining the cotton spinnability on conventional systems are: fibre length, fineness and strength. The above factors are interrelated as follows:

(i) the longer the fibres, the finer yarns can be made,
(ii) the finer the fibres, the finer yarns can be made,
(iii) the stronger the fibres, the stronger yarns can be made.

In the light of the above rules it is evident that the best results can be obtained with long, fine and strong cotton fibres. However, from the viewpoint of economy such fibres cannot always be used.

With conventional spinning, another rule specifies that the number of individual fibres in a yarn cross-section should be at least 80 fibres if good performance of the ring spinner and satisfactory yarn strengths are to be secured. In the case open-end spinning, at least 10 individual fibres in a yarn cross-section are recommended. This is as yet prerequisite because of the high bulkiness of open-end spun yarns. The open-end yarn is formed on the principle of twisting a ribbon of fibres under a low tension. This inevitably results in an increase of the yarns bulkiness which in turn is the reason for decreased yarn strength.

Making use of our experience the factors influencing the spinnability of different cotton varieties could be classified as follows.

Open-end spun yarns are weaker than the yarns spun on conventional systems. For the time being this has to be tolerated and instead an effort should be made to make the best of the advantageous properties, such as the increased bulkiness and excellent yarn regularity, in particular end-products. However, there is a possibility to improve the yarn strength to some extent by selecting convenient types of cotton.

From investigations and practical experiance with using various types of cotton it has been found that the fibre strength does not affect the open-end spun yarn to the same extent as in the case of ring-spun yarns. On the other hand, the effect of fineness is more distinct. Since strength is the critical property of open-end yarns, any feasible ways to improve it are investigated. Some basic properties of cotton fibres are correlated with the twist and strength of open-end spun yarns in Table 1.

Table 1

Cotton type	Staple length in.	Fineness Micronair	Fineness Nm	Strength PI	Tenacity g	Breaking length km	Cotton yarn count	Twist t.p.i.	Breaking length km
Ashmouni Atuit	1 1/16"	4.4	5,800	87	4.2	24.5	30	26.2	10.2
Turkey, Adana	1 1/32"	3.9	6,500	78	3.15	20.4	30	26.2	10.6
Akala	1 1/16"	4.6	5,500	82	3.9	21.1	30	26.2	10.0
Orleans, Texas	1 1/16"	4.9	5,250	80	4.0	20.8	30	26.2	9.8
Mexico	1 1/32"	4.6	5,500	80	3.8	20.8	30	26.2	9.7
Iraq	1 1/16"	4.1	6,200	85	3.8	23.1	30	26.2	10.9
Iran	1 1/16"	4.8	5,300	78	3.6	19.6	30	26.2	9.7
Pakistan NT	1 1/16"	4.5	5,600	87	4.5	25.0	30	26.2	10.2
289 F	1 1/16"	4.5	5,500	92	5.0	27.0	30	26.2	10.2
Syria	1 1/32"	4.4	5,750	83	3.8	21.6	30	25.2	10.1
Greece	1 1/32"	4.2	6,000	66	4.0	24.0	30	26.2	11.0
USSR 1st grade	1 1/32"	5.4	4,700	83	4.4	20.7	30	26.2	9.0
2nd grade	1 1/32"	4.7	5,500	78	3.6	19.8	30	25.2	10.2
3rd grade	1 1/32"	4.1	6,200	77	3.1	19.2	30	26.2	10.5
4th grade	1 1/32"	3.6	7,000	74	2.5	17.5	30	26.2	9.8

From the data in Table 1 the following conclusions can be drawn:

- Fibre fineness affects the yarn strength considerably. The finer the fibres, the more fibres contribute to increasing the yarn strength.
- Fibre strength influences the yarn strength to a low degree.
- In order to obtain comparable results, various kinds of cotton of nearly the same staple length were purposefully spun into yarns of the same count and twist.
- Some of the results were derived from rather small fibre lots (approx. 300 kilos) particularly if cotton had been supplied for trials by foreign manufacturers.

2.2 Effect of staple length on the yarn twist

The twist rate of open-end spun yarns is influenced by staple length in a similar manner as in the case of the ring spinning. A specific feature of open-end spinning is the effect of cotton cleanliness on the end-breakage rate. By varying the twist factor the breakage rate can be controlled to some extent. Since open-end spun yarns require higher twist than common ring-spun yarns, it is advisable to keep the twist as low as possible. With cotton fibres properly cleaned the optimum twist rates for various cotton types can be calculated from the expression

$$\text{Twist (turns per in.)} = \alpha \sqrt[3]{\text{cotton count}^2}$$

using the coefficients from Table 2.

Table 2

staple length in.	effective length mm.	twist coefficient α
7/8	24.7	3.07
15/16	26.4	2.90
31/32	27.2	2.84
1	28.3	2.78
1 1/32	29.0	2.70

1 1/16	30.0	2.65
1 1/8	31.7	2.55
1 1/4	35.2	2.42

In addition, fibre length also affects the yarn count range. In determining the fibre length suited for particular yarn count, the same rules can be applied as for conventional spinning.

Also other cotton characteristics, such as the percentage of short fibres, staple length distribution (dispersion of length in %) and cotton maturity, influence the quality of open-end yarns. Cotton maturity is partly included in the PI Pressley index and the percentage of short fibres is of negligible importance. For this reason the effect of these factors has been excluded.

3. Characteristics of the open-end spun yarns

Open-end spun yarns differ from ring spun yarns in some properties which should be borne in mind in further processing and in designing new end-uses. It should also be realized that new acceptance specifications will have to be approved for open-end yarns. Already at the development stage of open-end spinning, large scale trials of open-end yarns in comparison with ring spun yarns were carried out. The properties of open-end yarns should be known in order to achieve higher productivity. This is why the decisive mechanical and physical properties of the yarns will be reviewed.

- Cotton open-end yarns have about 15 - 25% lower strength than the corresponding ring spun yarns. The lower limit of the range, i.e. 15%, applies to coarser yarns up to 25 tex (40 metric count); with finer yarns the strength decrease of 20 - 25% applies. The decreased yarn strength has no detrimental effect on the breakage rate in subsequent processing. Although the strength of open-end yarns is lower, the variation of strength is reduced and, as proved by bulk trials, this helps in increasing the productivity. The strength decrease of fabrics is proportional to that of open-end yarns. However, the fabric strength can be improved by the fabric construction (sett, weave, yarn count, etc.).

- The mean twist of open-end yarns is 10 - 15 % higher than with conventional yarns. It is recommended to set the twist e.g. by moistening the yarns to the commercial regain or, exceptionally with weft yarns, by steaming. The cheapest setting consists in storing the yarns three days in a conditioned room.
- Excellent yarn uniformity is a feature of open-end yarns. The recurrent thick and thin places, responsible for the unsettled appearance of the fabrics made from carded ring spun yarns, occur in open-end yarns to a fairly low degree. It has been found, using the Uster evenness tester, that the deviation of open-end yarns is in the range of 10 - 14 % so that O.E. yarns are superior even to some combed cotton yarns in this respect.
- On visual inspection, less bolls are found in open-end yarns as compared with ring spun yarns made of the same cotton lot.
- The absolute elongation at break of the yarns is higher by 1.5 - 2.0 %, particularly with coarser yarns up to 34 metric count. In the case of finer yarns this effect is less distinct. The higher elongation at break is very important in subsequent processing.
- The yarns are about 10 to 15 % bulkier than ring spun yarns.
- Heat-insulating properties of the yarns are improved by 10 - 15 %.
- The yarn hairiness is 30 - 60 % lower because of the higher fibre entaglement in the yarn core.
- The yarns exhibit up to 30 % higher abrasion resistance because the fibres are better anchored and the yarn surface is less susceptible to abrasion than that of ring spun yarns.

- The yarn affinity to dyes is high.
- The yarn count variation is lower (up to 1 %).
- The yarns have a decreased number of thick and thin places and of neps.

During spinning the yarns are wound on flat cheeses 210 - 230 mm. in diameter. The package weight ranges from 1.25 to 1.50 kg. Because of the increased amount of yarn on the cheeses, thread piecing in pirn winding is not so frequent as with ring spun yarns. The actual reduction in the piecing rate is 15 - 17 knots per kilo of yarn. This is particularly important for some sophisticated end-uses, the quality of which is endangered by a high number of knots.

In unwinding any further twist insertion should be avoided. For this reason the cheese top is usually marked in order to prevent misplacement.

It is known that yarns are permanently under stress in the course of weaving. Although exhibiting higher initial elongation, open-end spun yarns lose their extensibility more readily as compared with ring spun yarns because of the different structural configuration. Pilot plant trials and bulk trials have shown the importance of keeping the yarn elongation unaltered during the warp preparation, and in particular during the sizing, since it has a decisive effect not only on the processing performance but also on the fabric strength. During processing the yarns should not be braked or strained exceedingly.

It is of advantage to employ sizing machines with easy to control of the warp tension. The yarn tension should be kept at minimum mainly between the yarn dip and the first drying drum. By meeting this condition, good performance of open-end yarns in weaving is secured.

4. Experience from processing open-end spun yarns

4.1 Pirn winding

It is convenient to perform this operation at 65 - 70 % R.H.

and at temperatures 20 - 23°C. Individual spinning lots are recommended to be processed separately. The cheeses should be equipped with inserts in order to prevent their movements (similar as in warping). In the course of pirn winding the yarn should be drawn-off centrally. If in unwinding the yarn is drawn over the edge of the cheese, the breakage rate would increase.

It is also needed to maintain a uniform, rather low yarn tension. In pirn winding disc tensioners with adjustable pressure and compensating tensioners of various types are frequently used.

The maximum yarn tension after tensioning and maximum specific package weights are given in Table 3.

Table 3

yarn count	maximum tension g	max. specific package weight g/cm^3
50 tex - 35 tex (20 - 40 metric count)	90-60	0.39-0.40
24 tex - 20 tex (42 - 50 metric count)	55-45	0.41-0.43
19 tex - 17 tex (52 - 60 metric count)	up to 40	0.44-0.46

4.2 Warping

If the regain of open-end spun yarns is below the commercial value (8.5 %), it is recommended to store the yarns for at least three days in a conditioned room before warping. The warping is then done at 70 % R.H. and at temperatures 20 - 23°C.

With cotton yarns beam warping is most widely used. The pitch of the creel pins is 260 mm.

Using flat cheeses, the open-end yarn can be warped directly from the spinning packages without any rewinding and clearing, if the yarn end-breakage rate is at a commercially acceptable level, i.e. for instance 50 - 70 end-breakages per 1,000 spinning heads per hour with 20 tex (50 metric count) yarns made of medium length cotton. In addition, the yarn breaking length of the 20 tex cotton yarns should be over 9 km.

The yarns are wound onto 210-230 mm. dia. flat cheeses weighing 1.25 - 1.50 kilos.

In spinning, open-end spun yarns are wound onto tubes with outside and inside diameters 55 mm. and 50 mm., respectively. Special inserts should be used to secure firm creeling of the cheeses. It is necessary to adapt the cheese position so that the yarns are fed right into the centre of the guide. The inserts are also provided with pins to accomodate both ordinary and open-end yarn bobbins in warping.

There are many reasons for using flat cheeses which have a unique behaviour in unwinding. Yarns can be wound off in a normal mode or over the cheese head without being abraded by the package body as the width of the flat cheese is half of the cone width. Flat cheeses can be virtually employed almost in all machines and due to favourable tension conditions in unwinding they are particularly suited for high-speed drawing-off. The package layers show no tendency to slip off in warping.

The lift ranging from 80 to 90 mm. is fully satisfactory.

Because of the increased ballooning during the warping, the recommended distance between the bobbin rear end and the creel guide is about 150 mm. The shape of flat cheese provides better drawing-off than that of a cone; also maximum and mean balloon diameters and potential energy of the ballooning of the flat cheese is preferable to the cone. Taking into account the balloon size, warping speeds in the region of 600 - 800 m/min. are most convenient with cheeses of 150 -

210 mm. in diameter. Using the yarns wound on perforated dye bobbins it is recommended to reduce the warping speed by about 20 %.

Open-end yarns are "lively" and tend to slip off of common open tensioners. Capstan type of tensioners, such as those made by the Benninger Co., will do better job.

In warping the tension of single and plied yarns leaving the tensioner should be 10 - 12 g and 13 - 16 g, respectively. Single yarns are recommended to wind on warp beams at a density of 0.40 - 0.45 g/cu.cm. The package density of dye beams should be 0.30 - 0.32 g/cu. cm.

The beam should be adequately wider than the reed. In this respect the following sizes are applicable:

warp beam length	reed width	finished fabric width
180 cm	171 cm	150 cm
165 - 170 cm	160 cm	140 cm
110 - 115 cm	106 cm	90 cm

If the above recommendations are met, the quality of warping is satisfactory and the breakage rates are ususally lower than those of comparable ring spun yarns.

4.3 Sizing

The essential purpose of this process is to deposit a thin protective film onto the surface of warp yarns in order to prevent excessive mechanical strains in the yarns in the course of weaving. At the same time protruding fibre ends are cemented to the yarn body and the yarns become smoother. As a result, fibres of adjacent yarns are prevented from getting entangled. This secures an improved weaving performance.

As open-end spun yarns are bulkier and of a different structure, the sizing bath penetrates into them easily making them stronger. Depending on yarns count, the strength increase is in the region of 30 - 40 %, which is 5 - 10 % more than with corresponding ring spun yarns.

Although common starches still predominate, some starch modifications are suited better because they give low-viscous solutions which penetrate between yarn fibres more readily. As a result, the yarns acquire improved strength and abrasion resistance. It is also of advantage that modified starches have no adverse effects on the yarn flexibility. In addition, the solutions are easy to squeeze-off in sizing and easy to remove in scouring. The sizing speed can be increased by nearly 30 %.

The size preparation is simple since the modified starches are soluble in water at 70 - 75°C. For sizing yarns containing polyester fibres, oxidized starch "Special" with polyvinylalcohol is used.

Size preparation:
The oxidized starch is first dissolved in cold water in a tank of the agitator type, and then added suitable agents, such as lubricants and adhesives. After thorough stirring the bath is heated to 75°C and stirred for further 20 - 25 minutes. The size concentration is checked with the aid of a refractometer.

Warp waxing

Yarn smoothness can be improved by waxing with a wax which is readily removable in scouring. The wax in the form of a melt is applied onto the dried warp before it enters the splitting section by means of a licking roller rotating slowly in the direction of the warp movement. An alternative method is the so-called "smoothing the warp by warp" using a device located behind the sizing trough.

With sized open-end warps that have not been smoothed, the actual capacity of the warp beam is about one twelfth lower than with ring spun yarns. This is due to the higher bulkiness of open-end spun yarns.

Sizing of open-end yarns on a 9-drum Zucker slasher

Yarn count : 25 tex (40 metric count)

Sett : 280 ends per 10 cm.

Number of drums : 9

Temperature:

1^{st}	drum	105°C
2^{nd}	drum	105°C
3^{rd}	drum	98°C
4^{th}	drum	96°C
5^{th}	drum	86°C
6^{th}	drum	86°C
7^{th}	drum	83°C
8^{th}	drum	83°C
9^{th}	drum	to 50°C

Warp extension : max. 1 %

Sizing agent : oxidized starch

Bath temperature : 72 - 75°C

Squeeze pressure : 1^{st} pair of rollers - 340-450 kg

2^{nd} pair of rollers - 340-500 kg

Warp moisture content : 9.5 %

Recommended size add-on:

- 6 % for 84 - 56 tex (12 - 18 metric count) yarns
- 7 % for 50 - 34 tex (20 - 30 metric count) yarns
- 8 % for 30 - 23 tex (34 - 44 metric count) yarns
- 9 % for 21 - 17 tex (48 - 60 metric count) yarns

Sizing conditions for open-end spun yarns

The size concentration should be 25 - 30 % lower than normal (savings in the starch consumption). This less viscous solution can easily penetrate into yarns so that the yarns are also sized inside. Most convenient concentrations of the sizing bath, as controlled by refractometer, is in the region of 6.5 - 7.5.

It is recommended to increase the ratio of fatty substances by 30 % in order to reduce yarn stiffness. The warp should be split when wet by means of a 1/1 lease.

In sizing open-end yarns, both chamber and drum sizing machines can be employed. With the Sucker drum sizer the speed of 90 - 100 m/min. and minimum breakage rates are attainable.

As an example the following bath compositions are listed:

open-end yarns	ring spun yarns
6.0 kg modified starch	8.0 kg modified starch
0.08 kg Molian	0.50 kg dextrin
0.08 kg tallow	0.06 kg Molian
0.25 l glycerol	0.06 kg tallow
	0.26 l glycerol
per 100 l	per 100 l

Note: The above bath compositions were used in the production of cotton linings from 30 tex yarns with the sett of 210/210.

1.4 Drawing-in

Warps from open-end spun yarns can be drawn-in using the same number of shafts and common healds as with corresponding ring spun yarns. The reed should be smooth to enable double-end draft per dent, thus eliminating reed marks in the fabrics and minimizing the yarn abrasion.

1.5 Twist setting

The twist of open-end spun yarns is 10 to 15 % higher than that of common ring spun yarns and makes consequently the yarns "lively" in processing. There are several methods for stabilizing the twist :

1/ Moistening the yarns to commercial regain (the regain of cotton is 8.5 %) using a hygroscopic mixture, such as the following:

1.5 kg Formalin	per 150 l
3.0 kg Neokal EX	
1.5 kg sulphuric acid	

This mixture is diluted 1:10 for use.

Open-end yarns [illegible] r [illegible] recommended climatic conditions, i.e. 21 - 23°C and 65 - [illegible] moisture regain [illegible] 4.7 - 5. [illegible] additional moistening to [illegible] 8.5 % [illegible] cotton [illegible].

2/ Storing the yarns [illegible] in a conditioned room. This sophisticated method is the cheapest.

3/ Steaming is another feasible alternative. It has been found that yarns can be steamed when wound onto perforated metal tubes directly from spinning. The tubes also prevent shifting of the yarns. On the basis of wide trials steaming for 5 - 8 minutes at 1.5 - 2.0 atm. is recommended.

Uneven yarn steaming might result in faults in subsequent treatments (weft barriness after piece dyeing, skittery dyeing). Good steaming can be achieved by using automatic vacuum steamers thus eliminating possible human errors. In this instance it is sufficient to steam open-end yarns of medium counts for 5 minutes.

4.6 Weaving

The recommended climatic conditions are: 21 - 23°C and 74 - 78 % R.H.

Open-end yarns have been commercially woven on a variety of weaving machines.

It should be realized that it is the fabric elongation and elasticity which are two of the most important properties from the viewpoint of weaving. In addition to yarn properties it is the fabric construction that effects the elongation as well as other properties of the fabric. In yarn preparation and in weaving in particular, the textile materials undergo certain structural changes which depend also on the fibre arrangement in the yarns.

With open-end spun yarns the weaving conditions should be prepared carefully. A particular attention should be paid to yarn preparation and sizing, taking care that the yarns are not unduly strained. In the weaving itself it is of importance to work at low to medium warp tensions; excessive tension should always be avoided.

As far as the weft is concerned, the yarn must be rewound when automatic shuttle looms are employed, whereas with air jet looms and gripper looms (such as the Sultzer loom) the weft can be supplied directly from the flat cheeses from spinning machines.

Excellent results were obtained with the P-105 air jet looms at the speed of 400 - 440 picks per minute. Due to the high uniformity of open-end yarns the weft yarn deceleration was more reproducible and the pick metering more exact than normal. Also the uniformity of fabric selvedges was improved.

In the weaving of fabrics with very dense setts (upholstery fabrics) the Sultzer gripper looms proved to be very successful.

In the weaving of pile fabrics the breakage rate, particularly that of the weft, was found substantially lower than in the case of ring spun yarns.

Bulk trials with open-end yarns in Czechoslovakia and other countries have confirmed that if the technological conditions established by the Cotton Industry Research Institute are met, very good results can be obtained at all the processing stages. In general it may be noted that open-end yarns usually show 15 - 20 % lower breakage rate in weaving both in warp and weft than corresponding ring spun yarns.

1.7 <u>An example of the processing of open-end spun yarns</u>

In the below example both open-end- and ring spun yarns were made from the same cotton type. Also the preparation to weaving and finishing were carried out on the same machines.

Manufacture of the [illegible] shirting fabric

A 10,000 m of the [illegible] shirting fabric have been produced on a commercial scale.

Basic data:

Reed width :	104 cm
Grey width :	99 cm
Finished width :	90 cm
Sett per 10 cm (grey)	2[illegible]4/304
Sett per 10 cm (finished)	296/292

Yarns : warp 20 tex (50 metric count) - 100 % cotton RI
weft 20 tex (50 metric count) - 100 % cotton RI

In weaving the F 44 automatic shuttle looms operating at 190 revs. per minute were employed.

Finishing: singeing, desizing, mercerizing, chlorinating, acidifying, scouring, resin treatment, calendering and making-up.

Control analysis of the RI cotton

Maximum length, mm	33.0
Effective length, mm	30.3
Low effective length, mm	24.5
Length variation, %	19.4
Short fibres, %	13.48
Medium fibre length, mm	26.8
Mature fibres, %	88.83
Semimature fibres, %	7.53
Dead fibres, %	3.64
Maturity coefficient	2.80
Class	I
Fineness	0.224 tex (4.464 metric count)
Dry strength, g	6.07

Shirley analyzer

Sample weight, g	100
Clean cotton content, g	96.50
Fibre loss, g	3.50
Dust, %	-
No. of neps per g	45
No. of shales per g	95
Weight of shales, mg	1.10

Variation in strength, % 34.32
Breaking length, km 27.10

Mechanical properties of the 20 tex (50 metric count) open-end spun yarns and ring spun yarns are summarized in Table 4.

Sizing conditions

Machine : Sucker SMT chamber slasher
Warp length, m : 1,350
No. of warp beams : 6
Speed, m/min. : 60
Warp elongation, % : 0.1
Controlled moisture content of the warp, % : 10
Squeezing pressure, kg : 500
Size composition : 8.0 kg modified starch
0.14 kg kolian
0.14 kg tallow
0.25 l glycerol
per 100 l

Size concentration, % : 7.4

As the size was of rather low viscosity the warp was easy to dry so that some drying fans could be shut off. The sized warp was pliable, flexible, not overdried and easy to weave. The sized open-end yarns showed a strength increase of 32 % compared with 20 % for the corresponding ring spun yarns.

Pirn winding

Pirn winder HACOBA
Speed, m/min. : 270

	open-end yarn	ring spun yarn
Workload per operator :	72 spindles	72 spindles
Breakage rate:	some 20 % lower with O.E. yarns	

Table 4 - Mechanical and physical properties of the 20 tex (50 metric count) open-end and ring spun yarns; 100% cotton RI

property	open-end yarn	ring spun yarn
Mean count, tex	19.45	19.40
Mean count, metric	51.40	51.40
Count variation, %	1.65	2.04
Mean twist per metre	1069	811
Twist variation, %	2.1	3.1
Strength, g	181.1	212.65
Strength variation, %	10.5	8.82
Elongation at break, %	9.65	3.37
Breaking length, km	9.30	10.93
Max. strength, p	294	276
Min. strength, p	136	124
Total difference in strength, %	87.1	71.47
Unevenness, USTER model B	12.74	15.10

Table 5 - Mechanical and physical properties of the comparable MERKUR shirtings - standard No. 15

property	grey fabric		finished fabric	
	open-end yarn	ring spun yarn	open-end yarn	ring spun yarn
Warp sett per 10 cm.	274	275	296	296
Weft sett per 10 cm.	304	304	292	292
Weight per sq.m, g	123.30	122.78	116.37	114.97
Width, cm	98.5	98.7	90.2	90.1
Warp yarn count, tex	20.0	22.0	17.48	18.26
Weft yarn count, tex	19.80	20.30	20.24	20.70
Warp strength (dry), kg	33.80	38.40	33.0	37.1
Weft strength (dry), kg	37.3	42.6	32.0	41.3

Elongation in warp, %	12.8	12.2	4.3	4.1
Elongation in weft, %	15.1	14.7	18.5	16.8
Warp strength (wet), kg	37.6	43.6	36.7	45.9
Weft strength (wet), kg	44.3	50.7	33.1	41.1
Elongation in warp (wet), %	19.3	19.1	6.2	6.2
Elongation in weft (wet), %	19.7	19.1	31.9	30.3
Abrasion resistance, 100 g load, cycles	228	164	169.4	100.4
Shrinkage at 100°C, warp, %	6.8	7.4	-	-
Shrinkage at 90°C, warp, %	-	-	1.6	1.2
Shrinkage at 100°C, weft, %	7.0	5.2	-	-
Shrinkage at 90°C, weft, %	-	-	3.4	3.4

<u>Weaving</u>

F 41 automatic shuttle looms	open-end yarn	ring spun yarn
Picks per minute	190	190
Breakage rate per 10,000 picks		
Warp breakage rate :	some 30 % lower than with ring spun yarns	
Warp contraction, %	7.9	7.5
Weaver loading, no. of looms	24	24
Dustiness :	approx. 30 % lower than with ring spun yarns	
Quality of grey fabric :	on average 10 faults per 100 m	on average 14 faults per 100 m

The above evaluation indicates that in all the processes the breakage rate of open-end yarns was distinctly below that of ring spun yarns.

Already in the grey state more settled appearance and freedom from interferring thick yarn places could be found in the fabric made of open-end yarns. Also the fabric cover was satisfactory.

Mechanical and physical properties of both the grey and finished fabrics are compared in Table 8. As the fabric setts exactly correspond to the standard, a comparison of the two fabrics is justified.

5. End-uses of open-end spun yarns

Open-end spun yarns can be used in a wide range of fabrics that are characteristic of pleasing appearance and loftiness of handle. The fabrics are noted for a high degree of usage value which can be advantageously utilized in the ready-made clothes of high quality.

It may be emphasized that for a given count of both warp and weft yarns the appearance and handle are evidently in favour of the fabrics made from open-end yarns in majority of instances. As far as the fabric appearance is concerned, the O.E. yarns can successfully compete even with cotton combed yarns.

When considering suitable applications, the fabrics requiring yarns of high regularity are the natural choice; however, in designing the fabrics the bulkiness of O.E. yarns should be taken into account.

Czechoslovak and foreign cloth manufacturers have already produced a large amount (tens of million meters) of various fabrics from open-end yarns. It has been confirmed that applications of particular suitability include loop terry fabrics, shirtings, handkerchiefs, damasks, printed fabrics, pile fabrics (such as corduroy, velvets, etc.) and, shortly, all the fabrics that should have full handle and high degree of evenness.

The following are some of the suitable outlets:

Yarn-dyed, piece-dyed and printed dress cloths. In addition to high usage value the fabrics are characteristic of bright dyeings (due to the different yarn structure). A wide range of the printed fabrics currently produced on a large scale are of particular interest.

Medium sett shirtings. The fabric pattern is even and plain. The shirts are comfortable to wear.

Bed sheetings. The fabrics have settled appearance and pleasing handle. They are smooth, airy and easy to launder.

Bed tickings. Open-end yarns have been also successfully employed in thi application.

Diaper fabrics. Bleached diaper cloths are soft and supple.

Loop (terry) fabrics. The fabrics are characteristic of settled appearance due to the loop regularity and, if dyed, of bright shades.

Pile fabrics. The fabrics are easy to cut or raised; their appearance is excellent. The range of applications can be further extended.

Apparel fabrics - medium coarse coatings. The fabrics exhibit pleasing handle and improved appearance resulting from the high yarn regularity. Yarn count of (30 + 30) tex to (25 + 25) tex proved to be suited for this purpose.

Flannels. The fabrics have pleasing handle. The raised surface is uniform; no extra rounds are needed during raising.

Lining fabrics. In this application field the advantage of employing O.E. yarns for semisilk linings should be stressed.

Twills. The fabrics have settled and smooth appearance.

Technical fabrics. There are many applications in this area. Open-end yarns are particularly suited for the fabrics, the surface of which should be smooth (e.g. fabrics for rubber coating). Other suitable outlets are the tent and canvas fabrics. The fabrics have adequate abrasion resistance and high degree of evenness.

Airy dress cloths (laces), gauze fabrics and curtain fabrics.

These fabrics represent another important group of end-uses characteristic of improved appearance resulting from the freedom of thick yarn places.

A potential field of applications is in the production of tape, braid and similar narrow fabrics where cotton combed yarns are still mostly preferred because of their regularity.

Crochet and hand knitting yarns belong to another feasible applications.

The quality of open-end yarns is high enough not only for almost the whole range of fabrics made of carded yarns but also for some kinds of fabrics produced from combed yarns. In deciding a suitable application, the important characteristics of open-end yarns, i.e. bulkiness, abrasion resistance, etc., should be taken into account and optimum fabric construction found. A mere replacement of conventional yarns in the construction cannot be recommended.

6. Properties of the fabrics made from open-end spun yarns

Dyeing and finishing treatments of the fabrics containing O.E. yarns are generally similar to those of fabrics from ring spun yarns. However, as a result of the different structure of O.E yarns, the fabrics have brighter colour shades, this being particularly appreciated with prints.

Fabric strength

The strength of fabrics is proportional to that of yarns, and in the case of open-end yarns it means some 15 - 25% lower strength as compared with fabrics from ring spun yarns. However, the strength can be partly improved by suitable fabric construction (weave, sett and yarn count).

Crease-resistant and wash-wear treatments

It is known that resin treated cotton fabrics made of conventional yarns lose some 30 - 40 % of their initial strength. The same applies for the fabrics from open-end spun yarns.

Shrinkage of finished fabrics

The shrinkage of fabrics with a dense sett in both warp and weft is comparable to that of conventional fabrics. With loosely sett fabrics, however, the shrinkage is about 0.5 - 1.0 % higher.

Fabric appearance

Because of low occurance of neps in the yarns, the fabric appearance is more settled. The fabric surface is closed and, therefore, smooth.

Mercerizing

It is caused by the different fibre configuration that mercerized fabrics from O.E. yarns are about 5 % less lustrous than conventional fabrics treated under the same conditions. This appears in bed sheets, shirtings and similar fabrics.

Abrasion resistance

Since the abrasion resistance is of extraordinary importance to fabrics, it has been tested thoroughly indeed. The tests carried out on a wide range of cotton fabrics have confirmed that fabrics made from open-end yarns are superior in this respect, being on the average 20 - 30 % more resistant than corresponding fabrics from ring spun yarns; it may be noted that in some instances this improvement is even more distinct. The above values apply for both grey and finished fabrics.

Raising

It is of advantage that fabrics from open-end yarns are easier to raise, obviously because of not too strong twist on the yarn surface. As a result, the raised fabric is less damaged, retaining more residual strength. The pile is uniform and free from cloudiness. The same number of round is usually required, although in some instances 1 - 2 rounds less than with common fabrics are sufficient.

Yarn shift

Having the different fibre configuration, open-end yarns show about 4 % higher resistance to the yarn shifting in fabrics than conventional yarns.

Crease-resistance

In general, there is no significant difference in crease-resistance of the fabrics. However, results from the Monsanto test based on visual comparison with standards, indicate that resin treated fabrics containing open-end yarns are slightly superior in this respect.

Fabric handle

As far as the handle is concerned, it may be shortly noted that there is usually no difference between the finished fabrics from open-end yarns and the corresponding fabrics made of ring spun yarns.

Covering capacity

The covering capacity of fabrics from rather coarse open-end yarns is high but with some fabrics composed of fine yarns the results are not as good as that, the latter being also confirmed by the air-permeability testing. This can be caused by the decreased yarn hairiness, differences in the warp sett, fan-shaped reed, etc.

7. Conclusions

The first part of the lecture was aimed at evaluating the processing behaviour of various cotton types in open-end spinning. According to the analysis it appears that cotton fibres for open-end spinning should meet the following requirements:

- fibre fineness should not be lower than 5,800 metric count, i.e. 4.8 in terms of the Micronaire value, in order to obtain the yarn strength required for general uses.

- The allowable degree of impurities in cotton depends on the cleaning power of blowing and carding machines. Good performance of spinning machines depends on the sliver cleanliness or on the use of cleaning device co-operating with the combing rollers of the spinning machine for removing in the course of fibre separation all the impurities which may cause end-breakages.
- All the cotton types of a mean or of higher maturity rating containing not more than 10 % impurities and of fibre fineness above 5,300 metric count (i.e. below 4.8 in terms of the Micronaire value) are suitable for open-end spinning. The use of coarser or immature cotton fibres results in deteriorated yarn strength.

- When evaluating the results obtained in commercial production and further processing of O.E. yarns it will be found that those yarns have wide application in the textile yarns processing industry. At present such break spun yarns are mostly used for terry fabrics, dress goods, bed sheetings, pile fabrics, twills etc. Large possibilites for applicating break spun yarns are in respect of printed fabrics and flannels.

- The utility value of textile fabrics has been established both by mechanic physical tests and by field tests i.e. by practical wear of garments. The results of those tests have proved that O.E. yarns influence favourably the utility properties of textile fabrics.

- There is a pleasant symptom that in those mills where O.E. yarns have been commercially processed, the demand for such yarns is growing thanks to extraordinary satisfactory results obtained both in production and in sale.

EFFECT OF FIBRE FINENESS ON YARN STRENGTH

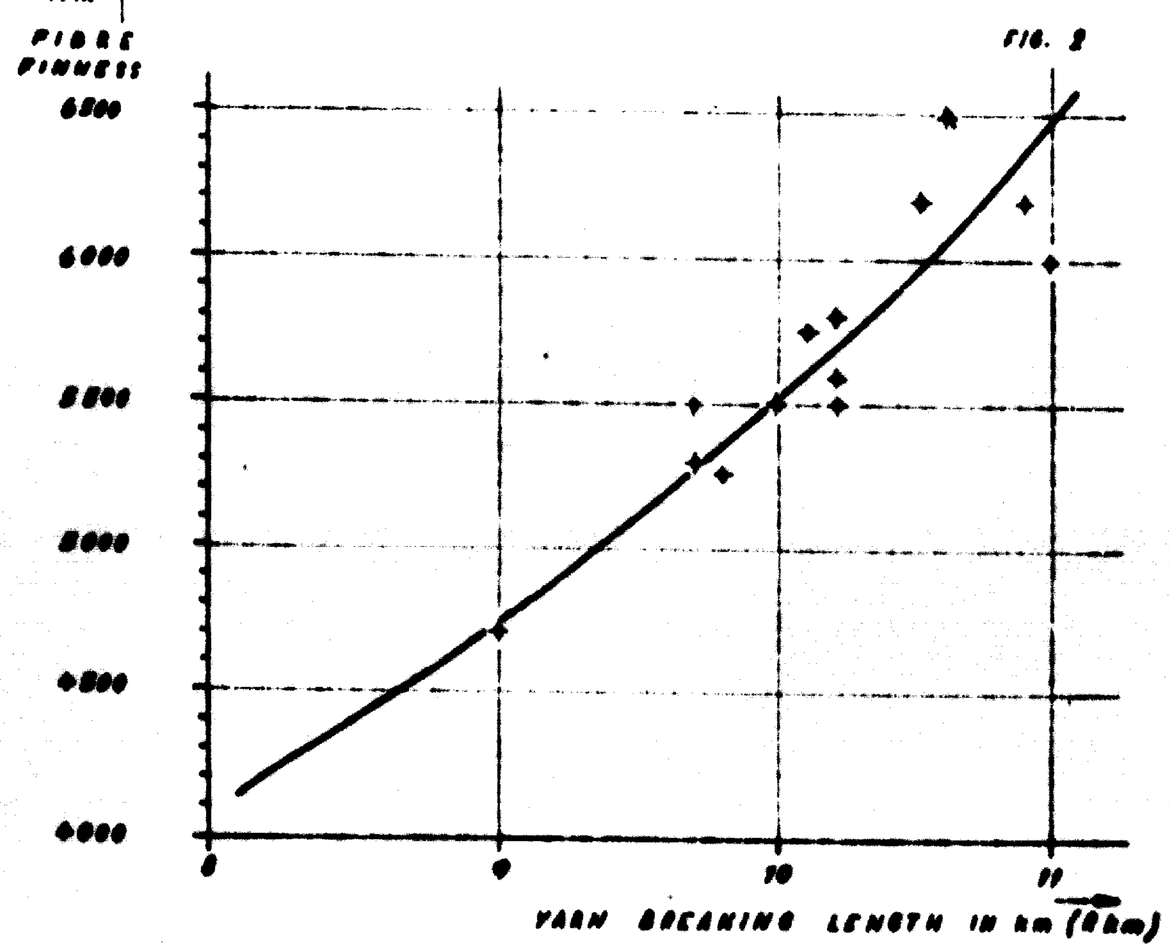

FIG. 2

EFFECT OF FIBRE LENGTH ON YARN TWIST

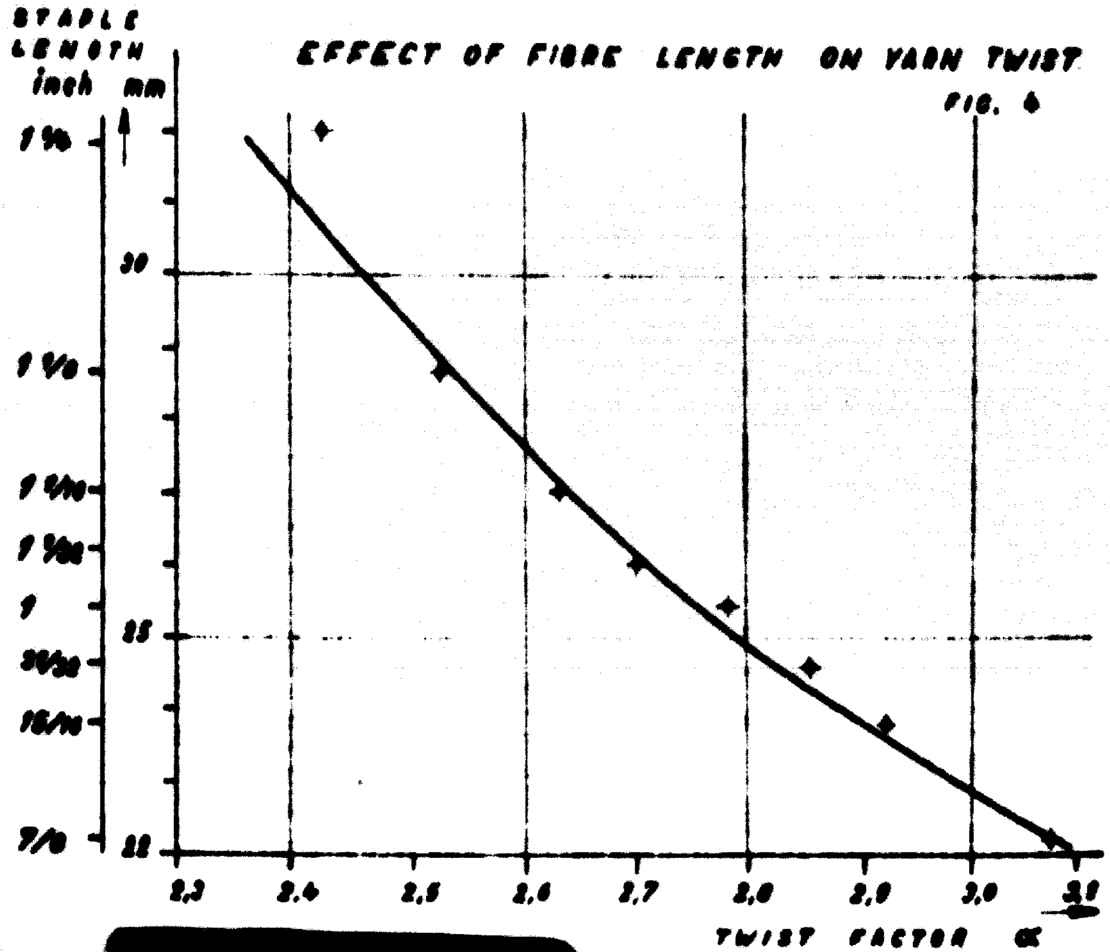

FIG. 4

31.7.74