USTER® *SLIVER STATISTICS*

Contents 1

1 Introduction

More than half a century ago, in 1957, the USTER® *STATISTICS* were published for the first time. With every new edition, the STATISTICS have been improved and extended by additional quality parameters and raw materials. The 1997 USTER® *STATISTICS* offered a worldwide innovation by providing fiber data and information on the effect of fiber characteristics on processing for the first time.

The success story of the USTER® *STATISTICS* originated from a communication deficit. Even today, there are many industrial sectors where standardized criteria to describe the quality still do not exist. This fact has prompted Uster Technologies to establish such standards in a pragmatic and applicable format. They have finally come into being and quickly gained acceptance as a result of making objective instrument measurements available to the worldwide textile community. Today, the USTER® *STATISTICS* are therefore appreciated as a universal language of quality.

With the present edition, we are presenting statistical information on the quality of sliver-regulating machines. All data and evaluations have been determined online on the finisher drawframe with USTER® *SLIVERGUARD* with an FP-sensor. The USTER® *SLIVER STATISTICS* contain quality data for the mass evenness of slivers. An evaluation of thick places was not made as the limit settings are handled differently in the spinning mills. But to give you some support in this case, we are providing extensive literature on this subject.

Today, the USTER® *STATISTICS* are utilized in many different ways. Unfortunately, there have been cases in the past where the STATISTICS have been corrupted, either deliberately or unintentionally. To prevent such cases in the future, we strongly recommend that the restrictions be read carefully and kept in mind. However, when employed properly and sensibly – as is the case with most customers – the USTER® *STATISTICS* are an important and useful tool for the textile industry.

At this point, we are showing Table 1. It illustrates the improvement in sliver evenness for the period from 1957 to 2009. The year 1957 was chosen as a starting point because STATISTICS for slivers were published for the first time. Of course, online measuring systems did not exist in 1957, so the diagram is based on the evenness values of the USTER® *TESTER* up to 1989. Since 2001, the evenness of regulated finisher drawframe sliver has been determined with USTER® *SLIVERGUARD*. The indicated values correspond to the 50% line of the CV_m. As with the USTER® *STATISTICS* for yarns and fibers, there has been a continuous improvement in the sliver evenness with drawframes.

Year	**CV_m [%]** **Cotton 100% carded** **4.25 ktex** **Finisher drawframe**	**CV_m [%]** **Cotton 100% combed** **3.9 ktex** **Finisher drawframe**
1957	5.6	4.2
1972	4.7	3.0
1989	4.3	3.2
2001	3.0	2.2
2009	2.6	2.2

Table 1 Improvement in sliver evenness (CV_m) over a period of over 50 years according to the 50% line of the USTER® STATISTICS

In the years from 1957 to 1972, there has been a marked improvement in the sliver evenness. For the most part, this can be attributed to the development of high-performance drawframes and drafting units since the early fifties. The development of those drawframes, which at that time were revolutionary, was made possible only with the invention of the evenness tester. Another reason for this improvement in sliver evenness is the modernization of the blowroom and carding equipment.

From 1972 to 1989, there has been only a small improvement and in parts even a deterioration of the sliver evenness. That does not mean that the machines of the spinning mill were not further developed. But the machines of that generation operated at much higher production speeds than the drawframes of 1957. An example: A 1957 drawframe had a production speed of 50 m/min, whereas the drawframes of the seventies already produced at a speed of up to 300 m/min. Now, faster does not necessarily mean worse. But with the same sliver count, the drafting equipment has to work much more accurately at high speeds to avoid a loss of quality. The increase in production speed was only made possible with the use of leveling systems. However, the first autolevelers only had long-term leveling. This is another explanation as to why there has been hardly any improvement in the evenness between the years 1972 and 1989.

In the year 1985, the first autolevelers with short-term leveling came onto the market. With this outstanding development, it is now possible to produce sliver with excellent evenness values. Due to the fact that the leveling has been continuously improved over the years, it was possible to increase the drawframe speed to over 1000 m/min. This technical progress is also reflected in the USTER® *STATISTICS*, which indicate a marked improvement in sliver evenness between 1989 and 2009. However, the improvement of the CV_m by 1% (ring spinning, combed) or 1.7% (ring spinning, carded) cannot only be attributed to the short-term leveling but is of course also a result of the online measurement directly at the drawframe. This prevents slivers from being damaged during transport and therefore a possible negative effect on the measurement result at the evenness tester. But if the slivers are handled with care, it is quite possible to compare the results of the USTER® *SLIVERGUARD* with those of the USTER® *TESTER*.

2 Restrictions

This section addresses the restrictions that apply to the use of the USTER® *STATISTICS* and we would like to repeat our advice that this be read carefully and adhered to. Both deliberate and unintentional misuse of the STATISTICS have in some instances in the past resulted in lengthy and costly disputes – all of which could have been avoided if all parties involved would have the same clear understanding of the concept underlying the USTER® *STATISTICS*. The reading of this section is a must for those who are not familiar with that concept, with the USTER® *STATISTICS* as such, or with the proper interpretation of the data.

Four primary variables have a decisive impact on corporate success in our textile environment as well as in any other industrial venture: man, machine, material and know-how or information in general. Among these four key elements, the raw material is the crucial component that largely dictates quality but also productivity and cost in yarn manufacturing. By virtue of their design, the USTER® *STATISTICS* do not provide direct access to information about the raw material used for spinning. However, those differences in raw material usage are indirectly reflected in the data. A high-quality yarn can only be spun from high-quality raw materials, and since the raw material frequently accounts for more than 50% of the total manufacturing cost in the medium to fine count range, the utilization of high-quality, high-priced raw materials will be proportionately reflected in the yarn price. Any measures taken in the field of raw materials will not only have a considerable impact on quality but also on a mill's competitiveness and bottom-line profitability. In those rare cases where the STATISTICS have been corrupted, the motives have always been related to what evidently is the single most important driving force in the global textile scenario: price.

The USTER® *STATISTICS* should not be interpreted as saying 5% is 'good'. On the contrary, the 5% line might be indicative of high cost, high price, luxuriousness – even a tendency to price oneself out of the market. By the same token, 95% should not imply 'poor' – it might be indicative of a very attractive price and just the right quality for the target markets. A 'good' spinner is actually one who is in a position to achieve an acceptable quality level from a less expensive fiber – the genuine mastery of spinning. The trouble starts when the USTER® *STATISTICS* are quoted in order to corroborate complaints about a low rating in certain quality categories. This complaint may be directed at the 'good' spinner who produces a reasonably priced yarn from a reasonably priced fiber. Yarn price, however, is directly proportional to fiber quality and fiber quality in turn dictates sliver and yarn quality to a great extent. Consequently, pushing yarn quality towards better values would simply cannibalize the price advantage. The USTER® *STATISTICS* should be employed as what they really are – a global survey of the quality of slivers as produced in every part of the world. Whether or not these slivers are produced economically from adequate raw materials and offered at a legitimate price is certainly beyond the scope of the STATISTICS.

It is a popular illusion that slivers with a high rating according to the USTER® *STATISTICS* are always above and beyond suspicion. A good overall quality does not only encompass excellent mean values but also low variability of the quality parameters between slivers as well as unconditional consistency. A faulty sliver production for one minute on a finisher drawframe, for example, is bound to ruin several hundred meters of fabric in the knitting or weaving mill.

We have come a long way in detecting and eliminating sporadic sliver and yarn faults with online data systems. Every now and then, however, various quality and productivity problems tend to occur with malicious persistence in spite of the blind faith often put in the USTER® *STATISTICS* ratings. These include outliers, mix-ups, damaged cans, problems with the correct sliver delivery into the can, inadequate machine maintenance, improper sliver piecing – just to name a few.

Last but not least, a few comments on reproducibility and variability of measurement values. No matter what measuring instrument is used – from yardstick to atomic clock – there will always be a certain measurement error.

This is also true for textile testing. There are three types of measurement errors: avoidable error, systematic error (bias), and random error. Avoidable errors encompass the failure to choose an appropriate measurement method or to properly operate a measuring instrument. For USTER® *SLIVERGUARD*, this is of little significance, but the setting of the machines from the sensor all the way to the sliver delivery into the can present a potential source of avoidable errors. Systematic errors can result from incorrectly set sliver guides, calibration errors, wrong setting of the linearity factor and instrument tolerances. This type of error can be quantified fairly accurately. Random errors are the most critical component in textile testing. It is predominantly caused by the variability of the tested sliver itself. Its magnitude can be approximated by statistical calculations – the confidence range of the mean value. The absolute error of a measurement is the total of all three types of errors. A measurement should therefore always be reported as $\bar{x} \pm \Delta x$, i.e. the arithmetical mean value plus/minus the total error, to indicate that the true measurement value is located somewhere within that interval.

When comparing actual measurement results with the data illustrated in the USTER® *STATISTICS*, it is of utmost importance that the total measurement error is kept to an absolute minimum to warrant compatibility. If this is not the case, false conclusions may be drawn from such a comparison. There are three things that can be done to minimize the measurement error:

- exact calibration and setting of the USTER® *SLIVERGUARD*
- correct setting of tensioning draft and sliver delivery at the machine
- adequate sample size

When actual measurement values are then compared with the USTER® *STATISTICS*, they would appear in the nomogram as a short vertical line – not as a dot. The top and bottom ends of that line represent the upper and lower limits of the confidence range with the mean value exactly in the middle. We cannot eliminate the influence of this error, but the confidence range becomes smaller when the sample size is increased.

If two consecutive measurements of the same sample produce different values, it often turns out that the basic conditions listed above have been ignored or that these have simply not been identical in the two testing periods. The problem can be quickly resolved by applying the t-test procedure.

With this procedure, it can be shown that the differences are not statistically significant but strictly random due to pronounced sample variability. A simplified t-test can be performed by comparing the confidence ranges: If the confidence ranges of the two means overlap, then the observed difference between the two means is random or statistically insignificant; if they are separated, the difference is considered statistically significant. Applying the concept of the confidence range can be both very helpful and revealing. It pinpoints the highly variable characteristics of textile materials that should always be taken into consideration.

3 The Making of the USTER® *STATISTICS*

The USTER® *STATISTICS* for slivers are established by collecting quality data on-line with the USTER® *SLIVERGUARD* in the spinning preparation of short-staple spinning mills. The collection of data was procured worldwide via our service engineers directly in the spinning mills and are based on the measurement results of a total of 800 deliveries of finisher drawframes.

The fact that most measurement values originate from Asia has to do with the strong presence of USTER® *SLIVERGUARD* systems in this market, but also with the fact that Asia has become the center of the textile industry.

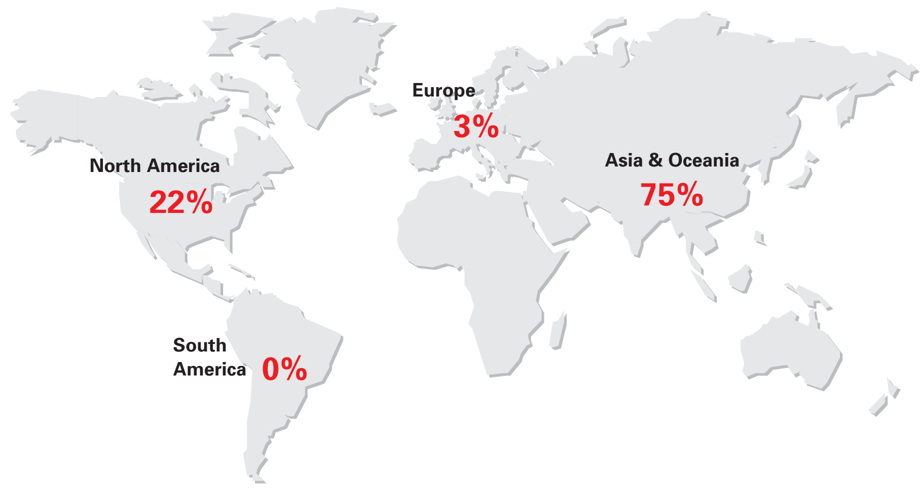

Fig. 1 Geographical distribution of the origin of all data procured for the USTER® SLIVER STATISTICS

All data were entered into a databank. The calculation of the percentile curves and the preparation of the nomograms were carried out with application software that has already been used with previous USTER® *STATISTICS*.

4 Interpreting and Applying the USTER® *STATISTICS*

The USTER® *STATISTICS* for slivers consists of several parts, each addressing a specific quality aspect in the production sequence of fiber slivers in the short-staple spinning mill. The different sections are arranged according to the material composition. Each section is subdivided into distinct quality characteristics (e.g. mass variation, etc.) which were recorded with USTER® *SLIVERGUARD*. These parameters are presented in graphic form. A register is provided for quick reference to the sections of interest.

The most important elements of these USTER® *STATISTICS* are the nomograms with the percentile curves, which were already used with the USTER® *STATISTICS* for fibers and yarns. The width of the percentile curves intentionally imposes certain restrictions on accuracy, but it is also an indication of the pronounced variability of most textile measurements. The x-axis should be the starting point of any analysis. The percentile curves refer to the percentage of the total world production that equals or exceeds the measurement value given for a particular sliver count. An example:

The coefficient variation of sliver mass of a Ne 0.12 (4.9 ktex, 69 gr/yd) finisher drawframe sliver of combed cotton is measured at CV_m = 2.0±0.04% by the USTER® *SLIVERGUARD*. A vertical line drawn from the x-axis at Ne 0.12 intersects with the two horizontal lines drawn from the y-axis at 1.96% and 2.04% (lower and upper confidence range) right at the 25% line. Hence, only 25% of all Ne 0.12 combed cotton drawframe slivers produced worldwide have a CV_m of 2.0% or better. Vice versa, 75% of the total world production of comparable Ne 0.12 drawframe slivers have a CV_m higher than 2.0%.

The 50% line corresponds to the median. In general terms, the median is the middle number when the measurements in a data set are arranged in ascending (or descending) order. This means that 50% of all observations exceed this value and the other 50% lie below. Depending on whether the frequency distribution of a given quality parameter is symmetric or skewed, the median may or may not be different from the arithmetical mean value.

Some USTER® *STATISTICS* nomograms are labeled 'provisional' to indicate that the respective data are based on less than 100 samples. As with the USTER® *STATISTICS* for fibers and yarns, the limiting sample size of 100 was chosen arbitrarily but applied consistently. With sample sizes lower than 100 and greater than normal spread of the data, only the 5%, 50%, and 95% line is shown. Diagrams that are labeled 'provisional' are neither inaccurate nor considered unimportant, they are simply subject to change in the form of a partial revision at a later date.

5 Sliver Quality

We are presenting STATISTICS on quality data of online measurements as determined with USTER® *SLIVERGUARD*. They replace all of the offline data published earlier.

One aspect that has frequently led to disagreements and confusion relates to the differences between the online measurement with the USTER® *SLIVERGUARD* and offline testing in the laboratory with the USTER® *TESTER*. These deviations can result from faulty deliveries or from damage caused during transport to the laboratory. Another factor that cannot be ignored is that the measurement with the USTER® *SLIVERGUARD*, equipped with the USTER® *FP-SENSOR*, takes place before the delivery rollers and therefore before the sliver delivery into the can. With properly maintained and correctly set machines, the influence of the sliver delivery on the coefficient of variation should be less than 0.1%.

5.1 Mass Variations

The determination of yarn and sliver mass variation with the USTER® *TESTER* needs no introduction. The sliver measurement data provided in these USTER® *STATISTICS* have been determined with USTER® *SLIVERGUARD*, which is comparable to the USTER® *TESTER* with regard to measuring accuracy. The quick-response USTER® *FP-SENSOR* permits sliver measurements that are equivalent to those carried out offline with the USTER® *TESTER* in the laboratory. In practice, and provided the above-mentioned sliver delivery aspects are kept in mind, the results of the USTER® *SLIVERGUARD* can therefore be compared with the measurements of the USTER® *TESTER*. The USTER® *STATISTICS* on sliver mass variation include nomograms on the coefficient of variation of sliver mass (CV_m, $CV_{m(1m)}$, $CV_{m(3m)}$, $CV_{m(10m)}$).

Proper maintenance of the USTER® *SLIVERGUARD* is a necessary prerequisite to make correct comparisons between the actual measurements and the USTER® *STATISTICS* on sliver mass variation. If the customer is in possession of the «USTER® *FP-MT* test set», he can carry out the calibration of the USTER® *SLIVERGUARD* himself. Otherwise, it should be left to authorized Uster Technologies service personnel.

Further explanations of the individual functional elements of USTER® online systems for the measurement of sliver mass variation, the significance of the measurements, and the proper calibration and operation of the systems are given in the respective operating instructions.

5.2 Testing Conditions

Parameter	**Description**	**Unit**	**Reference length**
Mass variation	CV_m	%	100 m
	$CV_{m(1m)}$	%	100 m
	$CV_{m(3m)}$	%	100 m
	$CV_{m(10m)}$	%	100 m

6 Validity

The information provided with this edition of USTER® *STATISTICS* supersedes all the descriptions pertaining to sliver quality published in previous editions of the USTER® *STATISTICS*. The quality and productivity of industrially manufactured goods are variable parameters. They depend on a multitude of factors, most of which are an intrinsic function of time. The dependence on time is predominantly related to the state of technology of the productive assets and the technological know-how prevalent in the industry. Time is also a factor in determining the overall economic environment. All of the above, acting jointly or separately, may have an effect on the quality and productivity of semiprocessed textile goods. Consequently, the information provided in the USTER® *STATISTICS* is confined to the period of time actually covered by the data. The data are essentially of historical value by the time this document is published. Naturally, such information will not sustain its initial significance as time progresses and will eventually become obsolete unless it is updated at some point in the future. Therefore, the information presented in this document in either verbal, numerical or graphic form is subject to change at any time without prior or public notice. However, the USTER® *STATISTICS* will certainly maintain their significance over an extended period of five years or more.

With no exceptions, all the information provided in the USTER® *STATISTICS* relates to data that have been established using USTER® *SLIVERGUARD*, which is designed, manufactured and distributed exclusively by Uster Technologies, Switzerland. Any attempt to utilize the information provided in this document in conjunction with data originating from sources other than USTER® *SLIVERGUARD* may result in some form of failure or damage. The USTER® *STATISTICS* are intended for use as a manual of comparative statistics complementing the operational installations of USTER® products at the customer site.

7 Disclaimer

This publication and the information provided therein is for intended use only and subject to change at any time without prior or public notice. Uster Technologies will not assume liability for any direct or indirect damage resulting from unintended use of this publication or the information provided therein. The use of this information for performance guarantees relating to textile production plants, textile machines or parts or accessories thereof is discouraged unless clear reference is made to this publication or parts thereof and clear numerical specifications, tolerances and restrictive clauses pertaining to other known influences on the specified performance are provided in the guarantee documents.