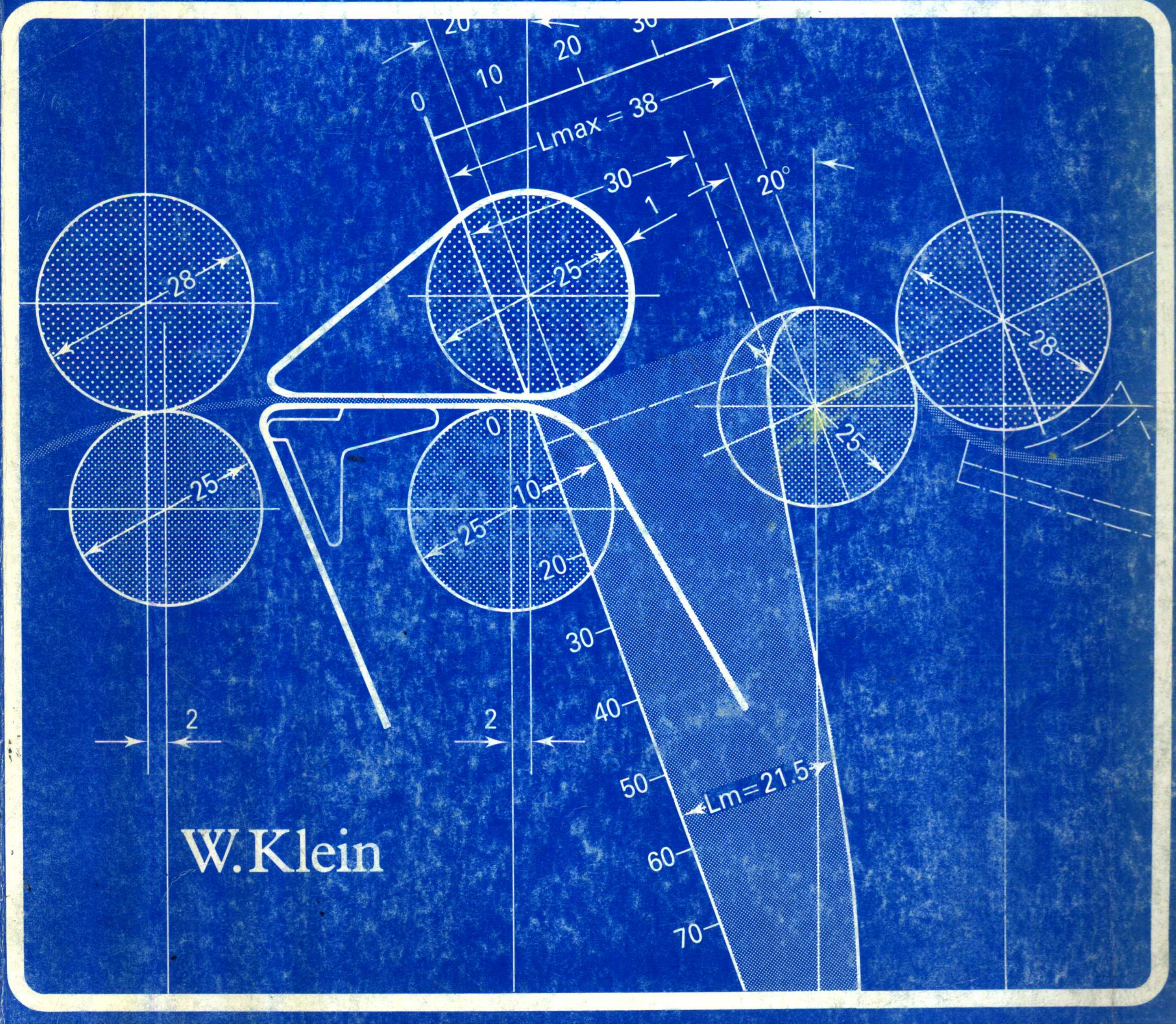
The Textile Institute

Manual of Textile Technology

Short-staple Spinning Series

# The Technology of Short-staple Spinning




W. Klein

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W. Klein

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# Preface

*This volume, **The Technology of Short-staple Spinning**, is the first in a series of six textbooks dealing with the state of the art in short-staple spinning. It sets out the basic, and therefore generally valid, technological relationships in the short-staple spinning mill. The following five volumes in this series will be organized according to machines or machine groups and will handle questions mainly related to machine design and operation. In this way, generally valid basic principles can be separated from the continuing further development in machine construction. Taken together, the six books will cover the topic of short-staple spinning within the framework of the **Manual of Textile Technology** published by the Textile Institute.*

*These books have a central purpose, namely to refresh and supplement practical knowledge for use in everyday operations in the spinning mill. As conditions in the competitive struggle become steadily harder, it becomes ever more important for the practical spinner to master his subject thoroughly. This volume, and the subsequent volumes, are designed to contribute to the achievement of that goal.*

***Dr. H. Stalder. dipl. Ing. ETH, CText FTI***

# Acknowledgements

*I am grateful that Mr W. Klein, senior lecturer in spinning at the Swiss Textile College in Wattwil, could be persuaded to write the Short-staple Spinning Series of the* ***Manual of Textile Technology****. His long experience in spinning and in teaching ensures that this series will be an extremely useful tool for those working in the spinning field.*

*I would also like to thank Mr V. Walker of Rieter Machine Works Ltd, who is translating these spinning manuals from German into English. His technical background and his clear use of language also help to make the use of the manuals easy.*

*Finally, my acknowledgement goes to the Project Team in Manchester for their technical support and their initiative in launching the* ***Manual of Textile Technology****; and last but not least, to the Rieter Machine Works in Winterthur, who have sponsored the Short-staple Spinning Series of the Manual. Without their support this series would not have been possible.*

***Dr. H. Stalder, dipl. Ing. ETH, CText FTI***

# Introduction

Annual world consumption of fibres is just under 40 million tons. While about 20% is processed as endless filament, about 80% is in staple fibre form. The greater part of this 80% is used in production of yarn. The spinning industry is therefore of great significance in all parts of the world.

It is correspondingly important that adequate trained management personnel is available, with the necessary technical and technological knowledge. While technical knowledge relates more to machines, technological aspects are concerned with processing. Technological knowledge is the summarized expression of the basic principles involved in conversion of raw material to semi-finished or fully finished products - separated from the actual or currently realizable possibilities for putting these principles into effect.

In relation to spinning, technology is concerned with the study of the production of a yarn. In this context the word 'spinning' refers to the conversion of a large quantity of individual unordered fibres of relatively short length into a linear, ordered product of very great length by using suitable machines and devices. In processing natural fibres, the same basic operations are always involved.

It is the aim of this volume to provide an introduction to the technology of spinning, to the relationships and laws involved in the performance of these basic operations and to awaken or to deepen understanding of what happens during material processing. The following literature regarding technology can be recommended for further study. W.I. Budnikow, I.W. Budnikow, W.E. Sotikow, N.J. Kanarski, A.P. Rakow, *Grundlagen des Spinnens* in 2 volumes. (Collective authorship): *Spinnereitechnische Grundlagen*, Fachbuchverlag, Leipzig.

At this point, I wish to express my thanks to Rieter Machine Works Ltd in Winterthur for their support and especially for the preparation of all the drawings.

| Operation | Machines used in short-staple spinning |
|---|---|
| Opening | Blowroom machines<br>Card<br>OE spinning machines |
| Cleaning | Cleaning machines<br>Card<br>Comber<br>Drawframe (dust removal)<br>Rotor spinning machine |
| Blending | Blowroom machines<br>Card (fibre blending)<br>Drawframe |
| Aligning | Card<br>Comber<br>Drawframe<br>Roving frame<br>Final spinning machine |
| Uniting | Card<br>Comber<br>OE spinning machines |
| Equalizing | Card with leveller<br>Drawframe<br>OE spinning machines |
| Attenuating | Card<br>Drawframe<br>Roving frame<br>Final spinning machines |
| Imparting strength | Final spinning machines |
| Winding | Roving frame<br>Final spinning machines |

# Contents

# Introduction

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# 1. Raw Material as a Factor Influencing Spinning

### *1.1. Characteristics of the Raw Material*

Raw material represents about 50% of the production cost of a short-staple yarn. This fact alone is sufficient to indicate the significance of the raw material for the yarn producer. The influence becomes still more apparent when the ease in processing one type of fibre material is compared with the difficulties, annoyance, additional effort and the decline in productivity and quality associated with another, similar, material. Hardly any spinner can afford to use a problem-free raw material, because it would normally be too expensive. Adapting to the anticipated difficulties requires an intimate knowledge of the starting material and its behaviour in processing and subsequent stages.

Optimal conditions can be obtained only through mastery of the raw material. Admittedly, however, the best theoretical knowledge will not help much if the material is already at the limits of spinnability or beyond. Excessive economy in relation to raw material usually does not reduce costs, and often increases them owing to deterioration of processability in the spinning mill.

As an introduction to the subject of raw material the following pages will sketch out several relationships which are important for the yarn producer. Only cotton will be dealt with here. Synthetic fibres will be dealt with separately in a further volume.

### *1.2. Fibre Fineness*

#### 1.2.1 The influence of fineness

Fineness is one of the three most important fibre characteristics. The fineness determines how many fibres are present in the cross-section of a yarn of given thickness. Additional fibres in the cross-section provide not only additional strength but also a better distribution in the yarn. Thirty fibres are needed at the minimum in the yarn cross-section, but there are usually over 100. One hundred is approximately the lower limit for almost all new spinning processes. This indicates that fineness will become still more important in the future. Fibre fineness influences primarily:

| | |
|---|---|
| spinning limit; | drape of the fabric product; |
| yarn strength; | lustre; |
| yarn evenness; | handle; |
| yarn fullness; | productivity. |

Productivity is influenced via the end breakage rate, the number of turns per inch required in the yarn (giving improvement of the handle), generally better spinning conditions.

In production of blends it must be borne in mind that, at least in conventional spinning processes, fine fibres accumulate to a greater extent in the yarn core and coarser fibres at the periphery. Blending of fine cotton fibres with coarse synthetic fibres would produce a yarn with an externally synthetic fibre character.

#### 1.2.2 Specification of fineness

With the exception of wool and hair fibres, fibre fineness cannot be specified by reference to diameter as in the case of a steel wire, because the section is seldom circular and is thus not easily measureable. As in the case of yarns, fineness is usually specified by the relation of mass (weight) to length:

$$\text{tex} = \frac{\text{mass (g)}}{\text{length (km)}} \quad \text{or} \quad \text{dtex} = \frac{\text{mass (dg)}}{\text{length (km)}}$$

While for synthetic fibres dtex is used almost exclusively, the Micronaire value is used worldwide for cotton. The fineness scale is as follows:

| Mi-value | Fineness |
|---|---|
| up to 3.1 | very fine |
| 3.1 - 3.9 | fine |
| 4.0 - 4.9 | medium |
| 5.0 - 5.9 | slightly coarse |
| above 6 | coarse |

Conversion factor: dtex = Mi × 0.394 (heavily dependent on degree of maturity).

It should be remembered, however, that the Micronaire value does not always represent the actual fineness of the fibres. Owing to the use of the air throughflow method, an average value is obtained where there is a high proportion of unripe fibres, and this does not correspond to the true value for the spinnable fibres. Specification by Titer tex is more accurate in such a case, but far harder to obtain.

There is a further difficulty. Cotton is a natural fibre. It grows in various soils, in various climates and with annually changing cultivation conditions. The fibres therefore cannot be homogeneous in their characteristics, including their fineness. Schenek (1) indicates that the

Mi-value varied, in an extreme example, between 2.4 and 3.9 from bale to bale in a lot of 500 bales.

1.2.3 Fibre maturity

The cotton fibre consists of cell wall and lumen. The maturity index is dependent upon the thickness of this cell wall. Schenek (1) suggests that a fibre is to be considered as ripe when the cell wall of the moisture-swollen fibre represents 50 - 80% of the round cross-section, as unripe when it represents 30 - 45%, and as dead when it represents less than 25%. Since some 5% unripe fibres are present even in a fully ripened boll, cotton stock without unripe fibres is unimaginable: the quantity is the issue.

Unripe fibres have neither adequate strength nor adequate longitudinal stiffness. They therefore lead to:

- loss of yarn strength
- neppiness
- high proportion of short fibres
- varying dyeability
- processing difficulties, mainly at the card.

### 1.3. Fibre Length

1.3.1 The influence of length

Fibre length is also one of the three most important fibre characteristics. It influences:

- spinning limit
- yarn strength
- yarn evenness
- handle of the product
- lustre of the product
- yarn hairiness
- productivity.

Productivity is influenced via the end breakage rate, the quantity of waste, the required turns of twist (which affects the handle), general spinning conditions.

It can be assumed that fibres of under 4 - 5 mm will be lost in processing (as waste and fly), fibres up to about 12 - 15 mm do not contribute to strength but only to fullness of the yarn, and only those fibres above these lengths produce the other positive characteristics in the yarn.

It is not only the condition at purchase that is important in assessment of fibre length; still more decisive is the length after carding. Processing conditions at the card, and also the fibre characteristics, must be such that the fibres survive carding without noticeable shortening. Where there is a high proportion of unripe fibres, this will not always be the case.

1.3.2 The staple diagram

The fibres in the boll do not exhibit extremely great length differences. Noticeable shortening of many fibres arises before the spinning process owing to mechanical working, for example ginning and cleaning. The effect is such that fibre length exhibits the greatest irregularity of all the fibre characteristics. In even the smallest tuft of cotton taken up in the hand there will be all lengths from the absolute minimum (2 mm) to the absolute maximum (between 30 and 60 mm depending on origin). If the fibres of such a tuft are arranged next to each other with their ends aligned and sorted according to length in a co-ordinate system, then the staple diagram (Fig. 1) typical of cotton is obtained, the so-called numerical diagram ('Hauteur').

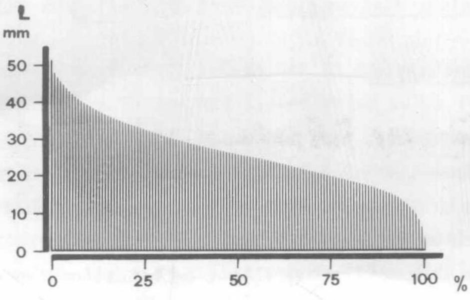


*Fig. 1. The staple diagram, numerical diagram.*

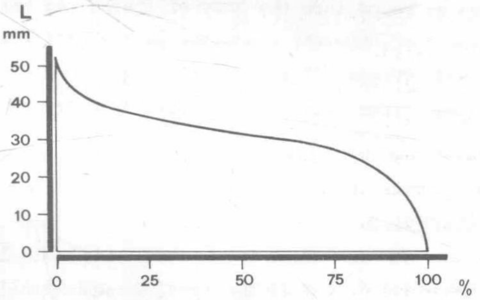


*Fig. 2. The staple diagram, weight-biased diagram.*

If the diagram is derived abstractly from the masses of the length groups, then the weight-biased diagram ('Barbe') is obtained (Fig. 2). This has a notably higher curve compared with the numerical diagram, because long fibres have more mass than short fibres and therefore a greater effect. The weight-biased diagram corresponds to the distribution of fibres in the yarn cross-section. This diagram should therefore be referred to in considerations and calculations relating to the yarn.

On the other hand, the numerical diagram emphasizes unduly the proportion of short fibres. It provides in visual form a good assessment of the running behaviour in the process. The two average staple lengths are related as follows:

$$\bar{\ell}_{\omega} = \bar{\ell}_N + s^2/\bar{\ell}_N$$

where $\ell_{\omega}$ is the average staple length based on the weight-biased diagram; $\ell_N$ is the average staple length based on the numerical diagram; s is the standard deviation of the fibre distribution.

In addition, in relation to fibre materials, five types of diagram can be distinguished according to their form.

### 1.3.3 Various diagram forms

#### Rectangular staple

This is achievable, and imaginable, only with synthetic fibres. Since the fibres are all equally long, no length variations are present, material of this type would seem ideal. Such an impression would be false, however. For one thing, the length evenness cannot be maintained into the yarn because fibres are shortened in the spinning mill, mainly at the cards. For another, spinning machines are not suited to processing of fibres having all the same length. In the drafting arrangement, for example, such fibres are not moved individually, but in bunches, thereby finally producing a high degree of unevenness.

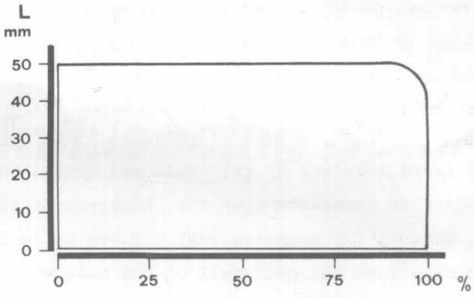


*Fig. 3. Staple diagram, rectangular staple.*

#### Triangular staple

This permits better processing than the rectangular staple, but contains too many short fibres. During movement of fibres, for example in the drafting arrangement, the short fibres cannot be maintained under control; they move freely and produce substantial unevenness. Also, they cannot always be bound into the body of fibres, so that some of them are lost, thereby producing waste and fly at the machines and devices. If a short fibre is bound-in, however, one end often projects. The yarn is hairy.

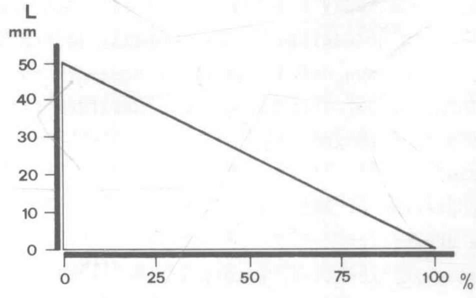


*Fig. 4. Staple diagram, triangular staple.*

#### Trapezoidal staple

This is the ideal staple for processing, and is all the more suitable the flatter the curve. However, a flat curve often means a high price.

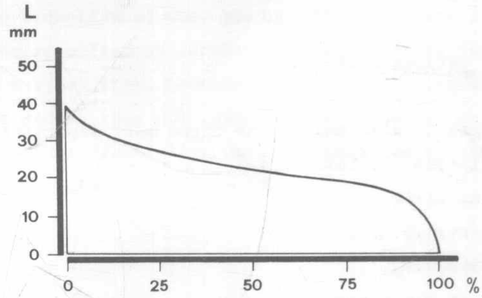


*Fig. 5. Staple diagram, trapezoidal staple.*

#### Stepped staple

If fibre materials of very different lengths are mixed in the wrong proportions, then a stepped staple curve can arise. As with a rectangular staple, the fibres can be moved only in groups, with the same effects.

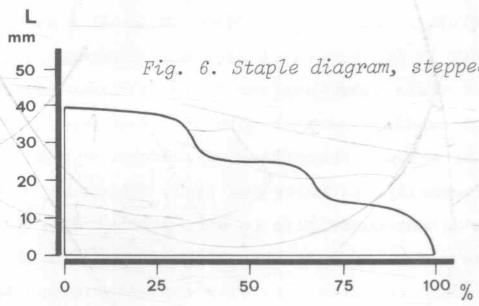


*Fig. 6. Staple diagram, stepped staple.*

#### Fibrogram

In addition to the staple diagram, the Fibrogram is available. Whereas in the staple diagram the fibres are aligned at one end, in the Fibrogram they are arranged randomly by clamping on a line.

While the staple diagram represents an artificial picture, which does not occur anywhere in practice, the Fibrogram corresponds to the arrangement of fibres at the nip line of rollers. It gives a good representation of the drafting operation and of the arrangement of the fibres in the yarn. It is produced by the Digital-Fibrograph. The lengths are stated as span-lengths, that is lengths which span a certain distance.

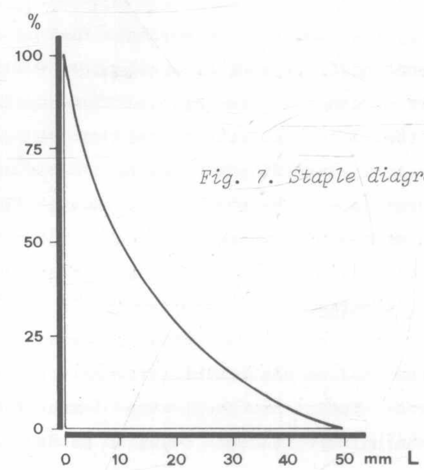


*Fig. 7. Staple diagram, Fibrogram.*

1.3.4 The specification of length

The parallelized, ordered bundle of fibres in the hand is referred to as the staple. The length derived therefrom is also referred to as the staple. From the staple diagram it is clear that various measures of length can be derived, for example:

maximum staple (maximum length)
minimum staple (minimum length)
average staple (average length).

These values may be of interest to the statistician, but they tell the spinner nothing because they enable neither a statement regarding the product nor one regarding the process. The trade and the processor therefore use other more informative data, such as:

classifying staple (trade staple)
hand staple (spinner's staple)
1%-staple (setting staple)
2.5%-staple (setting staple)
50%-staple, etc.

The trade staple is the most important specification of length. It is established to 1/32" during classifying of the cotton, and corresponds to the fibre length in the weight-biased diagram at about 25% and in the numerical diagram at about 15%.

The hand staple is similar and is established by the specialist in operation. The 1% and 2.5% staples are lengths which are needed in setting machines, especially roller spacings. The following length groupings are currently used in stating the trade staple:

| | |
|---|---|
| short staple: | 1" or less |
| medium staple: | 1 1/32" - 1 1/8" |
| long staple: | 1 5/32" - 1 3/8" |
| extra long staple: | 1 13/32" and above |

Specification of the trade staple alone is not enough, however, because the slope of the curve is not taken into account. With the same trade staple length, the staple

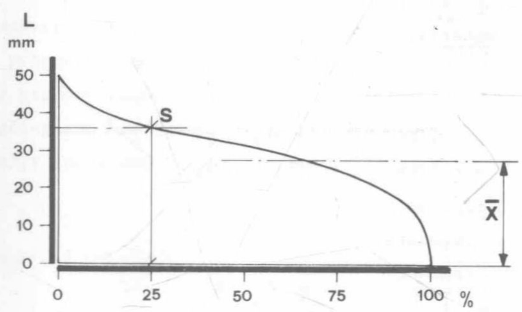


*Fig. 8. Staple diagram, specification of lengths.*

could approach either the rectangular or the triangular form. The proportion of short fibres will then be correspondingly high or low. In order to estimate how good the length is, the following can be used:

a second point on the curve (e.g. 50%-staple),
the coefficient of variation, or
the proportion of short fibres.

1.3.5 The proportion of short fibres

The proportion of short fibres has an extremely great influence on the parameters listed under 1.3.1 (except in the case of rotor spinning, where this influence is less). A large proportion leads to strong fly contamination (amongst other problems), and thus to strain on personnel, on the machines, on the workroom and on the air-conditioning, and also to extreme drafting difficulties. Unfortunately, the proportion of short fibres has increased substantially in recent years in cotton available from many sources. This is due to mechanical plucking and hard ginning.

Schenek (2) and E. Lord (3) distinguish according to absolute short-fibre content, and relative short-fibre content. In the great majority of cases the absolute short-fibre proportion is specified today as the percentage of fibres shorter than 10, 11, 12 or 12.5 mm (1/2").

The short-fibre limit has not been standardized, but might settle around 12 or 12.5 mm. Since the short fibres cannot be measured easily, this value is seldom really accurate. If more exact values are required, the relative short-fibre content must be established as proposed by Lord. The procedure is, however, very demanding.

### *1.4. Fibre Strength*

Strength is very often the dominating characteristic. This can be seen from the fact that nature produces countless fibres, most of which are not usable for textiles because of inadequate strength. The minimum strength for a textile fibre is approximately 6 cN/tex (about 6 km breaking length). Since binding of the fibres into the yarn is achieved mainly by twisting, and thus can exploit at most 30 - 70% of the strength of the material, a lower limit of about 3 cN/tex is finally obtained for the yarn strength, which varies linearly with the fibre strength. Fibre strength will increase in importance in the future, since most new spinning processes exploit the strength of the material less well than older processes.

Some significant breaking strengths of fibres:

| | |
|---|---|
| Polyester | 35 - 60 cN/tex |
| Cotton | 15 - 40 cN/tex |
| Wool | 12 - 18 cN/tex |

In relation to cotton, the strength of fibre bundles is measured and stated as the Pressley value. The following scale of values is used:

| | |
|---|---|
| 93 and above | = excellent |
| 87 - 92 | = very strong |
| 81 - 86 | = strong |
| 75 - 80 | = medium |
| 70 - 74 | = fair |
| under 70 | = weak |

Conversion to physical units should be avoided because the measuring procedure is not very exact.

Except for polyester, fibre strength is moisture-dependent. It is important to know this in processing, and also in testing. Since fibre moisture is dependent upon ambient air conditions, it depends strongly upon the climatic conditions and upon the time of exposure. While the strength of cotton, linen, etc., increases with increasing moisture content, the reverse is true for polyamide, viscose fibres and wool.

### *1.5. Fibre Elongation*

Three concepts must be clearly distinguished:

permanent elongation: that part of the extension through which the fibre does not return on relaxation

elastic elongation: that part of the extension through which the fibre does return

breaking elongation: the maximum possible extension of the fibre until it breaks, i.e. the permanent elongation and the elastic elongation together.

Elongation is specified as a percentage of the starting length. The elastic elongation is of decisive importance since textile products without elasticity would hardly be usable. They must be able to deform (e.g. at knee or elbow) in order to withstand high loading (also during processing), but they must also return to shape. The fibre elongation should therefore be at least 1 - 2% (glass fibres), and preferably slightly more.

The greater crease-resistance of wool compared with cotton arises, for example, from the difference in their elongations: cotton = 6 - 10%; wool = 25 - 45%.

For normal textile goods, higher elongations are neither necessary nor desirable. They make processing in the spinning mill more difficult, especially in drawing operations. Exceptions are sportswear, corsetry and, recently, stretch products.

If a fibre is subjected to tensile loading, then demands are made on both its strength and elongation. Strength and elongation are therefore inseparably connected. This relationship is expressed in the so-called stress/strain diagram (force/length change diagram). For each type of fibre there is a typical curve. In blending, it should be ensured that the curves of the fibres to be blended are similar in shape.

### *1.6. The Slenderness Ratio (Stiffness)*

Fibre stiffness plays a significant role mainly when rolling, revolving, twisting movements are involved. A fibre which is too stiff has difficulty adapting to the movements. For example, it is not properly bound into the yarn, produces hairiness or is even lost in processing. Fibres which are not stiff enough have too little springi-

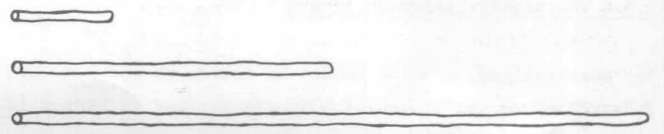

*Fig. 9. Stiffness of fibres of different lengths.*

ness. They do not return to shape after deformation. They have no 'longitudinal resistance'. In most cases this leads to formation of neps. Fibre stiffness is dependent upon fibre substance and also upon the relationship between fibre length and fibre fineness. Fibres having the same structure will be stiffer, the shorter they are.

The slenderness ratio can serve as a measure of stiffness:

Slenderness ratio = Fibre length/Fibre diameter

Since the fibres must wind as they are bound-in during yarn formation in the ring spinning machine, the slenderness ratio also determines to some extent where the fibres will finish up:

fine and/or long fibres in the middle;

coarse and/or short fibres at the yarn periphery.

### *1.7. Fibre Cleanness*

#### 1.7.1 Impurities

In addition to usable fibres, cotton stock contains foreign matter of various kinds (1):

Vegetable matter
- husk portions
- seed fragments
- stem fragments
- leaf fragments
- wood fragments

Mineral material
- earth
- sand
- ore dust picked up in transport
- coal dust picked up in transport

Other foreign matter
- metal fragments
- cloth fragments
- packing material (mostly polymers)

Fibre fragments
- fibre particles (which finally make up the greater portion of the dust)

This foreign material can lead to extreme disturbances during processing:

Metal parts can cause fires or damage card clothing.

Cloth fragments and packing material can lead to foreign fibres in the yarn and thus to its unsuitability for the intended application.

Vegetable matter can lead to drafting disturbances, yarn breaks, filling up of card clothing, contaminated yarn, etc.

Mineral matter can cause deposits, high wear rates in machines (grinding effect, especially apparent in rotor spinning), etc.

The new spinning processes are very sensitive to foreign matter. Foreign matter was always a problem, but is becoming steadily more serious from year to year. This is due primarily to modern high performance plucking methods; hard ginning and cleaning; pre-drying; careless handling during harvesting, packing and transport; modern packing materials.

Today, foreign fibres, for example, have become almost a nightmare for the spinner in industrialized countries. The amount of foreign material (primarily of vegetable origin) is already taken into account in grading. Figure 10 shows ranges for impurities in American cotton as given in the literature of the Trützschler company. The scale below represents the degree of contamination:

| | |
|---|---|
| up to 1.2% | = very clean |
| 1.2 - 2.0% | = clean |
| 2.0 - 4.0% | = medium |
| 4.0 - 7.0% | = dirty |
| 7.0% and above | = very dirty |

1.7.2 Neps

Neps are small entanglements or knots of fibres. In general, two types of neps can be distinguished; fibre neps and seed-coat neps, that is small knots that consist only of fibres and others containing foreign particles such as husk, seed or leaf fragments. Investigations made by P. Arzt and O. Schreiber, indicate that fibre neps predominate, particularly fibre neps having a core mainly of unripe and dead fibres. Thus it is clear that there is a relationship between maturity index and neppiness. Neppiness is also dependent, exponentially, on the fibre fineness, because fine fibres have less longitudinal stiffness than coarser fibres.

The processing method also has a considerable influence. A large proportion of the neps in raw cotton is produced by plucking and hard ginning, and the nep count is substantially increased in the blowroom. The card is the first machine to reduce the nep count to a usable level, and nep-reduction at the card is achieved primarily by disentanglement rather than by elimination. Neps not only create disturbance in themselves as thick places, but also in dyed articles because they dye differently from the rest of the yarn, and thus become clearly visible in the finished cloth.

1.7.3 Dust

1.7.3.1 Definition

Dust consists of small and microscopic particles of various substances, which are present as suspended particles in gases and sink only slowly, so that they can be transported in air over substantial distances. In accordance with a classification system established by the International Committee for Cotton Testing Methods, the following types are to be distinguished:

| | Particle size (μm) |
|---|---|
| Trash | above 500 |
| Dust | 50 - 500 |
| Microdust | 15 - 50 |
| Breathable dust | below 15 |

A paper published by the International Textile Bulletin (4) indicates that microdust comprises 50 - 80% fibre fragments, leaf and husk fragments, 10 - 25% sand and earth and 10 - 25% water-soluble materials. The high proportion of fibre fragments indicates that a large part of the microdust arises in the course of processing. Mandl (5) states that about 40% of the microdust is free between the fibres and flocks, 20 - 30% is loosely bound, and the remaining 20 - 30% is firmly bound to the fibres.

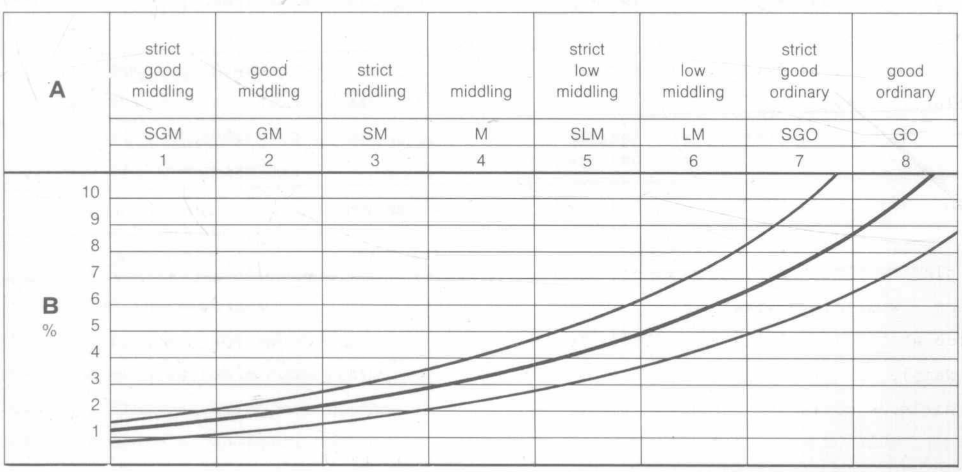


*Fig. 10. Proportion of waste in cotton of different classes. A, classification; B, proportion of waste in %.*

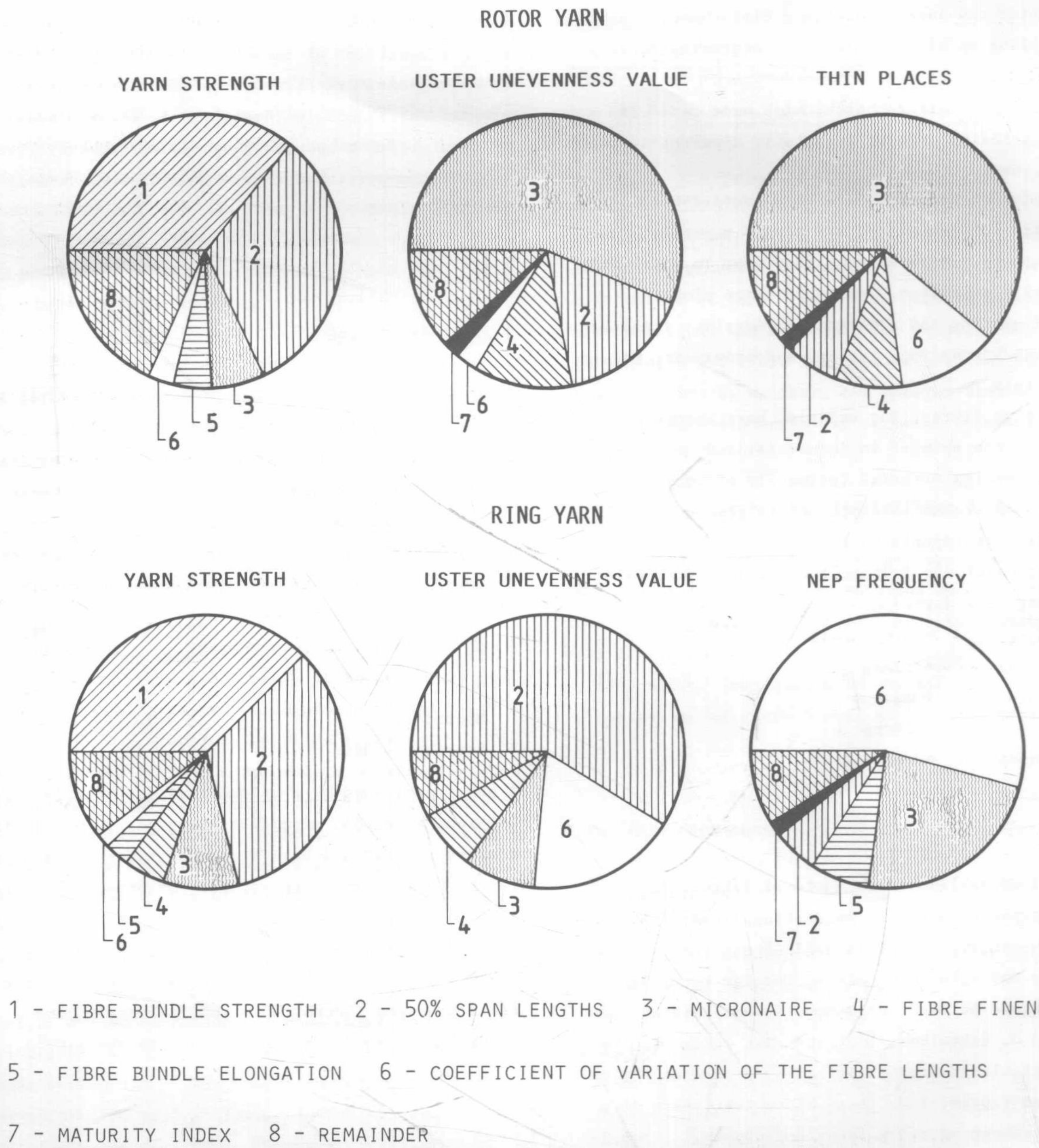


*Fig. 11. Fibre characteristics as factors influencing the yarn characteristics for a given yarn count.*

| Rank | Ring spinning | Rotor spinning | Air jet spinning | OE-Friction spinning |
|---|---|---|---|---|
| 1. | length/ uniformity | strength | fineness | friction |
| 2. | strength | fineness | length/ uniformity | strength |
| 3. | fineness | length/ uniformity | strength | fineness |
| 4. | | cleanness | cleanness | length/uniformity |
| 5. | | | friction | cleanness |

1.7.3.2 Problems created by dust

F. Leifeld (6) lists the following problems as created by dust:

Additional stress on personnel
- dust is unpleasant, e.g. for eyes and nose
- it can induce allergies
- it can induce respiratory disease (Byssinosis)

Environmental problems
- dust deposits
- dust accumulations which can fall into the machines
- loading of the air-conditioning equipment

Effects on the product
- quality deterioration directly, or
- indirectly through machine faults

Stressing of the machines
- dust accumulations lead to operational disturbances
- jamming and running out of true
- increased yarn unevenness
- more end breaks
- rapid wear of machine components (e.g. rotors)

1.7.3.3 Tolerated limits

The following table shows the limits already specified or to be specified in various countries (7).

| | | |
|---|---|---|
| USA | 0.2 $mg/m^3$ | breathable dust |
| Canada | 1.0 $mg/m^3$ | total dust < 29 µm |
| Great Britain | 0.5 $mg/m^3$ | total dust, including fly ≤ 2 mm |
| FRG | 1.5 $mg/m^3$ | total dust |
| Switzerland | 1.5 $mg/m^3$ | total dust |
| Austria | 0.2 $mg/m^3$ | breathable dust |

### *1.8. Chemical Deposits (Sticky Substances)*

The best known sticky substance on cotton fibres is honeydew. Strictly this is a secretion of the cotton louse, but today all sticky substances are incorrectly called honeydew. Schenek (1) identifies these sticky substances as:

| | |
|---|---|
| Secretions: | honeydew |
| Fungus and bacteria: | decomposition products. |
| Vegetable substances: | sugars from plant juices; leaf nectar; overproduction of wax. |
| Fats, oils: | seed oil from ginning. |
| Pathogens: | |
| Synthetic substances: | defoliants; insecticides; fertilizers; oil from harvesting machines. |

In the great majority of cases, however, the substance is one of a group of sugars of the most variable composition, primarily, but not exclusively, fructose, glucose, saccharose, melezitose, as found, for example, on Sudan cotton which is noted for it. These saccharides are mostly, but not always, produced by insects or the plants themselves, depending upon the influences on the plants prior to plucking.

Whether or not a fibre will stick depends, however, not only upon the quantity of the sticky coating and its composition, but also upon the degree of saturation as a solution (1). Accordingly, conclusions regarding stickiness in the production process cannot be drawn automatically from the determination of quantity. Elstner (8) states that the sugars are broken down by fermentation and by microorganisms during storage of the cotton. This occurs more quickly the higher the moisture content. During spinning of sticky cotton, however, the relative humidity of the air in the production area should be held as low as possible.

### *1.9. Relative Importance of the Fibre Influences*

The influence of fibre parameters on yarn parameters and on running performance varies with circumstances. Their significance also differs for the individual spinning systems, new or conventional. Schenek/Hunter (1) give the ratings shown in Fig. 11. Deussen (9) gives the ratings shown in the table below it for the new spinning processes.