USTER® *TESTER 5-S800*

Application Report

High-speed testing in textile laboratories

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1 Introduction

The measurement of quality characteristics in textile laboratories of spinning mills at high speed has various advantages. Therefore, manufacturers of testing systems try to develop instruments which operate at the highest possible speeds. The following are the most important reasons why high testing speeds are recommended:

- The results are statistically more significant
- The testing time can be shortened
- More rovings and slivers can be measured in the same period
- Periodic mass variations can be detected throughout the entire spinning process
- The sequence of yarn sample testing can be optimized in a way that every testing system in the laboratory requires the same duration to measure 10 or 20 bobbins.

When Uster Technologies decided to develop the USTER® *TESTER 5* it was the intention to increase the test speed of slivers, rovings and yarns by 100%. Fig. 1 shows the USTER® TESTER 5, a multi-purpose laboratory system for the measurement of spun yarns.

Fig. 1
USTER® TESTER 5

2 Development of testing speed in the history of evenness testers

Evenness testers have to provide reproducible results. At higher test speeds, measures have to be taken with respect to sliver, roving and yarn guiding elements to avoid the formation of additional mass variations, thin places, thick places and neps. Therefore, quantum leaps in the textile measuring technology require extended feasibility studies with respect to sliver, roving and yarn guiding.

Fig. 2 shows the development of the testing speeds for slivers and rovings and Fig. 3 shows the same for yarns. The two figures also demonstrate that the quantum leaps concerning test speeds have taken place with the introduction of new generations of testing systems.

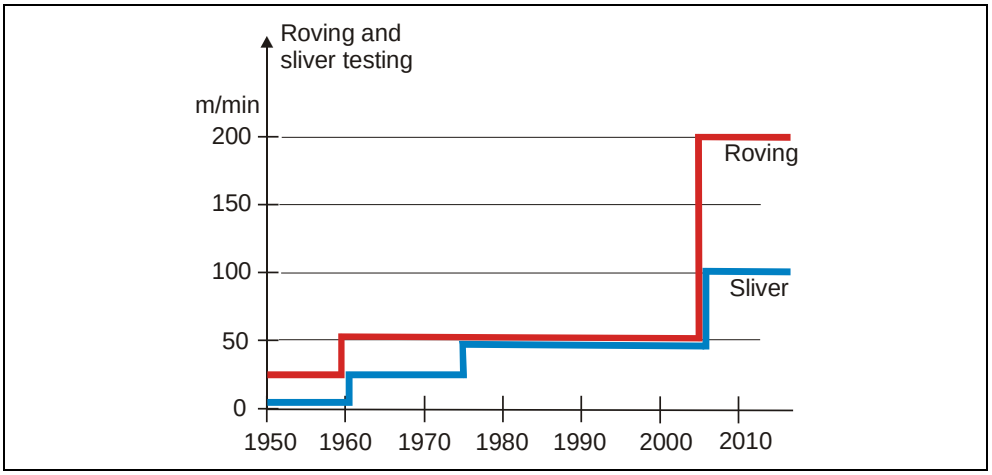

Fig. 2
Development of testing speeds for roving and slivers

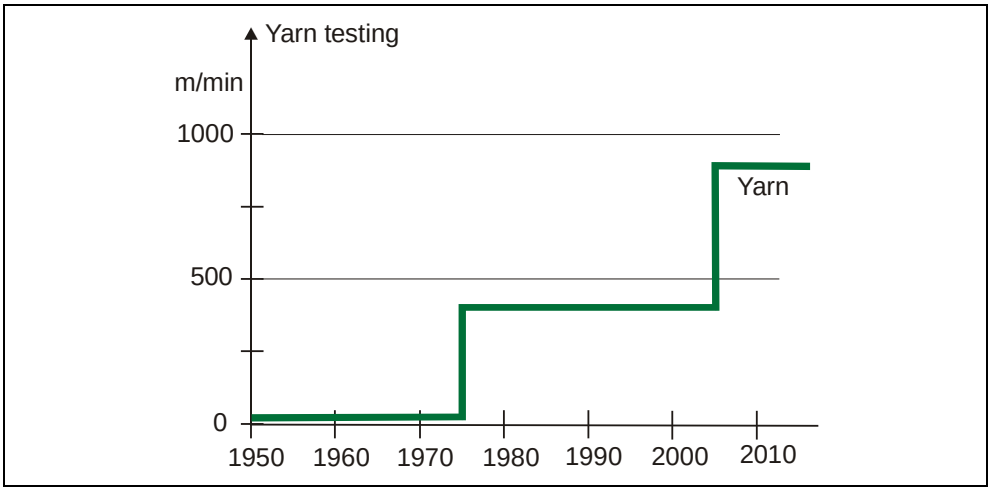

Fig. 3
Development of testing speeds for yarn

Fig. 2 shows that the speed for slivers could be increased since 1960 by more than 10 times, the speed of yarns by more than 30 times.

For the first generation of evenness testers the test speed for slivers was 8 m/min, for rovings and yarns it was 25 m/min.

The following description deals with the newly developed USTER® *TESTER 5*. With this multi-purpose instrument for the analysis of slivers, rovings and yarns in textile laboratories, the guiding elements for the test specimens were improved to such an extent that the test speed can be twice as high compared with the previous generation of instruments.

3 Reduction of test time

Table 1 shows the test duration for 100 bobbins, 1'000 m yarn per bobbin, at a speed of 800 m/min. Table 2 shows the test duration for the same number of tests at 400 m/min. The time saving is considerable. In our calculation it is 2 hours and 5 minutes.

Measurement at 800 m/min	Required time span
Settings of the USTER® *TESTER 5*	1 min
Preparation of the bobbins	20 min
Total test time at 800 m/min / 1 km test length	166 min
Test time required for 100 bobbins	187 min = 3 h 7 min

Table 1
Test time required for 100 bobbins at 800 m/min

Measurement at 400 m/min	Required time span
Settings of the USTER® *TESTER 5*	1 min
Preparation of the bobbins	20 min
Total test time at 400 m/min / 1 km test length	291 min
Test time required for 100 bobbins	312 min = 5 h 12 min

Table 2
Test time required for 100 bobbins at 400 m/min

In order to understand the durations mentioned in Table 1 and Table 2 we have to consider the following:

Setting of the measuring conditions of the USTER® *TESTER 5*	1 min
Handling of 100 bobbins / removing measured bobbins and creeling of new bobbins in sample sizes of 10	20 min
Entire test time for 100 bobbins, 800 m/min, 1,25 min (Table 1)	125 min
Total time needed by the instrument between two tests (90 x 0,45 min)	41 min
Printout of 4 data sheets after the measurement of 10 bobbins (1,75 min, but it will happen during the change of the bobbins)	0 min
Total (Table 1)	187 min

If a speed of 400 m/min is selected, the total testing time is 100 x 2,5 min = 250 min instead of 125 min. All the remaining time requirements will be the same.

This will result in a total test time per 100 bobbins of 312 min or 5 hours 12 min.

Therefore, at a test speed of 400 m/min the operator need 67% more time.

4 Optimization of the test sequence in a spinning laboratory

In a textile laboratory, it is of utmost importance that the duration of tests for a yarn sample is equivalent for each testing system. The following comparison shows how the quality characteristics shown below can be determined within an optimum time frame: evenness, imperfections, hairiness, diameter, diameter variation, roundness, remaining dust and trash, strength and elongation, count.

Example:

USTER® *TESTER 5*, 100 bobbins, test speed 800 m/min, test length per bobbin: 1'000 m according to Table 1.

Time required for evenness testing: 187 min

In order to determine the strength and the elongation, the USTER® *TENSOJET* was used. The USTER® *TENSOJET* needs the same time for the instrument setting and for the preparation of the bobbins (see Table 1). Therefore, 187 minutes remain for testing 100 bobbins. We also calculate 1 minute for the setting of the USTER® *TENSOJET* and 20 minutes for the entire bobbin handling. The print-out of the results after a measuring series of 10 bobbins can also be concluded during the handling of the bobbins. Therefore, for testing 100 bobbins a total time of 166 min is available. Since the USTER® *TENSOJET* is able to carry out 30,000 tests per hour, the system is capable of providing the following number of strength and elongation values in 166 minutes:

Number of tests per 100 bobbins: $\frac{166 \bullet 30'000}{60}$ = 83'000 tests

Number of tests per bobbin: $\frac{83'000}{100}$ = 830 tests

Conclusion:

In order to test 100 bobbins, test length 1'000 m, and to provide all the quality characteristics mentioned above, the USTER® *TESTER 5* needs 3 hours and 7 minutes. During this period, the USTER® *TENSOJET* is able to carry out 830 strength and elongation tests per bobbin. Therefore, the pace in a laboratory can be determined in such a way that the two most important instruments in a laboratory need the same time span to test 100 bobbins.

5 Higher testing speed for rovings and slivers

The measurement of slivers and rovings was improved to such an extent that most of these samples can be measured at double speed compared to the previous generation. For this purpose the active unwinding device was redesigned to allow higher test speeds. Fig. 4 shows the new unwinding device and the measurement of slivers.

Fig. 4
Improved Unwinding Device. The feeding of sliver is electronically controlled

It is recommended to install the evenness sensor MS 120 on top of the unwinding device for the measurement of bulky wool tops and converter tops.

6 Monitoring of the entire spinning process

The detection of periodic mass variations is a very important job in the spinning laboratory. It belongs to a systematic quality management in a mill. In order to detect periodicities in yarns, a periodicity has to occur at least six times to be classified as "periodic". Therefore, in order to detect periodicities up to a "wavelength" of 100 m, a test length of 600 m is required. Since the USTER® *TESTER 5* is able to test yarns at 800 m/min, periodicities up to a wavelength of about 130 m can be recognized within one minute.

Fig. 5 shows the range of machines in a carded cotton spinning mill which can be covered with the USTER® *TESTER 5*. At a test speed of 800 m/min and a maximum test time of 10 minutes, the spectrogram can cover a range from the ring spinning machine up to the card.

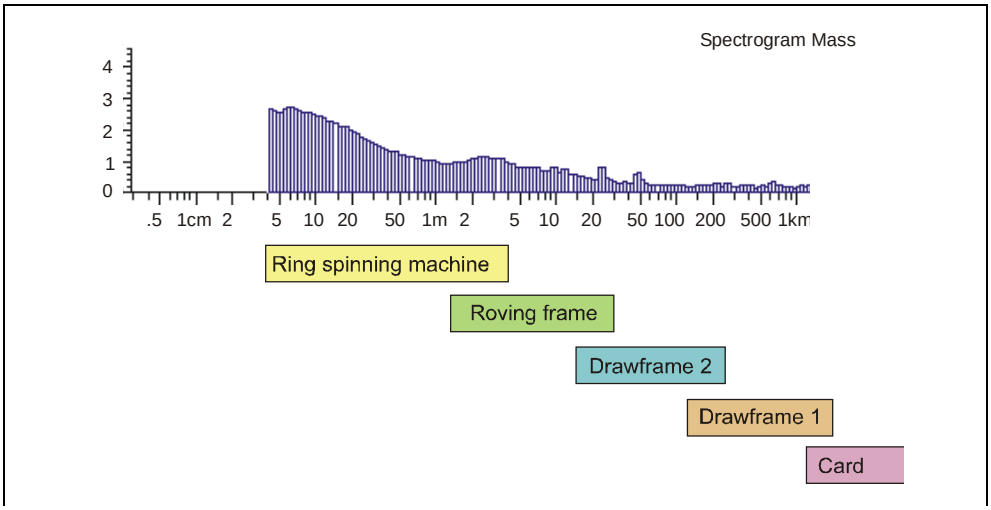

Fig. 5
Spectrogram length at test speed of 800 m/min, test time 10 min

Test speed	Test time	Length of spectrogram
800 m/min	10 min	1'300 m
800 m/min	5 min	650 m
800 m/min	2,5 min	325 m
800 m/min	1 min	128 m
400 m/min	1 min	64 m
200 m/min	1 min	32 m
100 m/min	1 min	16 m
50 m/min	5 min	40 m

Table 3 *Test speed, test time and spectrogram length*

7 Improvement of the test conditions in a laboratory

With the higher measuring speed of the yarn and with the increased measuring speed of roving, rubbing and sliver, we can give the following recommendation for the sampling and testing procedure in a ring spinning mill without online-monitoring systems. The figures in Table 4 are valid for a spinning mill with a size of about 35'000 spindles.

Machine	No. of machines or positions	Quality characteristics	Test intervals	Daily tests	Test speed	Test length	Required test time per day
Card	12	Evenness Diagram Spectrogram Variance-length curve	once per day	12	100 m/min	500 m	70 min
First draw-frame	2	Evenness Diagram Spectrogram Variance-length curve	once per day	2	100 m/min	500 m	15 min
Second draw-frame	2	Evenness Diagram Spectrogram Variance-length curve	once per day	2	100 m/min	500 m	15 min
Comber	12	Evenness Diagram Spectrogram Variance-length curve	once per day	12	100 m/min	500 m	70 min
Finisher draw-frame	5	Evenness Diagram Spectrogram Variance-length curve	once per day	5	100 m/min	500 m	30 min
Roving frame	600	Evenness Diagram Spectrogram Variance-length curve	once per month	20	100 m/min	500 m	120 min
Ring frame	35'000	Evenness Diagram Spectrogram Imperfections Hairiness Yarn diameter Density Trash Dust Count	once per 6 month	100	800 m/min	1000 m	191 min
Winder *	600	Evenness Diagram Spectrogram Imperfections Hairiness Yarn diameter Density Trash Dust Count	once per day	100	800 m/min	1000 m	191 min
Total							**702 min**

* Assumption: Analysis of ejected bobbins due to quality problems, 100 bobbins per day

Table 4 Total test time in the laboratory per day

The total test time per day at a test speed of 800 m/min is 702 minutes or 11 hours and 42 minutes. This indicates that the tests cannot be managed in one shift.

If the same tests have to be made at 50 m/min for slivers and rovings and at 400 m/min for yarns, the daily additional time consumption is 515 minutes or 8 hours and 35 minutes.

8 Statistically more significant results

With a fast testing system more bobbins can be measured within the same time span. The confidence interval of the mean of a tests series is proportional to $1/\sqrt{n}$, where n is the number of bobbins measured within a test series. Therefore, a high number of tests leads to a narrow confidence interval and a better statistical platform.

9 Conclusion

Considerable efforts were undertaken to increase the test speed of laboratory systems. This paper explains the reasons why high testing speeds are required in a modern laboratory.

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