QUICKSPIN-METHOD - A PRAXIS-PROVED METHOD FOR QUALIFICATION OF RAW MATERIAL

Dr.-Ing. P. Artzt
Institute of Textile Technology and Process Engineering
Denkendorf (ITV)

Abstract

The raw material in the spinning mill causes the main part of costs at yarn production. According to spinning method and yarn count, more than 50 % of the costs for yarn production are caused by raw material costs. For this reason the raw material is the essential feature with regard to an economical operation of a spinning mill and yarn quality.

Introduction

On processing raw materials, it's most important to get the demanded yarn quality at the lowest raw material costs. The spinning mill must be able to adapt to extremely, rapidly changing raw material situations. This means that in such a case an existing knowledge of raw material because of delivery connections during many years can't be used.

Because of changing growing-, crop- and gin processes within a certain cotton growing area, on the other hand, the raw material is subject to permanent changes. Nevertheless, every spinning mill needs a high degree of certainty on selecting the appropriate raw material. Very often there are only small samples for the purchase of raw material available. There can be watched a general tendency in defining the respective raw material by means of objective measuring methods for getting independent from the subjective method of classification. At present, both methods are still in use serving for the necessary decisions. Worldwide High-Volume-Instruments (HVI) and AFIS have been established for a quick evaluation of cotton.

In addition, however, the spinner needs a method which allows him to forecast the resulting yarn properties by means of small fibre samples. This process of calculated yarn construction could be described as 'yarn engineering'. This means the combination of raw materials which has to be found out for a certain task. 'Yarn engineering' also means the best construction of a yarn with respect to the costs. Apart from the raw material this can also apply to yarn twist and the selection of the optimal spinning elements mainly at rotor spinning.

According to growing-, harvesting- and origin conditions the raw materials show multiple differences. The user of the yarn, however, always expects a constant yarn. Now the 'yarn engineering' is fully effective. Raw material-know-how is of greatest importance.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:713-719 (1998)
National Cotton Council, Memphis TN

Discussion

The Quickspin process can provide first information about trends and influences about the combination of different raw materials within a very short time. Moreover, information will be provided concerning the processing behaviour and the cleanability of the fibre materials. By means of the Quickspin process there also should be developed a forecast method which doesn't use mathematical models or regressions, but a method that only refers to the properties of real spun yarns.

Therefore, it has become our aim to find a method which allows the spinning mill expert to get a prognosis of the expected yarn quality, a prognosis which is reliable and quick as possible by means of the use of a small sample of raw material.

A prognosis method should also include fibre properties, which aren't measured by HVI. They can be described as follows:

1. Cleanability
2. Opening behaviour
3. Fibre cohesion
4. Processing behaviour
5. Stickiness of cotton

etc.

Thus, the idea was born to conclude from the model yarn properties to the properties of real spun yarn. The use of short spinning methods is old and they have been applied often for some time. These methods, however, need too much time and they are also cost-intensive. Thus, the conventional Platt-short spinning method includes a mini-card, a mini-drawing frame and a ring-spinning tester.

A new short spinning method or Quickspin method should meet the following requirements:

1. Use of only few raw material
2. Few expenditure of time
3. Simulation of fibre opening, similar to carding process, for evaluation of cleaning- and opening behaviour
4. Yarn formation with real twist
5. Relatively high spinning limits (fine yarn count)
6. Possibility of testing raw material blends!

The method that has been developed for producing a model yarn is known as 'Quickspin'.

This method is divided into two process sections, thus, consisting of two modules, which are completely independent from each other.

Module 1
With the Uster MDTA3-unit tufts get opened up to single fibres, are cleaned, blended and formed to a sliver.
Module 2
At the rotorspin-unit the sliver is spun to Quickspin yarn.

Figure 1 shows the USTER QUICKSPIN System.

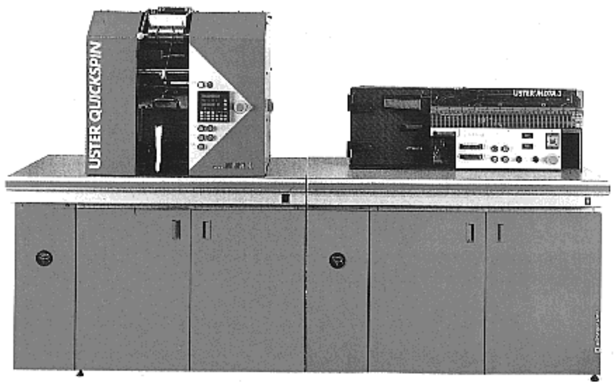

Figure 1. Quickspin system

During the testing of different types of cotton the spinning mill expert will realize that there is no complete cleaning of the cotton after the first passage. At this there remains in the sliver, depending on the type of raw material, a differently large amount of contamination; and this is similar to what happens to raw material after being processed in the blow-room. This effect is used for determining the cleanability of cotton. The sliver will be cleaned once more by means of a second passage.

Figure 2 represents the characteristic values of three different raw cottons. One can see a different behaviour of cleanability of these materials. At a high cleanability behaviour trash separation of the first passage is almost nearly 90 % and about 60 % at a low cleanability behaviour.

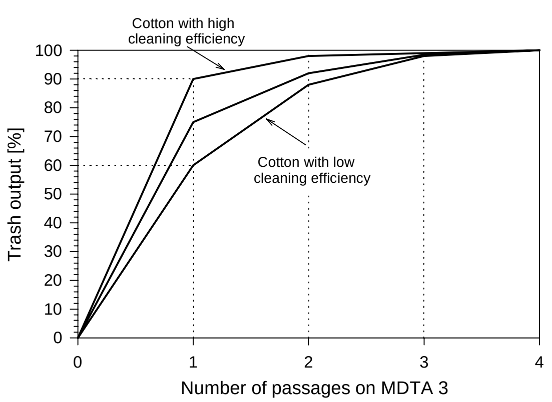

Figure 2. Characteristic cleaning curve of cotton depending on number of passages

In addition, it can be recognized that after the third passage there is an almost complete cleaning.

All this corresponds to the practical work in the blow-room. Usually there are two cleaning machines as well as the carding machine and this means three stages in cotton cleaning.

By means of both trash values you can now calculate the cleanability of the respective cotton. It has been defined by us and the expert of the spinning mill can quickly calculate it on using both trash values.

The analysis of six selected raw materials shows how important it is to find out the degree of cleanability. For this reason fibre materials of very different trash content had been selected.

Figure 3 shows the absolute trash content of these six types of raw cotton, which ranges between 'extremely clean' and 'extremely contaminated'.

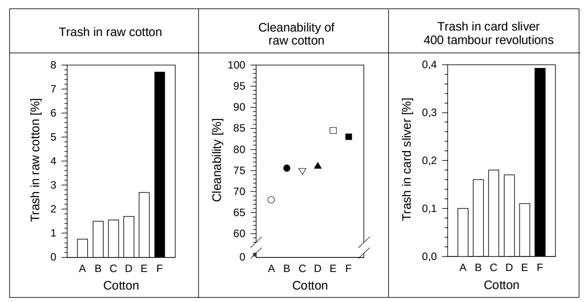

Figure 3. Prognostic method

The determined cleanability of the fibre materials, however, varies much. The two dirtiest fibre materials show the best cleanability. The cleanest raw cotton, on the other hand, reveals the lowest degree of cleanability. The reason for this is that this cotton contains seed-coat-fragments, which, as for their weight, represent only a small part of the total trash, but which can hardly be separated from the fibres. Experiences with many raw materials show that there exists no correlation between the contamination of raw material and cleanability.

Six cotton types from 34 raw materials were conventionally cleaned and carded according to the present state-of-technique. The trash content of the slivers was determined. Figure 3 shows clearly that the residual trash in the card sliver, which is responsible for the trash content in the yarn, doesn't correlate with the trash content in the raw cotton. Figure 4 shows the results of the total trash content as well as the cleanability behaviour of 34 different cotton types.

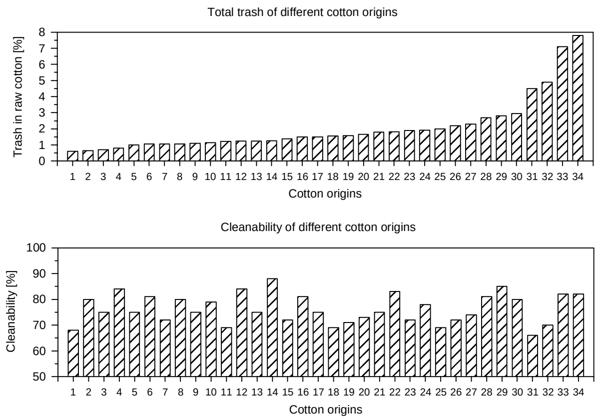

Figure 4. Correlation between trash in raw cotton and the cleanability of the cottons

If one makes a ranking according to the trash content and also considers the cleanability, so one must state that there is no correlation at all between absolute contamination and cleanability. Only a simultaneous study of raw material contamination and cleanability allows a realistic evaluation of the problem of raw material contamination. The tested cotton E shows the same residual trash content in the card sliver as this does the very clean cotton, type A, although there is a very high trash content before cleaning. From this it can be concluded that trash content as well as cleanability always have to be considered simultaneously. Both values are of extraordinary importance for the spinning result.

In order to confirm this, the sliver of the first module, MDTA 3, after two passages, was spun on module 2, under Quickspin conditions. Quickspin conditions means that the fibre ring of module 1 is directly spun according to the requirements of the new Quickspin method, which had originally been worked out.

On the other hand, the six types of raw cotton had been conventionally spun according to the ring- and rotor-spinning method. The trash particles in the yarn were opto-electronically measured. Figure 5 shows the number of trash paricles of the Quickspin yarn compared to those in the conventional ring- and open-end yarn.

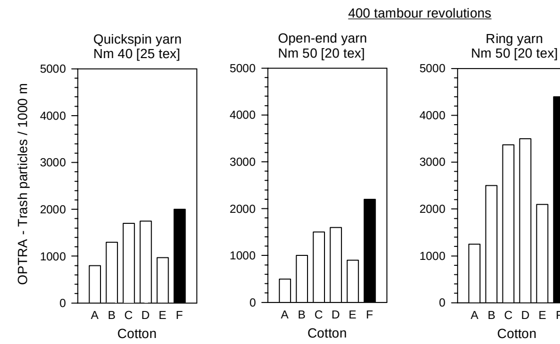

Figure 5. Prognostic method

This figure shows the same order of the raw materials with respect to trash content if one compares card sliver, Quickspin yarn, rotor- and ring-spun yarn with each other. Here again, the known fact becomes evident that ring-spun yarn contains more trash than rotor-spun yarn. Thus, it has been proved that the knowledge of the trash content of the Quickspin yarns allows to draw conclusions at high reliability with respect to the relative trash content of each real spun yarn. The correlation coefficient between Quickspin yarn and rotor- or ring-spun yarn is about 95 % and that means an extremely good correlation (figure 6).

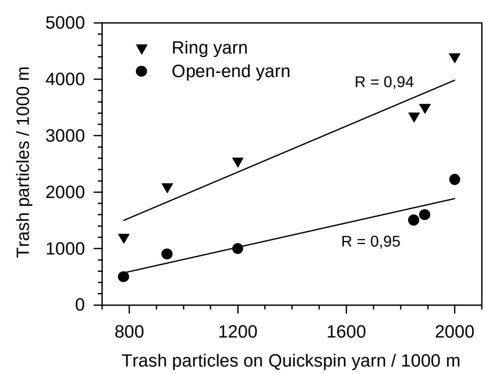

Figure 6. Correlation between the number of trash particles in Quickspin-yarn and conventional ring- and open-end yarn

The second criterion of 'yarn engineering' applies to an optimal and a quick selection of raw material with regard to yarn strength. The yarn strength is the result of many fibre properties. Besides

- Fibre length
- Fibre length distribution
- Fibre strength
- Fibre fineness

aspects such as fibre surface, fibre crimp, fibre drag, short-fibre content, etc. play an important role.

Figure 7 shows the fibre properties determined by HVI and Almeter. Those six selected raw materials show a large range of fibre strength, average staple length and short-fibre content.

Cotton	Fibre results HVI			Fibre results Almeter		
	Micro-naire	Strength [cN/tex]	Elongation [%]	ML [mm]	SF [%]	L 1 % [mm]
B	4,40	16,50	4,50	14,10	46,60	28,30
E	4,00	25,40	5,70	17,60	28,50	33,30
F	4,60	18,10	4,80	15,60	37,00	30,50
A	4,00	24,70	5,90	18,10	28,30	36,60
C	4,60	19,70	4,80	17,70	24,50	31,80
D	4,00	19,00	4,60	15,30	39,00	29,00

Figure 7. Fibre results of the tested cottons

On producing a yarn according to the three methods, Quickspin, rotor- and ring spinning there was an answer to the question expected, if it was possible to make a forecast for industrially spun yarns on the basis of the determined strength of the Quickspin yarns. Figure . 8 demonstrates that the strength of the Quickspin yarns correlates with that of the rotor-spun yarns and the ranking of the ring-spun yarns.

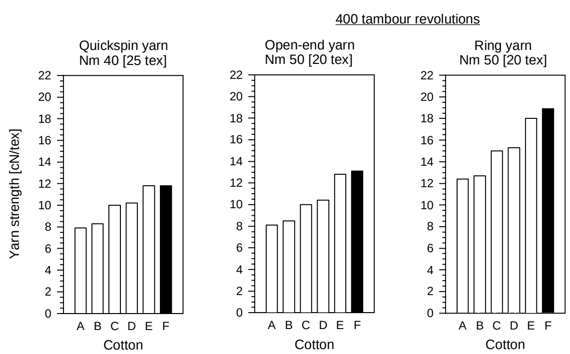

Figure 8. Prognostic method

The main purpose of the Quickspin method is 'raw material evaluation' and this has been proved clearly. Seventeen different raw materials have been spun out. The result shows that, depending on the fibre material, the correlation between yarn strength of Quickspin yarn, ring- and rotor-spun yarn is more than 95% in each case (figure 9).

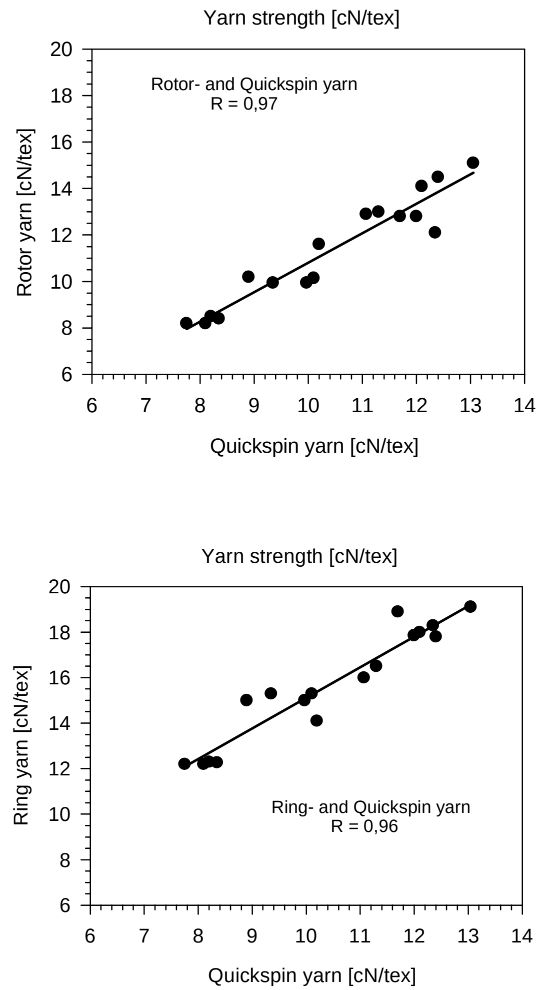

Figure 9. Correlation between the strength of Quickspin-, rotor- and ring yarn

Thus, it could be proved that it's possible to make a forecast with respect to the yarn strength on the basis of the Quickspin yarn.

The 'processing behaviour' of the individual raw materials can be assessed with the Uster evenness of the Quickspin yarns. Here, we still have a satisfactory correlation between the Uster values of the Quickspin yarns and the rotor- and ring-spun yarns (figure 10).

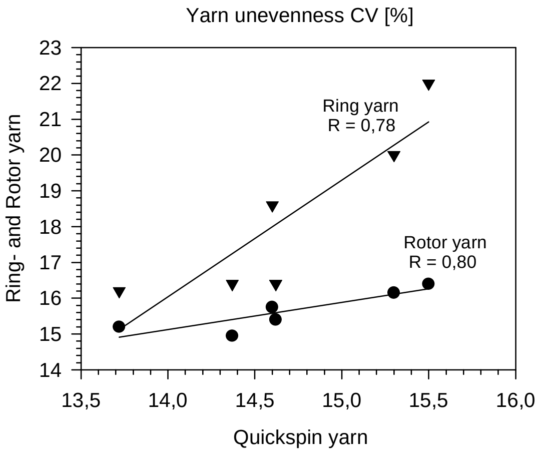

Figure 10. Correlation between the unevenness of Quickspin-, rotor- and ring yarn

This means, fibre materials with a bad processing behaviour result in a yarn of much unevenness both at the Quickspin method and at real spinning.

So, you are able to select and evaluate raw materials of optimal yarn evenness by means of the Quickspin process.

The finer the raw materials are spun the better the evaluation of the individual cotton types.

In order to be able to compare the individual cotton samples with one another it's, of course, essential that the yarn count is always the same one.

Determination of the Stickiness of Cotton

With current test methods, the stickiness behaviour of fibres is determined under conditions which normally have nothing to do with conditions of processing. The sugar content of cotton is determined by chemical methods (Orcin-/Benedict-/Clini-Test). All of these tests show a different reaction depending upon the type of sugar. However, the mini-card test - which simulates the opening process of the blowing room - seems to be practical. Here, the fibres - because of their sugar content - and oily capsule particles stick to the roller with their adhering fibres. The number of sticking places is determined at the end of the test. Today, however, there exist only a very few mini-cards and they haven't been made for a long time. With the thermodetection method as well as with the so-called Graf-test, the fibre fleece is heated up to more than 80 °C between heated plates. This test method also doesn't correspond to the real stress which fibres experience during the spinning process because temperatures as well as times are unrealistic.

While conducting trials with the MDTA 3 unit it was observed from time to time that it was difficult to remove the fibre ring from the rotor. Fibres and trash particles sticking to the rotor wall were the reason for this problem (figure 11).

Figure 11. Rotor of MDTA 3 with fibre ring

Some closer follow-up investigations - conducted with a foil placed in the rotor - revealed that the sticking places on the foil were identical to small honeydew drops. Afterwards, the foils with the sticking places were investigated photographically. Before the photos were taken the sticking places were exposed to heat treatment. Thermal treatment leads to the so-called caramelization of honeydew (figure 12).

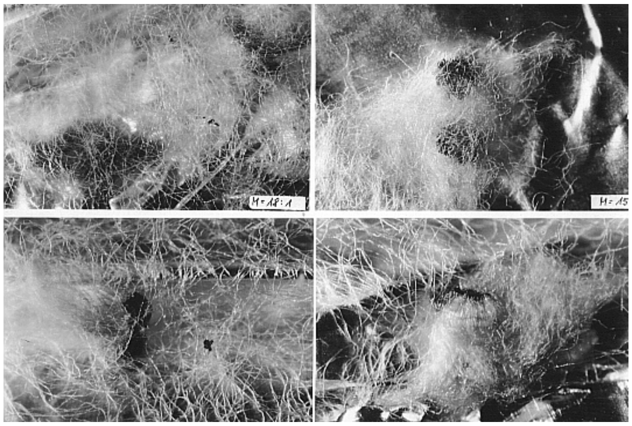

Figure 12. Sticky cotton (capsule oil)

However, oily trash particles can lead to sticking places (figure . 13).

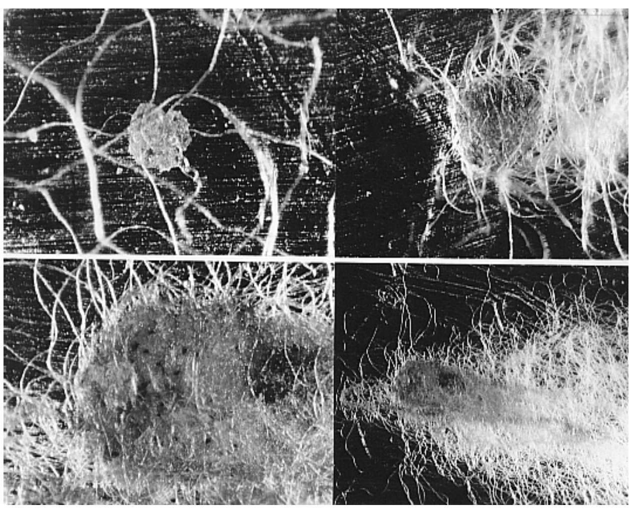

Figure 13. Sticky cotton (honeydew resp. capsule oil)

The MDTA 3 unit opens and cleans raw cotton in a fashion similar-the processes in the blowing room and the card. After having been opened the fibres are contacted with the rotor wall, the contact pressure of the fibre against the wall.

From this it follows that the sticking substance is subject to high contact pressure against the rotor wall. The sticking effect thus develops for a moment and doesn't need a longer time of influence. Figure 14 shows fibres sticking to the rotor wall.

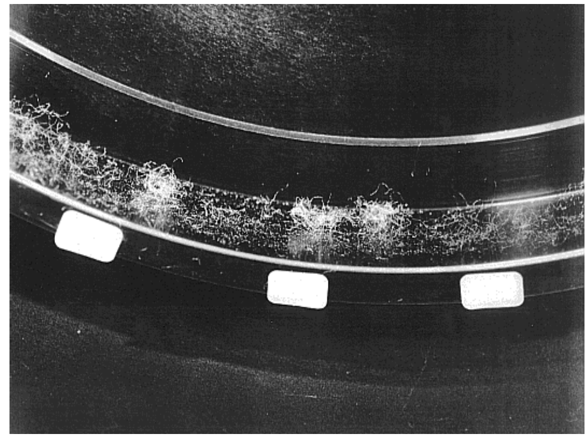

Figure 14. Sticky cotton fibres in rotor of MDTA 3

For the purpose of better evaluation the rotor has been eloxed (darkened). Now, one may remove the rotor ring while all sticking fibres and adhering fibre bundles - remaining in the rotor - are visible. The fibres in the rotor are collected by means of a brush and their weight is determined and calculated as a percentage of the sample weight. The sample weight is 2 g. Figure . 15 demonstrates the sticking fibres - related to the sample in % of the sample weight - which have been determined. For increased statistical reliability it is recommended that 5 tests be conducted with each sample.

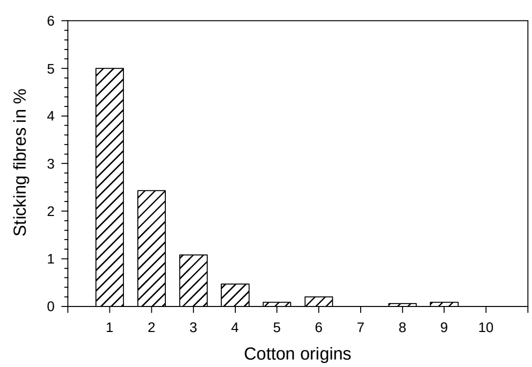

Figure 15. Determination of stickiness behaviour (weight) in % (ITV-method)

On the other hand, stickiness behaviour can be determined by means of the MDTA 3 unit either with or without trash separation. Through this trial variation it can be determined whether stickiness is caused by honeydew (sugar) or oily trash particles.

This is of importance to the spinner in so far as he can influence stickiness as a result of honeydew through an appropriate selection of climatic conditions. Up to now stickiness could not be eliminated through a change in climatic conditions because of the presence of oily trash particles. In this respect, this test variant appears to provide an important possibility for further improving the evaluation of cotton. It can be assumed that if there are single fibres sticking to the rotor wall there will be problems in processing. A series of different cottons has been investigated, both with regard to the Orcin test method - with a reaction to sugar content - and also with the MDTA 3 method. It was found that cottons which showed no stickiness also showed no sugar content. Those cottons with detectable sugar contents according to the Orcin test (stage 3-4) resulted in a small number of fibres sticking to the rotor in each trial. From stage 4 on, a considerable number of sticking fibres were detected (figure 16). There is a disadvantage, however, that applies to all known methods of stickiness measurement: reproducibility is poor. The lower the tendency for stickiness the larger the variation becomes.

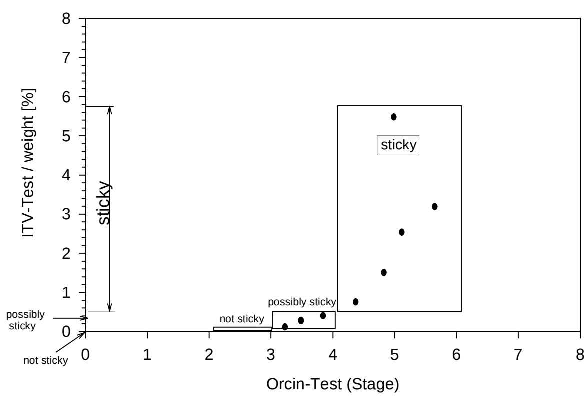

Figure 16. Stickiness of cotton (ITV- vs. Orcin testing method)

The most general method for the determination of stickiness tendency is to count the sticking places on a given heated surface. According to the method we have developed to determine the number of sticking places on the rotor wall. Accordingly, there results a correlation of nearly 100 % between the ITV method and the Graf/FCT test. There is only a difference regarding absolute values (figure 17) and it has to be mentioned that with our test the rotor has not been artificially heated. Further practical experience will show whether the gravimetric (%) or numerical method of evaluation will be most generally accepted.

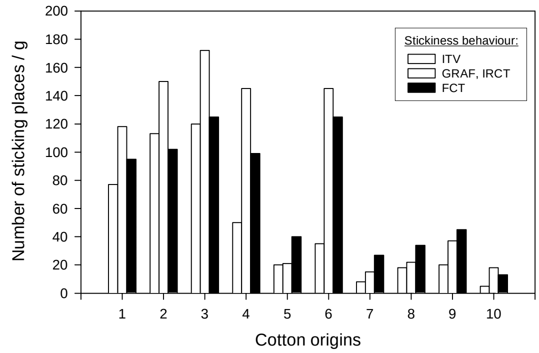

Figure 17. Stickiness behaviour at different test methods

It is understandable that pests (e.g. white fly) never evenly spread within a certain cotton area. The gins normally process cotton within a certain region. Therefore, it is advisable to test the cotton before ginning it, thus, being able to eliminate sticky cotton. It may happen that because of local attack a total region is affected by blending in the ginning mill.

In order to guarantee a certain reproducibility, the samples should be conditioned under standard climate conditions. On the other hand, the test itself should be carried out under climate conditions which are somewhat constant.

There is a considerable influence of conditions regarding the test results. Repeat tests after a certain time may lead to completely different results because of reduced stickiness.

So, it can be stated that the MDTA 3 unit is very suitable for the detection of sticky cotton. This opens up new possibilities to eliminate critical cottons before processing. And, it can be assumed that the detection of some single fibres sticking to the rotor wall will probably cause troubles in processing.

Now, I hope that I've been able to demonstrate the essential aspects of the 'yarn engineering'.

Summary

So - as a short summary - the following can be stated:

Quickspinning is applicable to:

- Raw material evaluation
- Process control
- Process optimization
- Blend optimization with regard to quality and price
- Determination of degree of stickiness