FCT - FIBER CONTAMINATION TESTER - A NEW INSTRUMENT FOR THE RAPID MEASUREMENT OF STICKINESS, NEPS, SEED-COAT FRAGMENTS & TRASH - FOR THE GINNER TO THE SPINNER

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Abstract

In the last 10 years of yarn production, cotton contamination has become a major problem because of the greatly increased use of high-speed spinning machines, which require high-quality cotton, especially with regard to stickiness, neps and seed-coat fragments (SCF). Cleaning the cotton of trash is a relatively simple operation in contrast to neps and SCF. The need to evaluate major contaminants led to the development of the FCT as a rapid machine for testing the four major contaminants together. The FCT measures neps, SCF and trash by means of unique image- processing techniques and algorithms that enable it to differentiate, in a thin web, between neps, SCF and trash in real time. Stickiness is measured by simulation of the crush rolls of the spinning mill - the place that stickiness causes most of problems in yarn production. Combining all four contaminants in one machine that functions both off line or on line (in the near future) opens to the cotton industry new possibilities of controlling cotton quality, which in turn will lead to better production of yarns. The first set of data obtained from the first system shows very promising results, which will be presented in this work.

Introduction

Fiber contaminants have become a mega problem in a wide areas of the cotton industry. The veteran, and most common, system to evaluate fiber contaminants is that used by classing institutes and the laboratories of the spinning mills. The major contaminants that have to be determined are stickiness, neps, seed-coat fragments (SCF) and all kinds of trash (pepper trash, dust, burks, plastic fibers, etc.).

Stickiness

Stickiness is a worldwide phenomenon, resulting from several causes, some of them from the physiology of the plants and others from insect honeydew. Stickiness is measured by a number of techniques, such as the indirect sugar content in the fibers, the Thermodetector and the Minicard. All these techniques are slow and are thus not suitable for the mass testing of cotton. A large number of articles have been devoted to the argument about the best way to measure stickiness, but there is no argument about the need to be able to provide stickiness labeling for every bale.

One of the major arguments centers on the source of stickiness and the best means of dealing with this source. At the last Bremen Conference held in March 1994, the Thermodetector was chosen as the standard apparatus for stickiness measurement, although this equipment measures mainly stickiness caused by honeydew, and the cotton community is well aware that honeydew is not the only source of stickiness. The FCT detects stickiness of any kind that sticks to metal drums (the same phenomenon that takes place in the spinning mill).

The Minicard was the standard apparatus before the Thermodetector. This equipment, which was basically not designed for stickiness measurements but was adapted for this purpose, lacks the, cleaning systems that prevent contaminants from one sample being carried over to the next sample. The FCT, in contrast, has a self-cleaning carding device and a self-cleaning system that cleans the machine between samples.

The ability provided by the FCT to measure every bale will benefit both ginners/growers and spinners, who at present to not have access to facile mass testing. Classers, in the best case and with limited results, are able to measure every cotton module, but not every bale. In case of a severe stickiness outbreak and high rates of stickiness, real time measurement of stickiness, for every bale, will save a lot of bales from being labeled as sticky and visa versa. The ability to check stickiness quantitatively will also enable spinners to mix some sticky bales, bought at lower prices, into cotton mixtures without damaging yarn quality.

Trash

Trash is measured by a variety of techniques. The most common method is manual comparisonto standard boxes, which enables mass testing for every bale but does not provide any information about neps and SCF. Electro-optical techniques, such as trash testing by HVI, enable mass testing but measure all kinds of trash, including SCF, without differentiation. In addition, these measurements suffer from a lack of statistical reliability, probably because they “look” at the surface of the cotton flock and not inside it. More detailed measurements based on mechanical separation, like Shrilly Analyzer or AFIS, are relatively slow and are not suitable for mass testing.

Seed-Coat Fragments

In some countries, SCF constitute a huge problem that is probably caused by mis-setting of the ginning machines, which then break the seeds, or by a combination of weak seeds and incorrectly set gins. Some areas send 50-90% of their cotton contaminated with SCF. This contaminant damages spinning machines and is the most difficult contaminant to remove. Most separate SCF measurements

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are performed manually by a neps counter. The new version of the AFIS claims the ability to separate SCF.

Neps

Neps are counted by manual techniques and by AFIS. Both are relatively slow and are not suitable for mass testing. Manual techniques, using the neps counter, measures only cotton sliver. The AFIS system opens the cotton into single fibers, an aggressive treatment that requires a small amount of cotton (1/2 g). The FCT is able to measure more cotton in half the time.

Basic Features and Design of the FCT

The FCT was developed after an in-depth study of all these limitations and is basically designed as a mass tester to work in heavy duty operation to test the four contaminants together . The objectives for the development of this machine were as follows:

* Providing data for every bale;
* Automatic & semi-automatic and heavy duty operation;
* Providing information rapidly and accurately with minimum damage to the fibers;
* Using processes that are very close to the spinning process;
* Testing stickiness without the need for heating or chemicals;
* Evaluation based on amount and size;
* Simple to operate and maintain and small in dimension to enable it to fit into laboratory operation.

The FCT can evaluate any kind of cotton, such as raw cotton (containing even relatively large amounts of trash), sliver, or rovers. The sample may vary from 20 cm long up to an unlimited length, depending on customer needs. The standard sample is a bundle of 4 g, 30 cm long. This bundle of cotton is carded into 1 m^2 of web, and the whole volume of the sample is evaluated.

The system can be supplied in three conformations:

* Complete module for all four contaminants;
* Module for stickiness only;
* Module for nonsticky contaminants only.

Benefits of the FCT to the Gin, the Mill and Other Segments

* The FCT gives much better statistics because the cotton is sampled from each ginning stand..
* The FCT provides the ability to check whether each stand is damaging cotton and breaking seeds (for example, if clothing of ginning drums has been damaged) by operating each stand alone and "looking" at the quality of the cotton with the FCT.
* The FCT provides the ability to find the optimum ginning process between cleaning pepper trash and producing neps. Today, the classing system is not able to identify neps and SCF because of lack of equipment, but in the near future this ability will be available in the form of the FCT.
* Detecting neps in real time can help the ginner to decide to clean once or twice with regard to cotton ginned.
* Since FCT has the ability to detect SCF, the gin will be able to treat different varieties differently if it is found that one of the varieties produces more SCF, or even to recommend that a variety that suffers from SCF problems be dropped.
* The second generation FCT will be able to provide feedback to the gin in the case of the presence of too much SCF or neps.

Materials and Methods

Operating Principles of the FCT

The basic principles are presented in Figure 1. A bundle of cotton is placed on a transporting belt, which feeds the cotton to a self-cleaning carding device. A very thin web is produced and passed between two crush rolls to expose the sticky deposits to the electro-optical device, which detects the amount and size of the sticky deposit. The cotton web is then vacuumed out and discarded. During transfer of the cotton web to the crush rolls, an image-processing system evaluates the nonsticky parameters and distinguishes between neps, trash and SCF. This system takes 70-100 pictures or more (depending on the cotton bundle) and calculates a running average on screen. All four parameters appears on the monitoring screen simultaneously.

Experiments

The first experiments with the FCT were performed in the laboratories of Rieter, Winterthure, Switzerland. These trials were carried out to compare the FCT with parallel equipment and methods available today.

Stickiness Tests - Long-Time stability

The FCT was compared to the Graf Thermodetector, on the same sets of samples for which was evaluation of long term stability. Two sets of raw cotton (N,N3) of 40 samples, both considered as nonsticky (average 5 & 15 deposits, respectively) were measured.. The results are presented in Figure 2.

Stickiness Testing - Comparison of Different Kinds of Cotton

In this experiment, 10 repetitions of cotton from 19 countries considered as nonsticky, sticky and very sticky were tested. All cotton samples was tested for sugar content (Fehling analysis) and by the Graf Thermodetector and the FCT. The results are presented in Figure 3.

Tests for Neps, Trash & Seed Coat Fragments

Three sets of comparisons were made at Rieter's laboratory:

1. Neps count by AFIS vs. FCT;
2. Trash count by AFIS vs. FCT;

3. Testing cottons in all stages of spinning, from raw cotton to combing cotton.

The results are presented in Figures 4-7. The results of these experiments must be examined very carefully, since the parameters measured are slightly different for each device. Rieter's AFIS measures only neps, but it is possible that SCýF are also detected. Since trash particles are separated mechanically by the AFIS, this point should also be researched in the future in regard to such comparisons..

Results and Discussion

Stickiness Tests with the FCT

As was pointed out by all the laboratory technicians who used with this equipment, the FCT represents a new generation of stickiness testers. With the FCT, testing for stickiness becomes a very simple and fast operation, without the need for experienced eyes or trained laboratory technicians. The argument between users of the Graf Thermodetector as to the best way to prepare the sample or the time needed for heating and cooling, has become academic. The only demand of the FCT is correct preparation of the sample.

Stickiness was evaluated by the FCT over a period of one year. During this time, the criteria for "defining" sticky and nonsticky deposits were delineated. The basic scale was chosen as follows:

0 - 20 deposits - nonsticky cotton
21 - 40 deposits - slightly sticky.
41 - 60 deposits - moderate
61- 80 deposits - very sticky
81 + deposits - very heavy

This scale is reflected in Figure 3 . The first 10 cotton samples from the countries shown cannot be considered as sticky, whereas the last 5 samples are very sticky. From Figure 3, it can be seen that with the FCT the variability is much smaller than with the other techniques.

Figure 2 shows that the FCT also has relatively long time stability, considering that the cotton itself varies from sample to sample. At this stage, size characteristics were not taken into consideration; these characteristics will, however, be considered in the near future since small deposits cause much smaller problems than large ones at the mill. These data are available as a built-in feature in the FCT and can be exploited very easily in the future.

In summary, although the FCT requires further calibration by testing large amounts of all kinds of sticky cotton, this machine has no competitor as the fastest sticky tester available today on the market.

Neps, Trash & Seed-Coat Fragments Measured by the FCT

As was discussed above, measuring these three contaminants together is a very simple operation. As a first step, the FCT was compared to the AFIS, which is considered as the standard for testing neps. The results of this comparison foe neps and SCF are presented in Figure 4. It can be seen that the trends for the samples are very similar with the AFIS and the FCT. Similar results were obtained for the determination of trash (Figure 5). It can be seen that although no statistical data are provided, the correlation between AFIS and FCT is very high: the basic reason for the lack of statistical treatment is that the amount of data collected up to this stage is not sufficient to allow for reliable statistics. Additional data will be collected in the next year in cooperation with the cotton industry.

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