SPINNERS' TOOLS TO DEAL WITH COTTON CONTAMINATION

ir. Els Van Nimmen and Prof. Lieva Van Langenhove
Universiteit Gent
Department of Textiles
Zwijnaarde, Belgium

Abstract

Contamination of textile materials with fibrous materials such as plastics, coloured fibres etc. is getting increasingly important. In this paper an overview is given of potential solutions, their problems and benefits. Within the framework of a European research project a system was developed to detect and eliminate foreign materials from the cotton flow.

Introduction

Cotton is a natural fibre. The fibres are picked from the plant, pressed into bales and packed. The bales are transported to spinning mills, where the packages are removed. Layer per layer the fibres are taken off of the bales for further processing into yarns.

All processing operations of cotton have been automated to a large extent. The discharge of people has led to the elimination of human inspection of the cotton material at all its processing stages. This means that all kind of foreign materials that may originally be present in or around the cotton bales are no longer detected and, hence, not removed.

Contaminants, impurities or foreign bodies can involve heavier materials like metal, sand and stones, but these are removed or separated during the cleaning process. More important are the "fibrelike" materials such as fabrics (pieces from shirts or clothes or rests of packages) and dark fibre tufts. Moreover, because of the quite aggressive mechanical action of the opening and cleaning processes, one piece is torn into a large number of smaller pieces spread over a large volume of fibres.

The problem of contaminants often is recognized not earlier than after dyeing, when they cause differently dyed or even undyed spots. At this stage, the economic value of the product is very high (e.g. carpets or clothes), so financial losses can be very high.

State-of-the-Art

Several systems have become available on the market over the last few years, such as the systems from Tatsumi, Jossi, Optiscan, etc.. However they show several disadvantages in terms of

- capacity,
- performance,
- price.

An alternative solution are yarn clearers. Loepfe and Barco have developed sensors that are able to detect foreign materials in a yarn. They are very efficient. The sensors are used as yarn clearers at the rotor spinning frame or at the winding machine.

Disadvantages of this principle are that the contamination is detected no earlier than in the yarn, after the contaminant has been torn into hundreds of pieces and spread over a large mass. Secondly the foreign fibres are removed by cutting the yarn, causing a splice for each particle that has been detected. Consequently contamination may drastically reduce the spinning or winding yield, and cause a significant reduction of quality. Experience has shown that indeed the spinner must balance impeccable yarn (removal of all foreign fibres) and acceptable spinning or winding yield.

Work Performed[1]

Within the framework of a European research project a system was developed to detect and remove foreign materials as efficient as possible, allowing normal production speeds.

During the first phase a survey of contamination, detection and removal was made.

Collection of Samples

No problem of computer inspection can be handled successfully without a representative set of samples. Therefore a person has been watching the incoming bales during several weeks. The contaminants were collected, and the way in which they appeared in the bales was registered.

The results of this task are listed in table 1.
It was concluded that:

- there are far more contaminants than expected,
- the degree of contamination strongly depends on origin of the fibres,
- in general the contaminants are not entangled intensively with thefibres.

Basic Principles of the System

The basic principles of the system had to be defined in terms of *image acquisition* and *image processing*.

The first question that was to be answered was the *location of the detection system.*

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The best place for location would definitely be at the bale surface. At this place the contaminants have their maximum size, as opening machines will certainly shear them into many small pieces. Moreover the fibre mass is moving at very low speed, so that processing speed is not a restriction. However, many false alarms are given due to the bale surface that is highly irregular.

So the detection place was moved to the opening line. Two options were still feasible, namely:

- detection in a transport pipe, where the fibre tufts move individually at high speed in a limited area, and
- detection in a filling shaft, where the tufts fall down in a broad chute at low speed, possibly in accumulated form.

Because even at the high speed of the tufts in the transport detection seemed effective, it was decided to install the system on a pipe. For the final selection of the location a balance was to be made between size of the fibre tuft and size of the contaminant. Subsequent to the bale opener the tufts are large, so the chance that a contaminant is hidden in the tuft is significant. At the end of the opening line, the tufts are small and loose, but the contaminant may have been sheared into several smaller pieces, which reduces the chance of detection.

Secondly choices had to be made regarding the conditions of illumination and the camera type. Several options were studied, and based on the results a final set-up has been fixed.

Another aspect that was to be studied is the separation system. Indeed, it is quite evident that it is useless to detect contaminants if no system to remove them from the fibre stream is installed.

From the beginning two options were possible, namely using a valve that temporarily deviates the fibre flow when contaminants are detected, or blowing out the contaminant by computer controlled air nozzles.
The first solution is quite simple, as several valve types are readily available. The main disadvantage is that a considerable amount of fibres may be rejected along with the contaminant.

Using air nozzles overcomes this problem, but this option is technically more complicated.

Industrial tests that were carried out within the project made the participating spinners to decide that a valve is an acceptable solution.

Several versions of prototypes have been built, using different image acquisition and image processing techniques. The first industrial tests were done with a static system. After one year of research, the first dynamic system was constructed. As the tests went along, several improvements were made. Their main features have been described in a previous paper At present, the final system is running in a cotton spinning mill in Greece.

Description of the System

The contaminants are detected by an opto-electronical system. It consists of ultra-fast high resolution CCD-cameras, powerful specific illumination and dedicated signal processing. The outside dimensions of the detection unit are 1750x1240x1550mm (l, w, h). It is installed on standard existing pipelines, in-feed as well as out-feed. The rejection is done by a special mechanical flap that is positioned in the outfeed pipeline located a few meters from the detection unit. (Fig. 1).

The system is designed to operate in strong and fluctuating conditions.

Settings can be made by simply pressing buttons. They include color, size and tolerances.

Results

The final version of the system has been installed in a Greek cotton spinning mill in September 1996.

A test has been carried out by adding different contaminants to the fibre flow. The tests were repeated and the number of detections was counted. In total about 300 tests were performed. Dimensions of the contaminants vary from 5x20mm to 30x40mm. The results are summarised in table 2.

From this it is concluded that the efficiency of the system is surprisingly good.

Generally spoken, there is no detection limit in terms of size and color of the contaminant. The detection limit is a combination of size, contrast to the cotton tufts, presentation to the camera and integration in the fibre tuft. One can only say that the more advantageous those four parameters are, the higher the chance that the piece will be detected.

As for the rejection system, it was shown that an ultra-fast valve is necessary to guarantee 100% rejection of the detected contaminants.

A second benefit of the system is that the number of yarn breaks during spinning shows a significant reduction when the detection system is being used.

Conclusions

Within this Brite Euram project a new machine has been developed, the PULSARR RX-CS, that has the ability to detect and remove contaminants and foreign bodies from a high speed throughput of raw cotton. Real-time in-line detection of packaging materials, pieces of wood and foreign fibers basically is performed on the base of colour differences. Detection starts from contaminant sizes of five by five millimeters.

The machine is easy-to-install as a black box application in existing pipeline designs directly after the bale opener. The price/performance relation is excellent as compared to what is already on the market. Final tests in production lines with strong environmental conditions have confirmed the efficiency of the system.

For wool the problem is similar, but so far tests have been unsuccessful, since wool tufts are bigger, less loosened and less separated. An adjusted set-up of the mentioned machine will be used for final wool tests also. Wool tufts however are less opened (bigger) than cotton tufts, so results are always likely to be less good.

Removing contaminants has following benefits:

- reduction of contaminated yarns and hence reduction of delay in delivery due to rejected products
- commercial arguments: “contamination free yarn”
- reduction of yarn breaks on rotor spinning frame, and henceincrease of efficiency
- reduction of energy consumption.

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Tables and Figures

Table 1 - Contaminants in cotton

Type	Mill 1	Mill 2
jute	50	19
coloured fibres	15	42
yarns	40	6
fabrics	17	0
coloured PP	53	2
white/transparent PP	25	0
other	21	14
pieces per hour	**1.47**	**3.46**

Table 2 - Detection rates for different types of contaminant.

Contaminant	# tests	# detected	% detected
Black defects	85	83	98%
Brown threads	5	5	100%
Green knitware	10	10	100%
Yellow knitware	10	7	70%
Red knitware	20	20	100%
Blue knitware	10	9	90%
Green fabric	20	20	100%
Yellow fabric	20	15	75%
Red fabric	10	10	100%
Blue fabric	20	19	95%
Black fabric	10	10	100%
Rose fabric	10	9	90%
Colored plastics	14	12	86%
Wood parts	4	4	100%
Brown jute	5	5	100%
Ordinary paper	5	2	40%
Sandpaper	10	10	100%
Multicolor fabric	20	20	100%
Carton piece	20	20	100%
Greased tufts	5	5	100%
Jute/cord	8	8	100%
Stones	6	4	67%

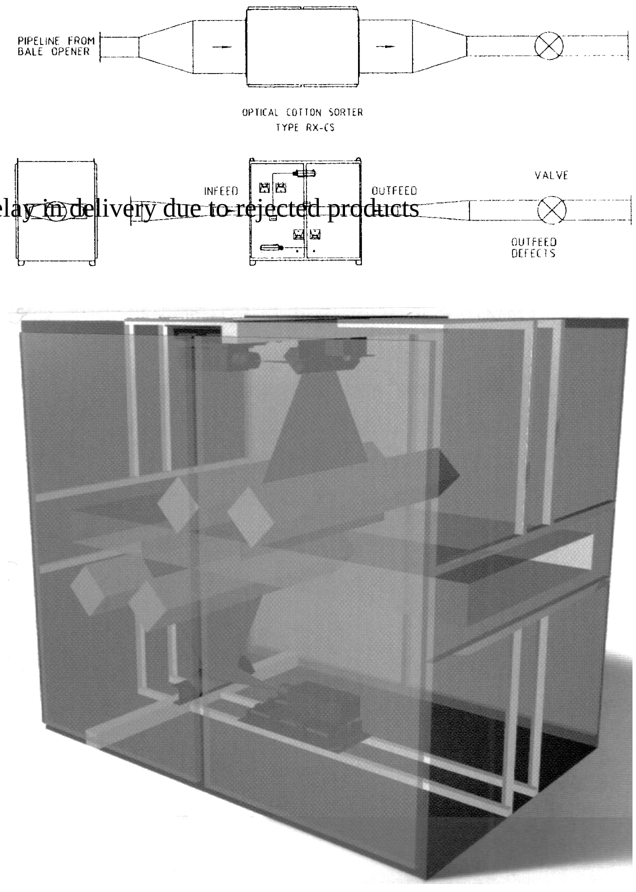

Figure 1 - Scheme of the RX-CS machine

References

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