

CONTAMINATION CONTROL IN SPINNING

I Biermann

Uster Technologies AG, Sonnenbergstrasse 10, 8610 Uster, Switzerland

Abstract

Total Contamination Control in practice

Contamination in cotton is a subject which has been discussed in the textile industry for many decades. Are all stakeholders of the fiber to fabric production doing enough to solve this problem?

This presentation contains explanations about the root causes of contaminations in cottons and analyses how a contaminant yarn can impact the downstream process and the textile goods.

Beside the technical possibilities to reduce the foreign matters in a spinning mill, the balance between maximum injection rate needed in the blowroom and the lowest amount of yarn cuts in the winding department are described.

The different business models of the spinning mills determine the optimum balance between fiber loss and best possible yarn quality.

The presentation of practical trials underlines USTER's experience with the 'Total Contamination Control' philosophy in the short fiber spinning mill.

Contamination in cotton is a subject which has been discussed in the textile industry for many decades. It was discussed to establish cotton value models – contamination free cotton bales for a higher price or models to avoid Polypropylene packaging material. New yarn clearer generations with foreign fiber detection and, later, Polypropylene detection were introduced.

But what has really changed since that time? Sometimes too little has happened because the problem has actually increased, instead of decreased.

No, these thoughts are too pessimistic. The dream of contamination free yarn at an acceptable economic level will become reality if all efforts, made in the different process stages of the entire textile industry, are combined.



Fig. 1 Initial control with USTER® JOSSI VISION SHIELD and final control at winding with USTER® QUANTUM 3

First I would like to look at the root causes of contamination.

Where does this problem start? Where are its root causes?

40 % of all contaminations are added during the growing phase on the journey from the cotton seed to the yarn.

Mulching films are used to support the cotton growing process in some regions. Then, foils are added to the cotton crop during harvesting.

A lot of rubbish like plastic bags are on the fields which end up as contamination in the cotton, especially in countries like India, Egypt, and Pakistan. As a result, plastic bags or textile cloths can be found in the cotton bales.

Most of the foreign matters (20%) are added during the harvesting process from the workers themselves. It is proven that machine-picked cotton can effectively reduce contamination, e.g. American, Australian and Brazilian cotton has less contaminants. Chinese cotton, especially Xinjiang corps, has a contamination problem, however, contamination has been reduced since there is more machine picking. There is a correlation between the higher level of vegetables, increased by machine-picked varieties, and a higher level of contamination by hand-picked varieties.

But also during the transport and the ginning, foreign matters are added to the cotton. Plastic covers from seed cotton stocks on the fields or workers handling the cotton manually increase the contamination problem.

The key is to establish contamination detection before ginning. This will ensure that these foreign matters will not be smashed into smaller pieces, even if we cannot avoid that items are added on the fields during harvesting and the transport.



Fig. 2 Root causes of contamination

Now that we have identified the root causes of contamination I would like to talk about the impact of contamination in yarns.

The later a contamination is found in the downstream process, the more expensive it will become. The target should be to eject it as soon as possible, at the lowest possible cost.

Defects in fabrics often become visible only after the dyeing and finishing processes.

This means a high risk of claims for the spinning mill or fabric and clothing producer. On the one hand, it will damage the spinning mill's reputation, on the other hand, the compensation cost will lower the financial yield.

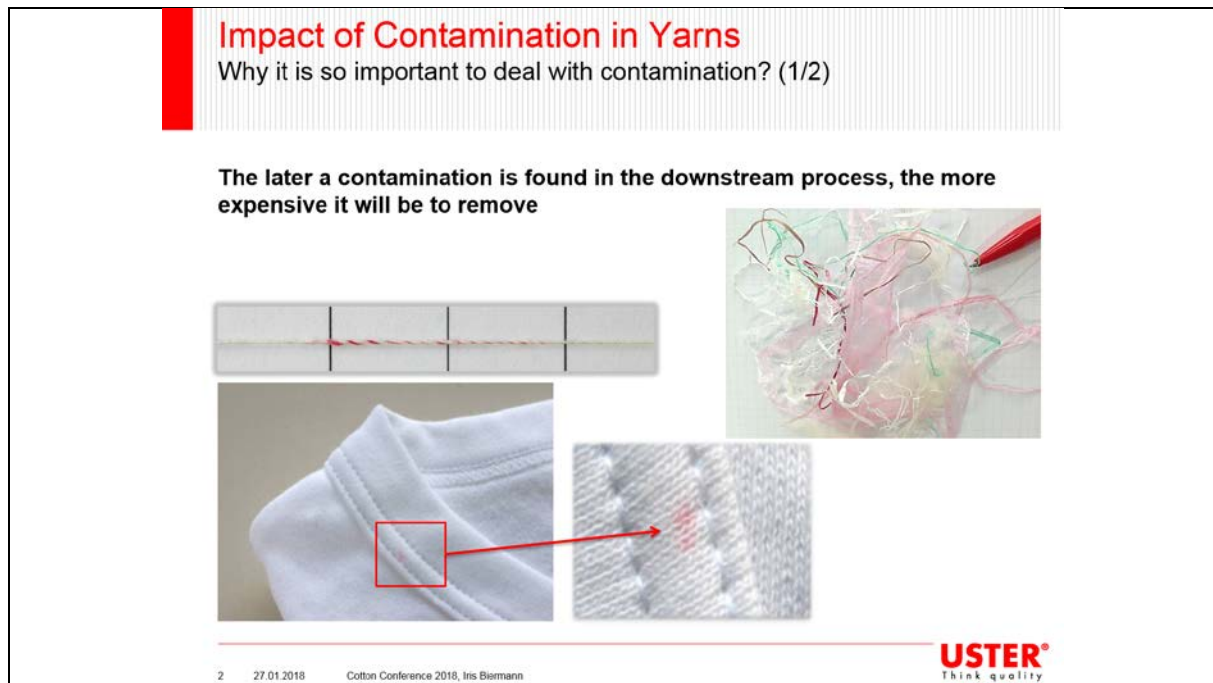


Fig. 3 Impact of yarn contamination in fabrics

Stop rates in knitting and weaving are also increased with a higher amount of foreign fibres in the yarns. Often, these are weak points with an impact on the processing behaviour of the yarn.

In the example given you can see that 19 % of the end breaks during the warping process are caused by foreign matters.

The amount of end breaks due to foreign fibers in the weaving process can be seen more often in weft because a 'pre-cleaning' effect in warp takes place during warping. 11% of all weft breaks are caused by foreign matters in the example given.

This shows that foreign fibers have a huge impact on the efficiency in the downstream process.

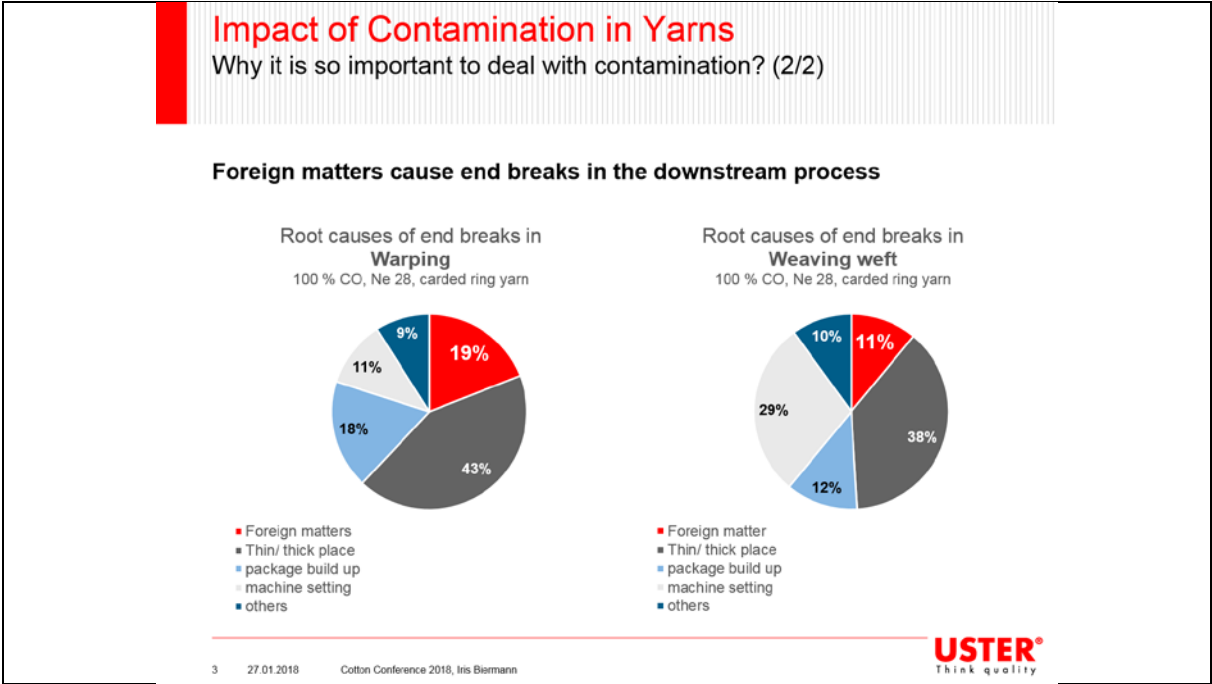


Fig. 4 Impact of yarn contamination in downstream process

You can also find a high amount of end breaks in knitting due to foreign fibers. 15% of all end breaks are yarn faults in this trial, and 25% of these end breaks are caused by foreign fibers.

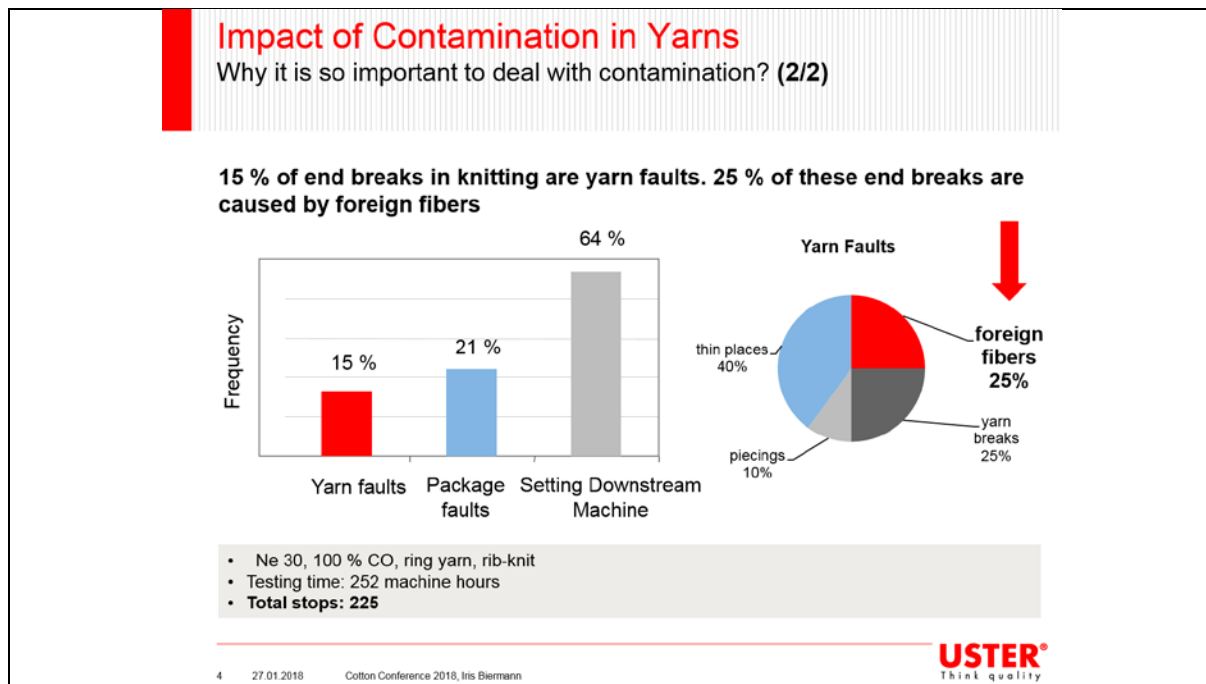


Fig.5 Impact of yarn contamination in knitting

Now let's look at the end user requirements.

End user requirements are different.

It depends on the final end use whether or not contamination is bad, e.g. in bleached or dark-coloured fabrics, the same contaminant can have a different impact on the fabric appearance.

The transparent and white contaminations become more disturbing in dark-colored fabrics whereas coloured contaminations are more disturbing in bleached fabrics, as shown in my example before.

This is also the reason why no real standard exists on how many foreign matters are generally expected in a fabric. It always depends on the final end use. Knitted or woven fabric, circular or flat fabric, colored or bleached fabric all have an impact on the requirements.

But also the frequency of the event plays an important role. Five events in a row are worse than five events which are distributed over a certain length.

End User Requirements

Why are the requirements different? (1/2)

A contamination level is not always equally bad

- End user requirements are different
- They depend on the final application and color
- The events frequency also plays an important role

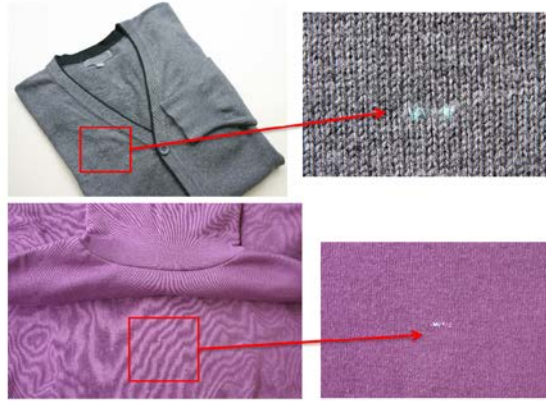


Fig. 6 End user requirements due to application

Why are the end user's requirements so different?

The subject matter of handling contamination varies greatly and, therefore, needs to be discussed differently within every mill.

The table describes the most common situations found in practice.

'Contamination is not an issue', which means the end use is not sensitive to contamination due to the end product requirements. A contamination reduction in the yarn is not required.

'Contamination free' is often the case for high quality applications such as for business shirts.

A tested yarn which has to fulfill contamination specifications is often seen in practice. It is a specification of the number of defects per kg yarn, e.g. 10 remaining events per 20 kg of knitting or 100 yards of woven fabric.

Last but not least, it happens that we can find a tested yarn on the market which is traded without knowing the final end use. In this case, the cleaning cannot be adjusted to the end use requirement.

Reality shows that mills have to be prepared for all types of demands.

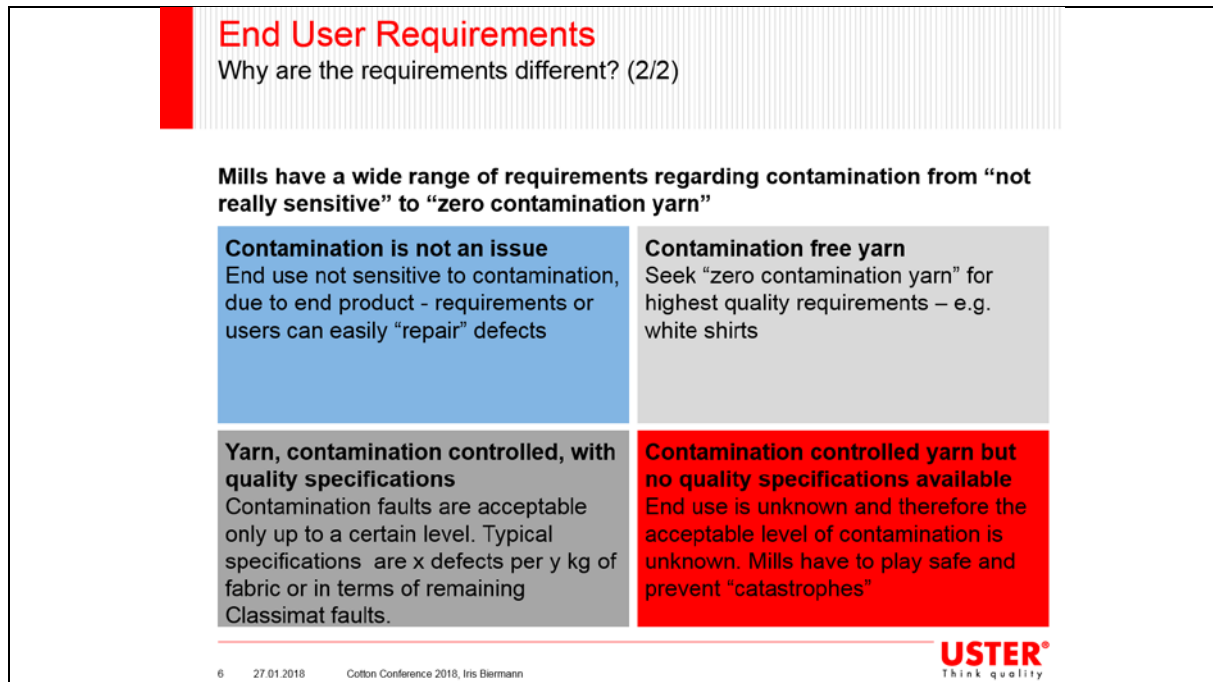


Fig. 7 End user requirements and the business model of the spinning mills

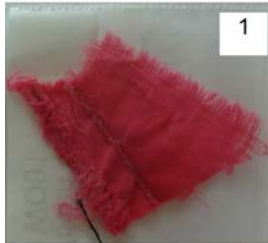
The next few slides show different kinds of contamination types.

The Textile Technology department of USTER[®] conducted a general investigation of how different kinds of contamination types behave in the spinning process. We processed different kinds of contaminations one by one and observed different behaviors inside the process. We processed the following different types of foreign matters:

- Woven fabrics,
- knitted fabrics,
- packaging material and
- plastics

Different Kinds of Contamination and their Impacts

Are all contamination types equally bad? (1/3)



1. Woven fabrics
2. Knitted fabrics
3. Packaging material
4. Plastic materials



Fig. 8 Different kinds of contamination and their impacts (1)

As well as

- dirty cottons
- jute
- vegetables and
- strings

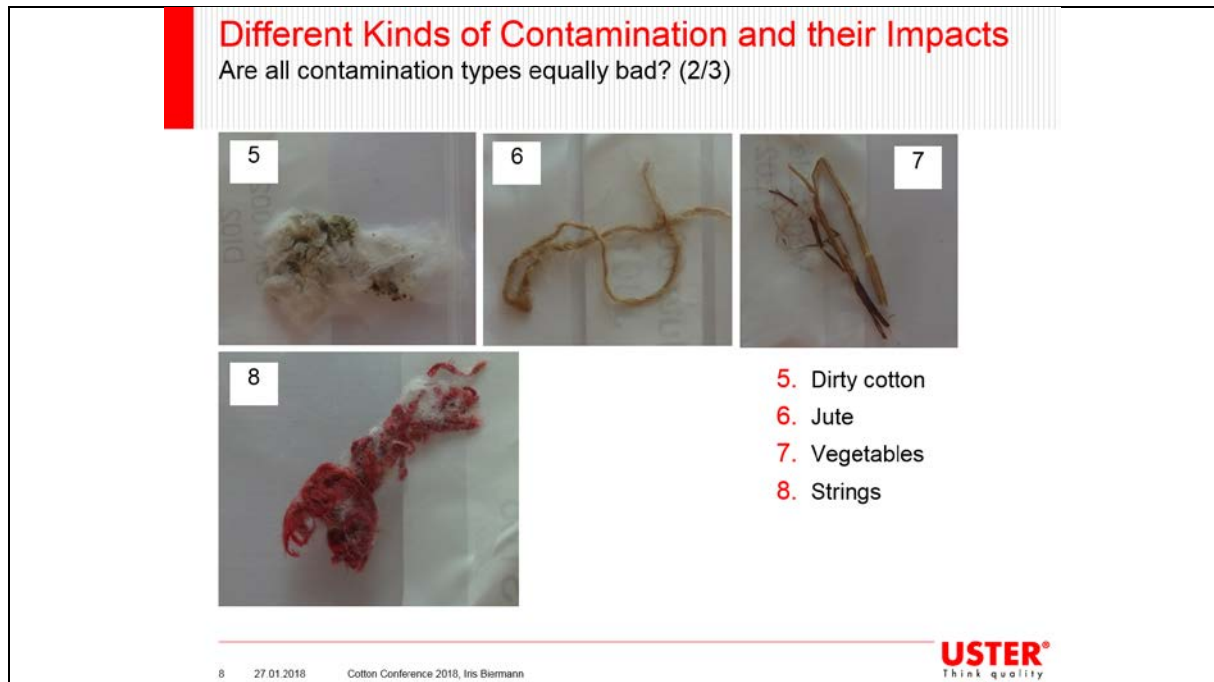



Fig. 9 Different kinds of contamination and their impacts (2)

Plus

- yarn bundles
- foil and
- other contamination like feathers

It was interesting to observe that certain contamination types tended to end up in the card flat waste more often than others. Some contamination was split into countless pieces and ended up in the yarn. A real pattern could be observed because we processed at least ten different samples per contamination type in order to be sure that it is a proven fact, and that it did not just appear by chance.

Different Kind of Contamination and their Impacts
Are all contamination types equally bad? (3/3)



9. Yarn bundles
10. Foil
11. Others

9 27.01.2018 Cotton Conference 2018, Iris Biemann **USTER**
Think quality

Fig. 10 Different kinds of contamination and their impacts (3)

I would now like ask the question which remaining events are critical in a yarn.

Not all contaminants remaining in the yarn can be removed because the winding efficiency is directly affected by the FD cut level. However, the closer the setting is selected, the higher the cut level will become.

We can distinguish and classify the contaminants into two groups to get an idea which events are important to eliminate:

- Infrequent contamination (influencing the cut level) - grey
- High frequent contamination (remaining in the yarn) - red

These remaining events are smaller than the events taken out and will be less disturbing than a single event.

Cotton quality and fiber cleaning systems can influence the overall level of remaining contaminants in all classes.

Yarn clearers help to eliminate the most disturbing contaminants (grey area). Therefore, it might not be the best solution to purchase a highly contaminated cotton variety and expect the fiber cleaning and clearing to produce a contamination-free end product.

Different Kinds of Contamination and their Impacts

Which remaining events are critical in a yarn?

%	AA4	A4	B4		C4	D4	E4	F	cm
20	AA3	A3	B3		C3	D2	E3		
10	AA2	A2	B21	B22	C2	D3	E2		
7	A1		B13	B14	C12	D12	E12		
5			B11	B12	C11	D11	E11		
	0.4	1.0	1.4	2.0	3.0	5.0	7.0		
	High frequent contamination (remaining in the yarn)								
	Infrequent contamination (influencing the cut level)								

Fig. 11 Different kinds of contamination and their impacts

The next slide shows a trial with the different contamination types and their impact on the yarn contamination level.

The bigger an undetected contamination, the higher the disturbance in the yarn will be later on.

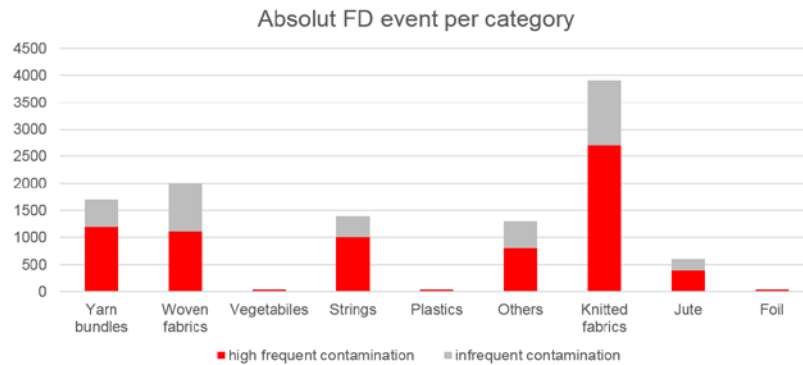
Not every contamination type behaved in the same way. Some of them affected the FD classification much more, and others much less.

A compact high dense event like a woven or knitted fabric or bunches of yarn will have a higher level of remaining defects compared to plastic films or vegetables.

The more high-frequent contamination is, the worst its effect in the yarn, the downstream process and the higher the risk of foreign fiber in the textile fabric.

Different Kinds of Contamination and their Impacts

A compact event like a woven or knitted fabric or bunches of yarns will have a higher impact compared to plastic films or vegetables



11 27.01.2018 Cotton Conference 2018, Iris Biermann

USTER
Think quality

Fig. 12 Different kinds of contamination and their impacts

Have you heard the term TCC, Total Contamination Control?

Total Contamination Control or as well called TCC is the unique approach of USTER to achieve the lowest remaining contamination in the yarn with a minimum of waste when using a combination of tools, expert knowhow and standards every time.

Total Contamination Control allows spinners to meet precise yarn specifications while also managing the mill's own productivity goals.

This with one point of service contact for both systems worldwide.

The term 'Total Contamination Control' is used to describe the ideal combination of USTER® JOSSY VISION SHIELD and USTER® QUANTUM 3 clearer to have the best possible systems to remove contamination at the beginning and at the end of the spinning process.

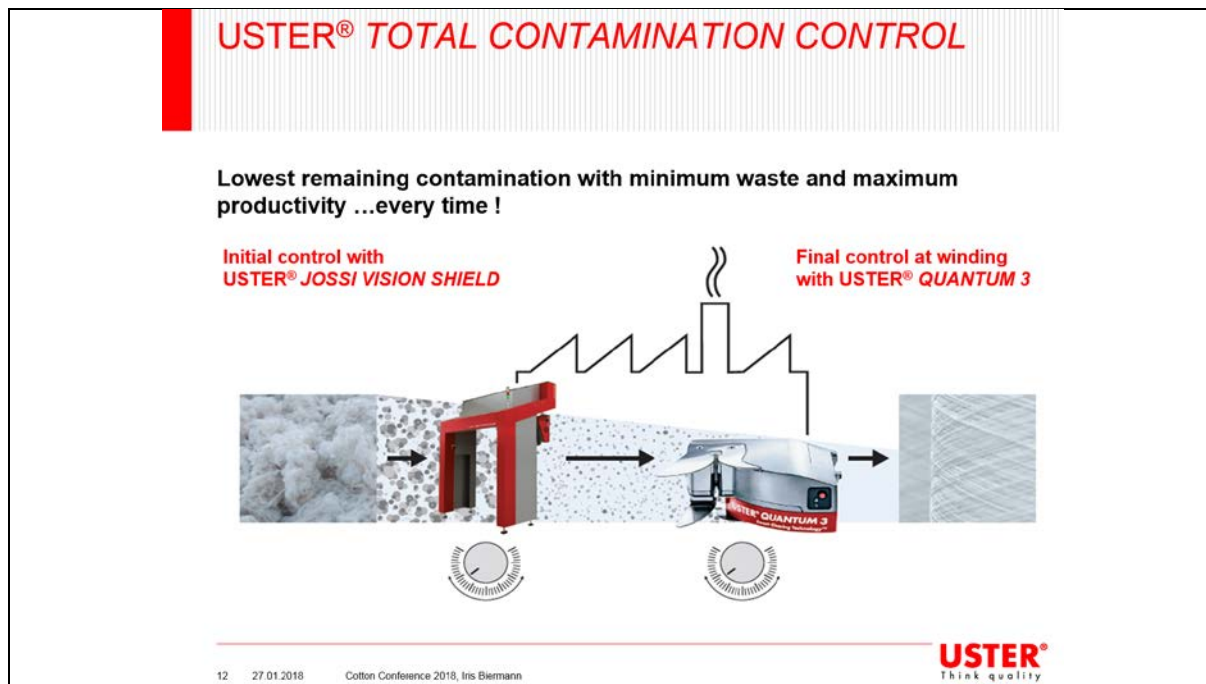


Fig. 13 USTER® TOTAL CONTAMINATION CONTROL

How does the USTER® JOSSY VISION SHIELD work?

USTER® JOSSY VISION SHIELD screens the passing cotton and shows a real picture of every individually ejected event. A mechanism ejects the foreign fibers depending on the set limits.

The limits can be set depending on the

- particle size and
- colour ratio, which is the contrast between the foreign fiber and the cotton itself.

The user can individually adjust what to eject according to the end user's needs.

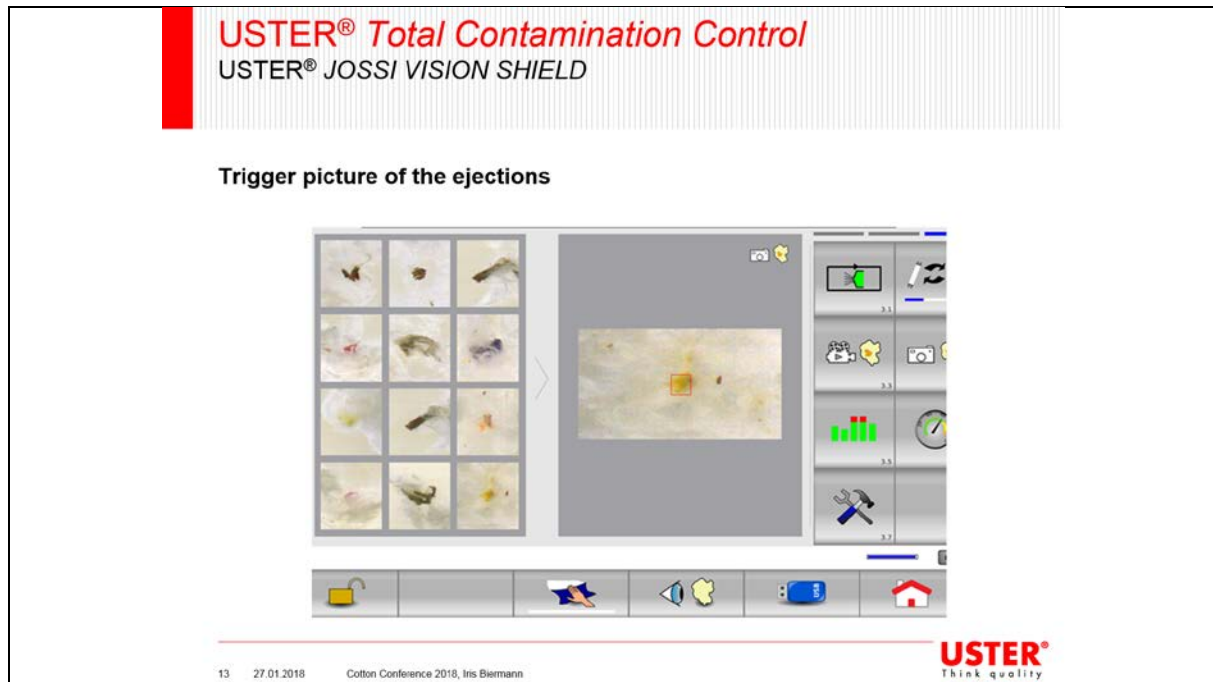


Fig. 14 USTER® *JOSSI Vision Shield*

Why combine both detection systems?

Only the combination of both detection systems, in the blowroom as well as at the yarn clearer stage, guarantees maximum FD reduction efficiency.

The idealized picture shows the effect of using these two detection systems.

An average of 60 remaining faults are counted per 20 kg knitted good if no foreign fiber detection is installed in the entire spinning process.

Market requirement, in this case, is 10 remaining defects per 20 kg of knitting.

Trials have shown that foreign fiber detection from competitors had 40 remaining events per 20 kg knitted fabric.

An average of 30 remaining events per 20kg was reached with the USTER® *JOSSI VISION SHIELD*.

We found levels of 10 – 20 events per 20 kg with the fiber detection and yarn clearer from competitors which is an average of 15 remaining events.

Only with the USTER® Total Contamination Control - with the *JOSSI VISION SHIELD* and the *QUANTUM 3* - was it possible to meet the requirements with an average value of 8 events per 20 kg.

USTER® *Total Contamination Control*

Only the combination of both detection systems guarantees maximum FD performance

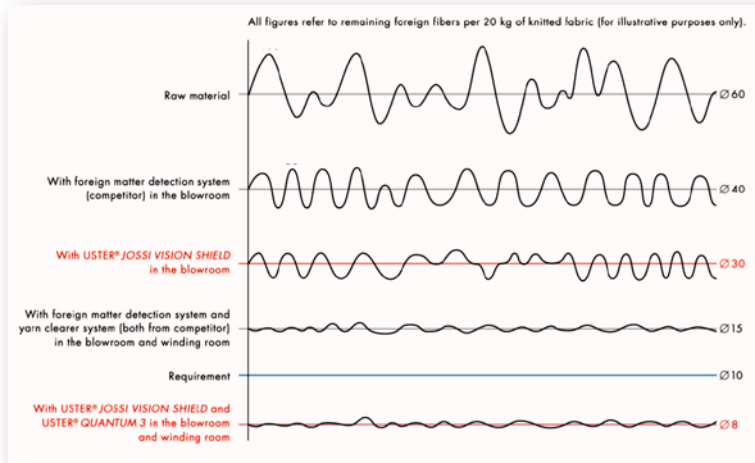


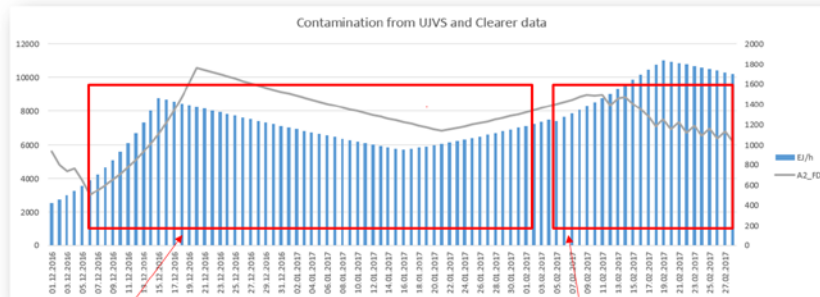
Fig. 15 USTER® *TOTAL CONTAMINATION CONTROL* in practice

The key to understanding and controlling the process is the consolidation of the information.

Bring for example the trend of ejection rate in relation to remaining FD-A2 event numbers. Therewith you can see that raw material changes have an impact. This is the only way the mill manager can react faster when there is an FD level increase of the yarns.

USTER® Total Contamination Control

Utilize the consolidated information to understand and control the process



Trend of ejection rate of USTER® JOSSI VISION SHIELD and remaining FD aligned. Raw material changes influence remaining FD in the FD-A2 class

Change in USTER® JOSSI VISION SHIELD settings. Higher ejection rate/h => lower remaining FD in the FD-A2 class

Fig. 16 USTER® TOTAL CONTAMINATION CONTROL consolidated information

Now let's move on to some trials which were performed by the Textile Technology department of USTER. All trials were performed in three different mills and mill setups in China.

These trials were done with and without the blowroom detection to understand how important early ejection of contamination is before such contamination enters the carding machines.

These three trials have comparable production rates between 450 and 480 kg/h. The ejection rate shows quite significant differences between 876 to 1,160 events per 100 kg cotton, depending on the setting used and the contamination level of the raw materials used. All yarns produced out of this fiber materials are 100 % combed compact yarn. The cotton was grown in Xinjiang. Two trials with manually-picked cotton and the other trial with machine-picked cotton.

USTER® Total Contamination Control

Practical examples

Trial overview

	mill 1	mill 2	mill 3
Production (kg/h)	480	480	460
Ejection rate (/100 kg)	1160	876	887
Yarn count (Ne)	60	80	32
Yarn type	all ring yarns, combed		
Raw material	100% Xinjiang cotton hand-picked		100% Xinjiang cotton machine-picked

Fig. 17 Practical examples

The following slides show what could be achieved with USTER® TOTAL CONTAMINATION CONTROL.

The yarn clearer settings had a huge impact on the remaining foreign fibers in the fabric.

The USTER® QUANTUM 3 clearer offers a tool to reduce the number of FD cuts by separating the vegetables from the foreign material with the help of the vegetable filter mode.

An open setting was used in this mill.

Utilizing this function, the FD cut level, even with such a close setting, only resulted in 15 FD cuts/100km.

USTER® Total Contamination Control

Mill 1: Ne 60 with VEG open setting, hand-picked cotton

The reduction amounts also depend on the yarn clearer setting

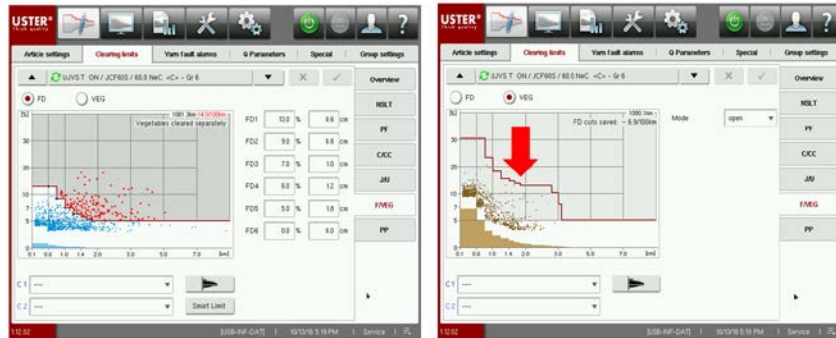


Fig. 18 Example 1, clearing limits

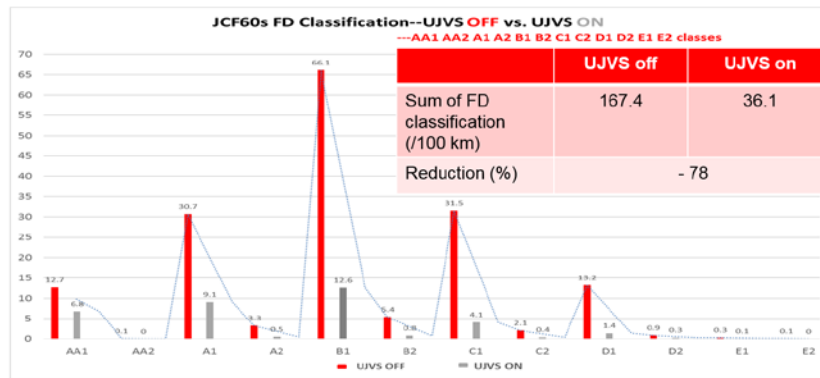
This graph shows a comparison of the individual classes of the FD classification in mill1. The red bar indicates the remaining events without using a fiber cleaning device. The grey bar illustrates the high impact of introducing the USTER® JOSSI VISION SHIELD.

Comparing the sum of all FD classes per 100 km between USTER® JOSSI VISION SHIELD on and off we saw a FD reduction of – 78%. An especially big impact could be found in the classes of AA1, A1, B1, C1, and D1.

USTER® Total Contamination Control

Mill 1: Ne 60 with VEG open setting, hand-picked cotton

The FD classification reflects the drop of remaining events when the USTER® JOSSI VISION SHIELD was activated.



18 27.01.2018

Cotton Conference 2018, Iris Biermann

USTER®
Think quality

Fig. 19 Example 1 Remaining events

A finer count yarn of Ne 80 was produced in mill 2. The contamination level as well as the FD cut level was higher than in mill 1.

At this customer the FD cut level used was set to 34.5 FD/cuts per 100 km. There was a saving of 19.6 cuts/km with the vegetable filter, on a medium setting

USTER® Total Contamination Control

Mill 2: Ne 80 with VEG medium setting, hand-picked cotton



Fig. 20 Example 2, clearing limits

Comparing the individual classes of the FD classification again, we can claim the following for mill 2:

The trend in reducing the contamination level by activating the fiber cleaning device was the same as in mill 1. Depending on the setting, and having a 25% lower ejection rate on the USTER® JOSSI VISION SHIELD (870 ejections per 100kg instead of 1160 ejection/100km), the reduction of FD classification resulted in a reduction of 34%.

USTER® Total Contamination Control

Mill 2: Ne 80 with VEG medium setting, hand picked cotton

Same trend as for mill 1, the reduction of FD in the yarn was found at 34% due to a lower ejection rate and finer yarn count

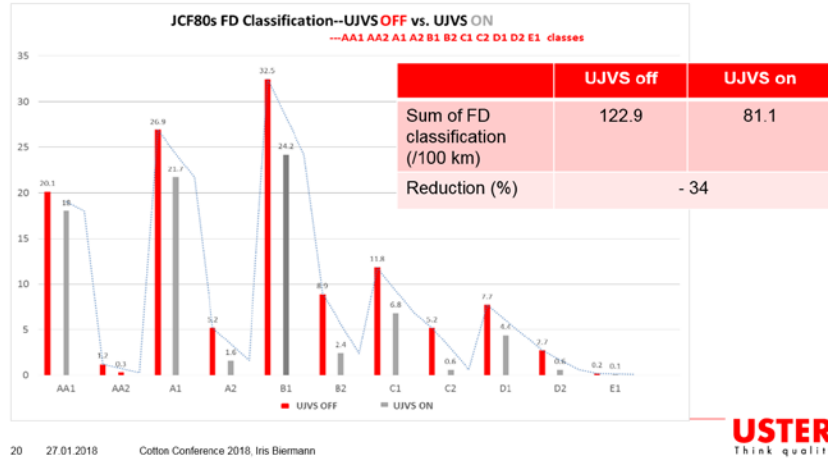


Fig. 21 Example 2, remaining events

The coarse count of Ne 32 only shows an FD reduction of 14 %. One of the reasons for the lower reduction can be related to the yarn count itself. The coarser the yarn, the higher the tendency that contaminants can penetrate into the yarn. Therefore, the overall level of contamination found is lower compared to the other mills.

USTER® Total Contamination Control

Mill 3: Ne 34 with open VEG settings

The FD classification reflects the dropped trend in most of the classes when the UJVS was ON.

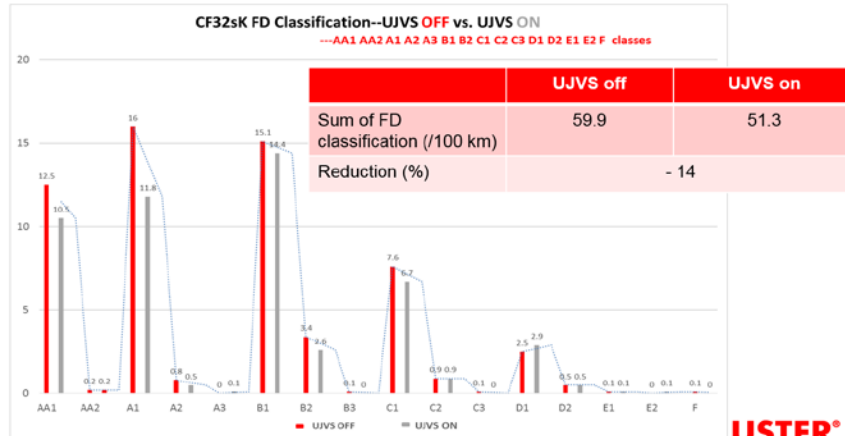


Fig. 22 Example 3, remaining events

I would now like to summarise the benefits of using USTER® TOTAL CONTAMINATION CONTROL.

The impact of the USTER® JOSSI VISION SHIELD is significant in all cases. Regardless of which level of foreign fiber the cotton had.

Trial 1 and 2 with manually picked cotton show the highest reduction.

Well, if a cotton has a higher amount of foreign fiber, it is also normal to reach a higher amount of reduction.

The yarn count also has an impact on the reduction. And of course, the comber noil level as well.

The result can be optimized according to waste versus remaining faults with the different Uster Quantum clearer settings.

USTER® Total Contamination Control Summary

That is clear evidence how important the cleaning of foreign fibers in the blowroom is. Plus what the impacts of the clearing limits are.

	Mill 1	Mill 2	Mill 3
Xinjiang cotton	Hand-picked	Hand-picked	Machine-picked
Count (Ne)	60	80	32
Blowroom production (kg/h)	480	480	460
Ejection rate (/100kg)	1160	876	887
Reduction in FD classification per 100km (%)	78.4	34.2	14.5

Fig. 23 Summary practical examples

In my opinion the interactions between all root causes are the key to success.

The cleanliness on the field should be as good as possible. If we solve more and more our rubbish problem on earth it will also have an impact on the contamination level of the cotton.

In my point of view, educating the farmer, or value models for less contamination in cotton bales, are the best way to come to less contamination in cotton.

The ginning mill is a better starting point to get rid of huge contaminants, so that the efforts in the spinning mills are getting less and less.

Then the spinning mills can balance the foreign matter reduction versus waste amount and machine efficiencies more easily. This balance is only possible when the information of a foreign fiber detection in the blowroom is combined with the yarn clearer results. This is the only way for mills to win their battle against the yarn manufacturing costs.

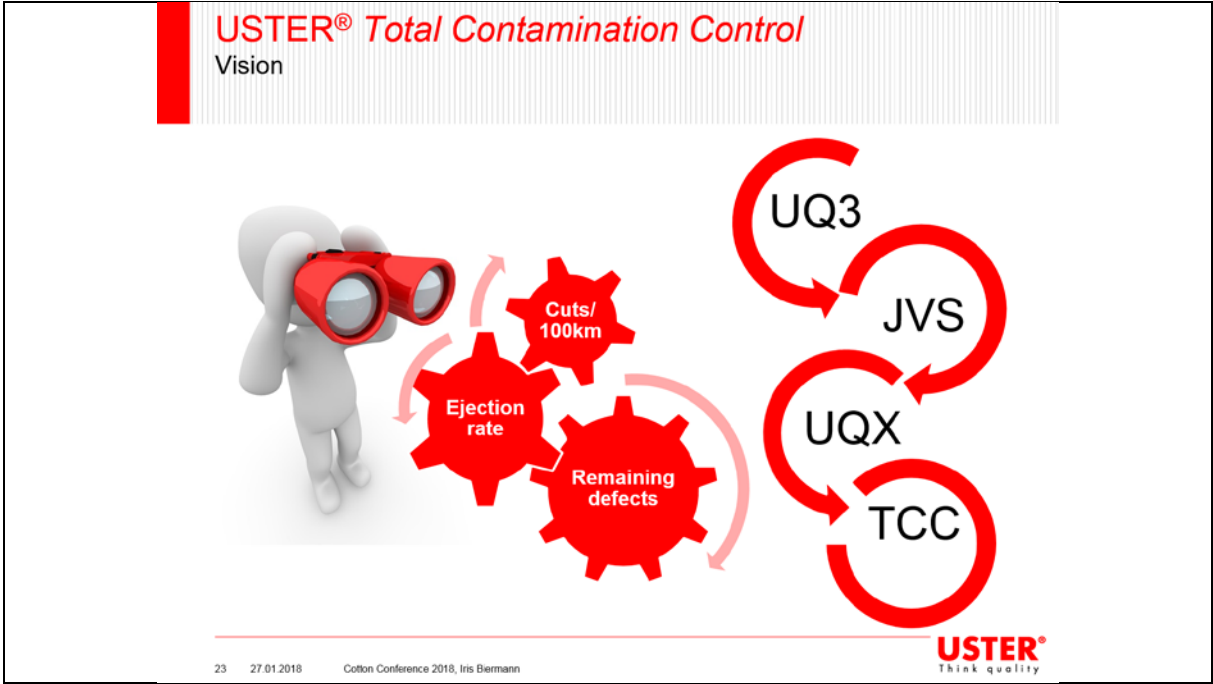


Fig. 24 USTER® TOTAL CONTAMINATION CONTROL the vision