

A modular approach to solving the foreign matter problem in ginning and spinning

by Trützschler GmbH & Co. KG

The nature and extent of foreign matter contamination is strongly dependent on the origin of the cotton. Cottons from the USA or Australia, which are 100% machine-picked, do not have significant problems with foreign matter. Cottons from Turkey contain many red ribbon-shaped contaminants. In China, mills are battling threads from bleached cotton as well as white fluorescent Polypropylene ribbons. Cottons from Central Asia are contaminated with white, non-transparent packaging residues. These are only a few examples.

1. Battle of the systems

There are a number of foreign matter separators available on the market which operate with different detection principles. In addition to different kinds of sensors, the material presentation to the sensors and the method of illumination are approached differently. Each system is distinguished by a combination of these three characteristics.



Fig. 1: Typical objects detected by photo sensors.

Sensors

Photo sensors are relatively cheap sensors that are arranged in line and detect differences in brightness in the passing flow of fibrous tufts. Depending on manufacturer, a measuring field has 24 to 236 sensors. Objects with low contrast to the

cotton tufts in terms of brightness or colour cannot be detected. An object must be fairly large to be reliably identified as foreign matter; this is not the case with threads and strings. Such simple sensors are often misleadingly labeled as cameras.



Fig. 2: Typical objects detected by ultrasonic sensors.

Ultrasonic sensors are also arranged in line. They detect foreign parts with solid, sound-reflecting surfaces, but cannot detect foreign fibres, threads and strings. The advantage is that the colour of the surface is irrelevant and the basic disadvantage is that they cannot detect small parts.



Fig. 3: Typical objects detected by 1-CCD colour sensors

Colour sensors are **line-scan cameras** with a single CCD chip (1-CCD camera). We all know such systems from office scanners. The sensitivity depends on the resolution of these cameras and the scanning width. Since these cameras work with

three adjacent scan lines (red, green, blue) with a certain offset, the colour recognition of moving objects is limited – an effect called colour noise is the result. Due to this, such systems provide lower detection rates with objects of pastel shade. 1-CCD cameras can detect small objects with high contrast and also thread-shaped contaminants. However, these parts must possess a distinct colour difference to the cotton.

Much more effective, though regrettably more expensive, are **3-CCD cameras**.

Today, such systems are used in TV cameras. Here, the three fundamental colours red, green and blue are separated by a prism and simultaneously directed onto three CCD chips.

Hence, we speak of a true-colour system. Due to this simultaneous process, the variable speed of objects in the material flow no longer has a negative effect. 3-CCD cameras provide sharper colour separation and are thus able to detect foreign objects of pastel shade as well as tiny threads/strings. Unfortunately, the resolution of regular TV cameras (768 pixels over the width) is not sufficient for our purposes - we need significantly higher resolution (> 2000 pixels). This makes the cameras and the true-colour analysis of the signals more complex. 3-CCD cameras currently represent the high-end approach to foreign matter detection.



Fig. 4: Typical objects detected by 3-CCD cameras.

Illumination

Another important factor in determining object detectability is the type of illumination. Cameras, as well as the human eye, can only detect objects that distinguish themselves in colour, contrast, structure or lustre from cotton tufts.

For this reason, the type of illumination applied in foreign matter separators plays an essential role. Today's standard are illumination units with fluorescent tubes operating in reflected light mode. They produce a light as we know it from the office. In the normal reflected light mode, colored objects and objects with pronounced differences in contrast can reliably be detected. However, transparent, semi-transparent, white and cotton-colored objects present a problem.



Fig. 5: Fluorescent contaminants which can be detected via UV illumination.



Fig. 6: Comparison of objects detected with a 3-CCD camera in a chute (left) and on a rotating cylinder (right).

UV light sources make white and colorless foreign objects with stronger UV reflection clearly visible. The phenomenon is called fluorescence. Such objects may include pieces of Polyester (PET) or Polypropylene (PP) or even bleached cotton treated with optical brightener. Though the proportion of such contaminants is relatively low from a worldwide perspective, it is still of regional importance.

With **polarised reflected light** and the corresponding camera filters, differences in surface lustre of foreign objects can be detected. With dull objects, e.g. contamination with honeydew, this system reaches its limits.

Polarised transmitted light is the ideal system for the detection of transparent and semi-transparent objects, usually Polyethylene (PE) or Polypropylene (PP). Precisely these parts often result in the dreaded foreign fibre claim. Polarised transmitted light is used to detect PE foils or PP fabric from bale packaging. The weak spot of this lighting is the detection of non-transparent objects.

Material presentation

The presentation of the fibrous material to the sensors also affects the performance of foreign matter separators. Almost all systems on the market monitor the tuft flow in a **rectangular chute**. The production rate determines the chute cross-section, width and height must be in a reasonable proportion.

One major disadvantage is the undefined velocity of cotton tufts and foreign objects. Since it is not constant, the downstream separation nozzles must be activated for a longer period of time. This inevitably results in an increasing loss of good fibres.

However, one advantage that should not be underestimated is the gentle treatment of cotton fibres, which are not mechanically stressed.

Systems that feature a detection on the surface of a rotating **needle roll** have three very important advantages:

First, it is the accurately defined material velocity and hence the minimal loss of good fibres during removal. Second, the accu-

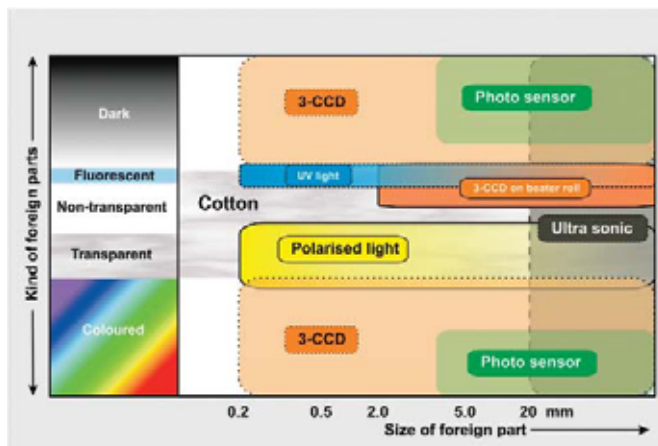


Fig. 7: Application range of different foreign matter systems relating to object size and optical properties.

rate position of the foreign objects is advantageous. There are no problems due to differences in illumination intensity depending on chute depth, as is the case with chute-based systems. The third advantage lies in the high degree of material opening and the associated excellent exposure of the foreign objects. However, presentation of the material on the surface of a needle roll has the disadvantage of additional mechanical stress on the cotton fibres and of additional power consumption of the motor. Transmitted light methods are also impossible with this system.

Summarising what we have discussed above, the schematic (figure 7) provides a comparison of these different systems and clearly illustrates the range of application as a function of object size and optical properties.

2. The answer is found in modular systems

This close examination of the different sensors, illumination systems and methods of material presentations shows very clearly that there is no single ideal system. However, by using systems precisely adapted to the actual requirements, we can come very close to this ideal. An optimum solution consists of an intelligent combination of different systems.

Truetzschler has developed three sensors which - individually or in combination - are integrated in different machines:

The **Truetzschler Colour Module** features high-resolution 3-CCD cameras and can be applied in conjunction with a chute as well as a rotating cylinder. If the latter is the case, even white, non-transparent PP objects can be detected. The high resolution of the cameras also ensures the reliable detection of tiny threads and ribbon-shaped objects.

The **Truetzschler PP Module** reliably detects transparent and semi-transparent objects in transmitted light mode. Here, the polarised light method (pat. pend.) is applied. The Truetzschler PP Module is ideal when the cotton is contaminated with PE foils or packaging residue from PP fabric.

The **Truetzschler UV Module** complements the other two systems if the cotton is contaminated with fluorescent objects from bleached cotton threads, PP or PET.

The combination of these three modules with the cylinder and/or chute system led to the development of a new range of foreign matter separators:

The Truetzschler SECUROMAT SP-F is a multi-functional machine. Besides the foreign matter separation, it offers high-per-

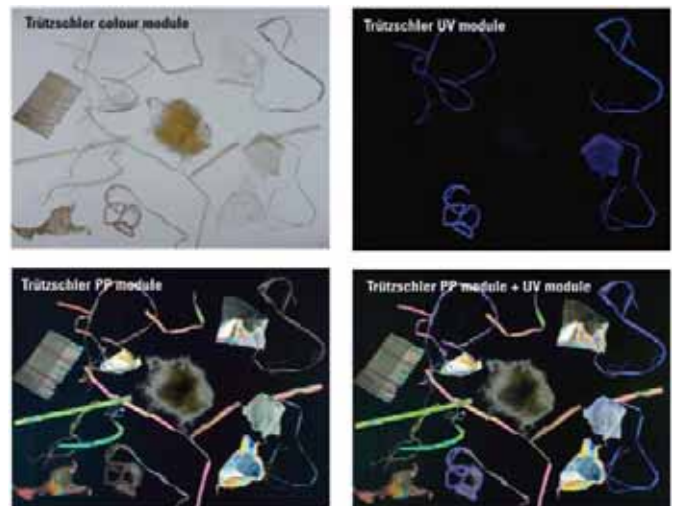


Fig. 8: Comparison: Each of the four pictures shows the same foreign objects with a cotton tuft in the middle. By using different sensors and illumination systems, the different parts can be detected.

formance dust removal and continuous card feeding with the CONTIFEED system. The combination of the Truetzschler Colour Module and a needle roll means high detection efficiency and minimum loss of good fibres.

In the Truetzschler SECUROPROP SP-FP, the functionality of the SECUROMAT SPF is complemented by the Truetzschler PP and the UV Module. The SECUROPROP is an armed weapon in the fight against PP contamination. The integrated high performance dust removal makes this solution first choice in rotor spinning. The combination of 3-CCD colour cameras, adapted light colour of the reflected light setup as well as the needle roll allows the detection of non-transparent white PP already on the cylinder. The transparent and semi-transparent PP objects are detected by the downstream Truetzschler PP Module.



Fig. 9: SP-FPU prototype installation in a cotton gin.

The Truetzschler SECUROPROP SP-PU is a chute system with the two Truetzschler Modules PP and UV. It serves as an addition to existing SECUROMAT SP-F or separators by other manufacturers with only a colour detection.

The Truetzschler SECUROPROP SP-FPU is a chute system with the three Truetzschler Modules Colour, UV and PP. It

represents the most economical and complete solution for many plant configurations, particularly in ring spinning. This machine is also available in a special high-production design for application in cotton gins. This means that the SP-FPU has a larger working width and is equipped with more camera systems.

The following illustration serves to summarize and highlight the specific design, features and performance of the four different machines.

3. Particular requirements and selection parameters

He who has the choice has the torment. This proverb is true here as well. Four solutions, each designed for specific applications, are available. The right decision depends on the particular requirements. The most important decision criteria are:

- ❖ nature and extent of foreign matter contamination;
- ❖ plant configuration;
- ❖ dust removal is required;
- ❖ required detection and separation efficiency;
- ❖ investment costs;
- ❖ operating costs;
- ❖ waste handling.

The foreign matter separator must fit into the plant concept. An optimal cleaning line is more than just stringing together individual units. Hence, foreign matter separation cannot be a foreign object in the line; rather, it must become an integral part of the cleaning line concept.

The experts at Truetzschler can be contracted to discuss and eventually identify the truly optimum solution for each and every application – be it in a spinning mill or a cotton gin. ♦



Fig. 10: Comparison of different foreign matter separators.