USTER® *QUANTUM 2*

APPLICATION REPORT

Current trends to improve the yarn quality in spinning mills

THE YARN QUALITY ASSURANCE SYSTEM

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Think quality

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1 Introduction

Today the textile industry is facing higher competition in the globalized market than ever before. The overall level of quality is increasing constantly. Due to steadily growing production capacities, the quality consistency must be improved. Especially in the booming countries like China, India, Bangladesh, Vietnam and Indonesia, the yarn quality is improving rapidly.

International sourcing, long distances, the danger of claims due to late delivery or the deterioration of quality are gaining more and more the attention of the textile community. One option to handle these strong requirements is the "Think Quality Concept" of Uster Technologies. The concept describes how the spinning mill has to use the available information and convert the readings into actions to improve the quality and to minimize the variations within the daily production. It also includes the elimination of outliers.

This article explains how to improve quality by means of a modern quality management. For this purpose examples of Chinese spinning mills are used.

2 Principles of a quality improvement

The spinning process can be divided into four main important sections as shown in Fig. 1.

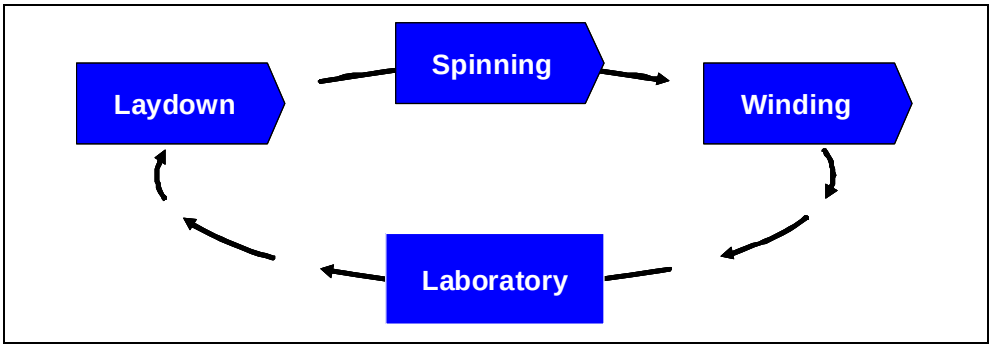

Fig. 1
Existing quality circle of spinning mills

The bale lay-down and the bale management are the platform of the yarn quality consistency. Only a few bales which are not monitored properly can deteriorate the whole quality level of the current production. Even by using the entire know-how available and the most modern machines, the fiber characteristics such as micronaire, length, strength, etc., do not improve during the spinning process.

Currently the spinning mill has to avoid to reach the opposite, i.e. a deterioration of the fiber quality parameters during the spinning process. The spinning mill has to produce a yarn which should fulfil the agreed requirements of the customers.

During the yarn manufacturing process the spinning mill has to use the installed machines and the technology parts and resources which are defined by the management. In some cases it might be needed to change the machines or lower the production to a certain extent to optimize the quality. However, this may not be accepted because the production costs are already calculated and cannot be altered anymore. The last stage of the ring spinning process, the winding machine, plays the key role of quality assurance.

The entire production of a ring spinning installation will pass this final quality control check through the yarn clearer. This sensor has to check 100% of the production. The measurement has to take place at very high speed, and it must be assured that no disturbing defect will pass.

3 Bale lay-down management

As already mentioned, the fiber blend and its homogeneity is one of the keys for a high yarn quality. If the fiber characteristics chosen are wrong or beyond the acceptable limits, there is no possibility to produce a good yarn even using most modern machines and best spinning technologies. The knowledge about the accepted variations of fiber characteristics is published and discussed already to a large extent.

The basics for a quality consistency is a proper bale management system. On one side the modern fiber testing instruments such as the USTER® *HVI* 1000 are able to measure the most important fiber characteristics such as the length, the length variation, the micronaire, the strength and elongation, the colour expressed by Rd and +b but also the maturity ratio, the number of neps, etc.

Some cotton producing countries already supply all the bale data tested on USTER® *HVI* instruments along with every bale. This allows the spinning mill to store the bales according to selected quality characteristics in the warehouse.

However, particularly in the Asian countries, this information is not available for every bale. The mill owner is also not aware of a single bale testing requirement. In order to produce a yarn of certain quality characteristics it is a must to keep the major fiber parameters within defined limits, but also the maximum variations of these parameters. An average micronaire level of 4.2 does not guarantee a high quality yarn if the micronaire varies from 3,3 to 5,2. Practical experience has shown that the yarn remains within narrow quality limits if the variation of the fiber quality characteristics is small. It is a must to define the maximum or minimum level of each quality characteristic in addition to the mean values.

It is useful to establish a procedure of infeed test of the card. The example shown in Fig. 2 is the average of the card infeed of a ring spinning line if single bale data is not available for all bales.

The sampling rate shown is once per shift and tested by means of an USTER® *AFIS* and USTER® *HVI* system. In this mill the lay-down was made with tests of only 10% of the bales.

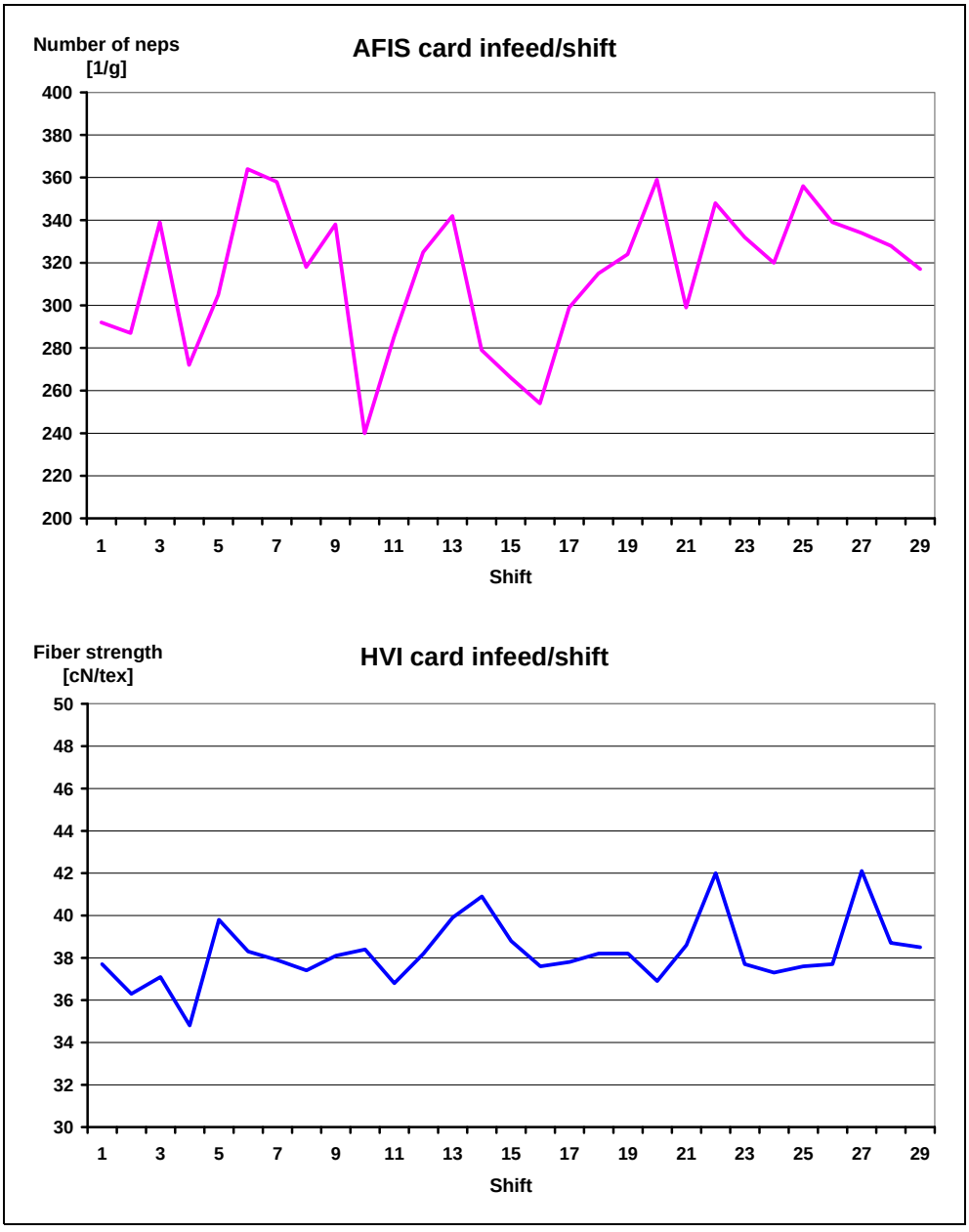

Fig. 2
In feed test of the card. Sampling rate every 8 hours.
USTER® *HVI:*
Fiber strength cN/tex,
USTER® *AFIS: Neps/g.*

4 Spinning process

Fig. 2 shows that the variation of the two quality characteristics in this mill at the input of the card is considerable. The number of neps varies from 240 to 360 per gram, the fiber strength from 35 to 42 cN/tex. This will result in significant variations of the yarn quality characteristics as well.

Today spinning mills in some Asian countries are mainly of larger size like 100'000 spindle units or even higher numbers. For Chinese installations this can be up to 300 single ring spinning machines under one roof. All these machines will produce bobbins which will be mixed up at the stand alone winding machines. The challenge is to assure that all machines are running under constant conditions to produce as low quality variations as possible. Modern machines and a wide-spread knowledge of the spinning process will assist to produce a yarn of a good quality level. Mainly the lack of training of the workers or a bunch of small deteriorations will create outliers which are nearly invisible in the whole production lot. Mostly after the weaving or knitting, e.g. after producing added value, these outliers will show up as defects and downgrade the whole fabric.

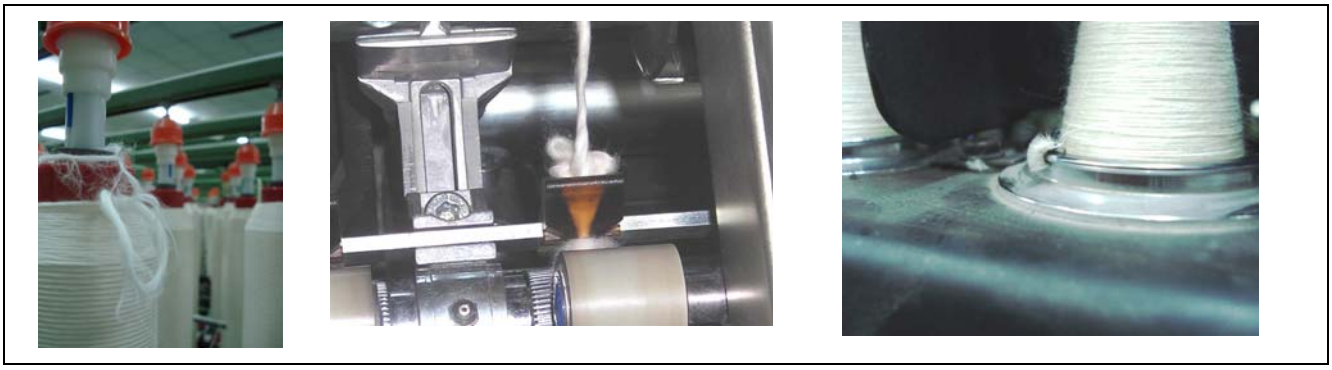

Fig. 3 Typical reasons why quality outliers are produced. From left to right: Damaged roving / Roving fragments in the trumpet which case additional mass variations / Ring traveler with fiber fragments.

5 Yarn clearer

A modern yarn clearer does not only detect the disturbing thick or thin places and foreign fibers. It also provides all the important quality characteristics of the yarn of the entire yarn production, except the strength and elongation values.

In order to judge the quality of a yarn, the first step is to decide the limits for outliers and, afterwards, the customer has to decide whether they have to be eliminated.

Fig. 4 represents a scatter plot of all detected thick and thin places of a yarn. The measured yarn length was 1000 km. The red dots are thick and thin places which have to be eliminated because they will be disturbing in a fabric. These yarn faults are separated from the tolerated faults by the red clearing curve.

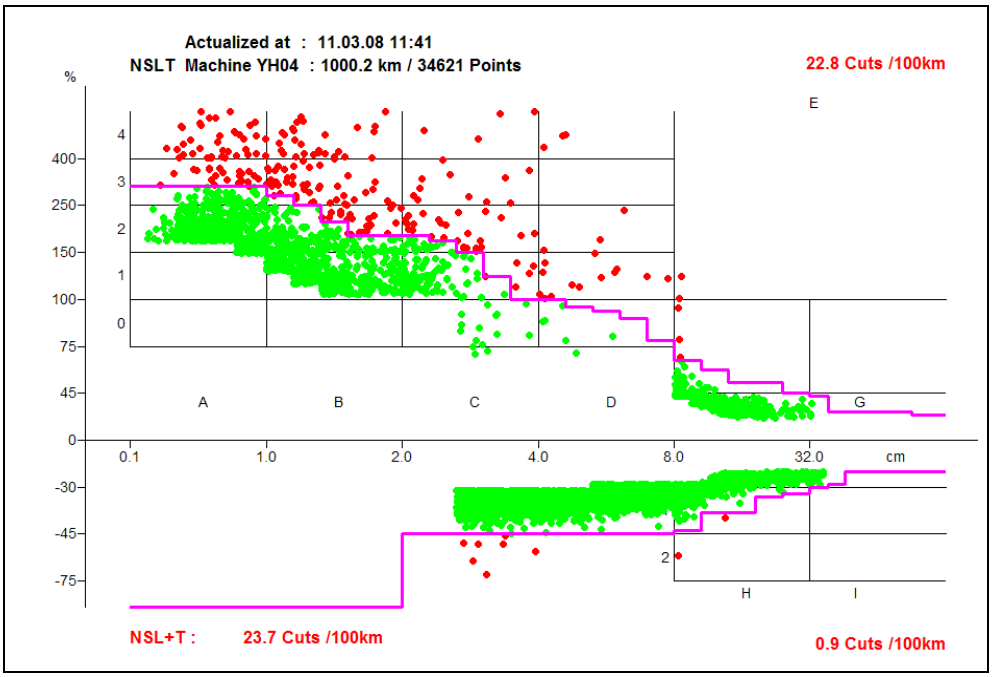

Fig. 4
Scatter plot of thick and thin places of a ring spun yarn, 100% cotton, Ne 40/1, carded, test length 1000 km / Horizontal axis: Fault length / Vertical axis: Mass increase or decrease

Besides the common task to detect and eliminate outliers such as thick and thin places or count variations the yarn clearer plays a major role for the quality assurance.

Single bobbins which are beyond the defined range of yarn characteristics can be ejected. The spinning mill can establish a spindle identification procedure by identifying and tracing back the defects to their origin. Afterwards, the overall quality level will improve because the source of the quality deterioration can be eliminated (Fig. 3).

It is of course a must to use the same language like in the laboratory. Therefore the USTER® *QUANTUM* determines the evenness CVm, imperfection values and hairiness as known from the USTER® *TESTER* system in the laboratory.

The data acquired from the clearer directly on the winding machine at high speed shows a very high correlation to the results from the laboratory under constant climatic conditions and defined testing speed.

Fig. 5
On-line yarn imperfections of a Chinese ring spun yarn, cotton 100%, Ne 40/1, quality display of USTER® *QUANTUM*

Besides the actual quality readings additional functions such as the continuous count channel CC and the detection of periodic defects by means of the Pearl Chain Channel (PC-channel) is nearly a must in modern spinning mills.

6 Laboratory

Still today in many spinning mills the laboratory is used to determine a lot of single results, without analyzing the data in detail. A well organized and perhaps also ISO certified testing routine is well established. The task of the laboratory is defined to concentrate mainly on routine tests and only in special cases to assist product development or to assist during article change.

But this process should be changed. If a bobbin with quality characteristics beyond tolerance is detected in a sample of 10 bobbins, it can be expected that this bobbin is not the only outlier.

s	Ma No	S	Po	Run time min	Lengt km	Neps +200% /km	Thick +50% /km	Thin -50% /km	IP Eval length m
1	M09	2	13	245	208.0	63	34	2	1000
1	M09	2	14	204	170.2	66	16	0	1000
1	M09	2	15	192	160.4	86	10	1	1000
1	M09	2	16	162	134.8	64	22	1	1000
1	M09	2	17	193	157.0	94	29	0	1000
1	M09	2	18	211	174.0	64	34	0	1000
1	M09	2	19	208	173.6	78	24	0	1000
1	M09	2	20	231	190.4	78	35	1	1000
1	M09	2	21	181	151.0	72	25	1	1000
1	M09	2	22	150	124.2	77	21	0	1000
1	M09	2	23	193	160.6	214	55	2	1000
1	M09	2	24	141	117.8	65	31	2	1000
1	M09	2	25	253	206.8	87	27	0	1000
1	M09	2	25	106	87.8	76	25	3	1000
1	M09	2	26	275	227.8	74	35	0	1000
1	M09	2	26	100	82.4	82	29	3	1000
1	M09	2	27	268	221.4	207	42	10	1000
1	M09	2	27	108	90.0	74	14	3	1000
1	M09	2	28	250	212.8	85	34	2	1000
1	M09	2	28	97	82.4	107	25	2	1000
1	M09	2	29	270	225.2	73	21	1	1000
1	M09	2	29	105	87.0	78	29	3	1000
1	M09	2	30	232	186.2	76	16	0	1000
1	M09	2	30	95	76.4	82	31	3	1000
1	M09	2	31	268	222.2	80	22	0	1000
T				181	12579	83	28	2	1000

Fig. 6
On-line yarn imperfection measurement of a Chinese ring-spun yarn, cotton 100%, Ne 80/1. The bobbins at winding positions 23 and 27 are beyond the given limits for neps +200% of 130 per km.

A procedure must be established that if there is one single test beyond the defined quality range, the source of the problem must be found, analyzed and solved. Therefore, the yarn clearer on the winding machine has to take over a significant part of the quality assurance in the spinning mill because 100% of the yarns are monitored by this sensor. Outlier bobbins which are ejected at the winding machines will be tested in the laboratory to determine the action plan for the repair crew. In addition, the laboratory has to determine the quality level of the regular production.

Fig. 6 shows that two bobbins were detected on a winding machine (positions 23 and 27) which are beyond the defined limits for neps of 130 per km. These bobbins were afterwards tested in the laboratory for a detailed analysis.

Fig. 7 shows how the limits can be set at the Central Unit of the clearer.

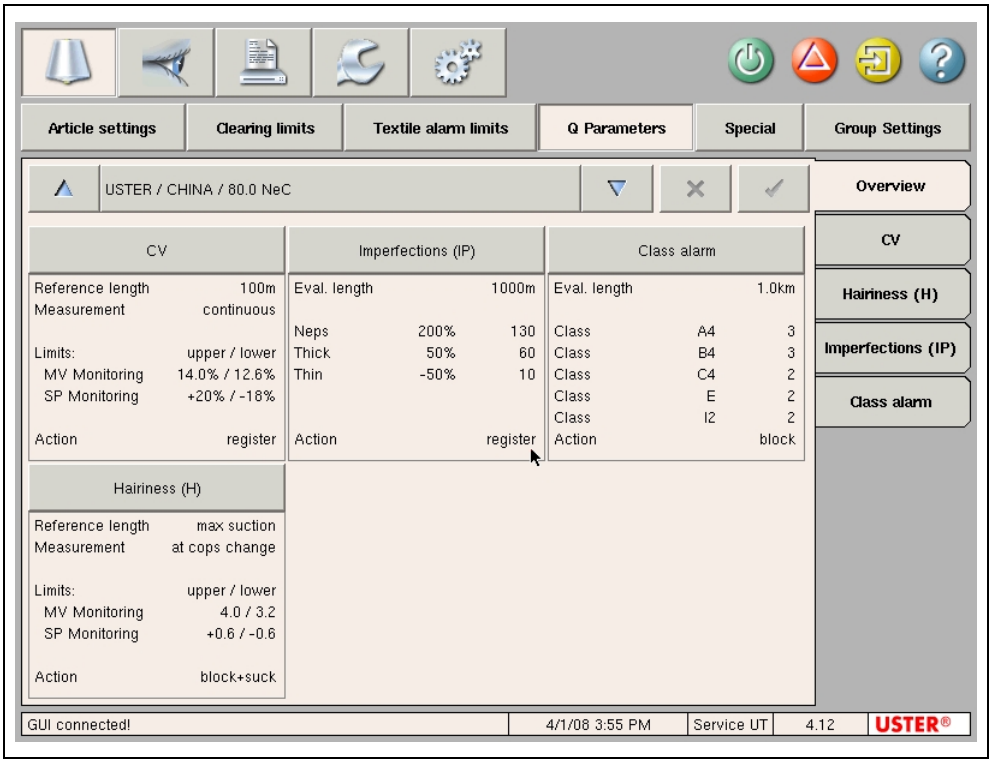

Fig. 7
Limits set for yarn quality parameters for a combed ring-spun yarn, 100% cotton, Ne 80/1

7 Summary

An overall quality management concept is essential to deal with the quality challenges in modern spinning mills. This has to include effective bale management, fiber process control and the elimination of outliers using sophisticated yarn clearers for final quality inspection.

A modern yarn clearer on the winding machine is now a multi-purpose sensor which cannot only eliminate disturbing thick places, thin places and foreign fibers. It can also determine quality characteristics such as the evenness, the imperfections, the hairiness, etc. Therefore, the clearer can also be used to separate bobbins which are beyond the quality range defined for a specific yarn. Such bobbins can be ejected at the winding machine and tested in the laboratory. Laboratory systems allow a very detailed analysis of outliers. The laboratory prepares the action plan for the repair crew. This “closed loop system” permits the systematic elimination of outlier bobbins and represents a modern method for a continuous process.

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