1. Introduction

The sole purpose of pretreatment is to prepare the textile material for subsequent processing steps such as dyeing, printing and finishing as well as the manufacture of white goods.

An optimum pretreatment boosts a company's income by guaranteeing the reproducibility of the effects and reducing losses as second- and third-rate qualities.

2. Impurities to be removed during pretreatment

While for synthetic-fibre textiles pretreatment is limited to the removal of finishes such as spinning lubricants, knitting lubricants and sizes, for cotton and cotton blends 8-10% naturally occurring cotton impurities must be removed in addition to approx. 10-20% size. (fig. 1)

![Image of cotton impurities]

Approx. 4% size
- up to 20% size
- Up to 10% fibre impurities
- hemicellulose
- pectins
- proteins
- seed husks
- fruit capsules
- colored substances
- salts

1 Cotton warp yarn and its impurities

In addition, one can find various amounts of metallic impurities (iron, copper, lead, aluminium, etc.) that are incorporated into the cotton fibre during its growth or deposited on it during the initial stages of cotton processing (spinning, weaving, knitting, etc.).

Cotton analysis:

<table>
<thead>
<tr>
<th>Country</th>
<th>Calcium ppm</th>
<th>Magnesium ppm</th>
<th>Iron ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Texas</td>
<td>264</td>
<td>165</td>
<td>37</td>
</tr>
<tr>
<td>Memphis</td>
<td>139</td>
<td>312</td>
<td>44</td>
</tr>
<tr>
<td>Kalschinen</td>
<td>44</td>
<td>37</td>
<td>81</td>
</tr>
<tr>
<td>China</td>
<td>846</td>
<td>389</td>
<td>74</td>
</tr>
<tr>
<td>Alabama A</td>
<td>343</td>
<td>476</td>
<td>25</td>
</tr>
<tr>
<td>Alabama B</td>
<td>612</td>
<td>78</td>
<td>44</td>
</tr>
</tbody>
</table>

Harvest 1982: adequate soil moisture
Harvest 1984: irrigated soil

2 The cotton quality is the variable factor in pretreatment

All in all, up to 30% total impurities may have to be removed from the loomstate cotton fabric by pretreatment.

3. Processing aims that can be directly or indirectly influenced by pretreatment

- Levelness
- Uniformity
- Dimensional stability
- Low shrinkage values (< 3%)??

In order to achieve these processing aims, a pretreated textile material must meet the following requirements of the dyer, printer and finisher, the individual points receiving varying weightings (fig. 4).

3. Chemicals and auxiliaries for pretreatment (fig. 5)

While basic chemicals such as
- Enzymes
- Caustic soda
- Oxidation agents
are responsible for the chemical degradation of impurities, auxiliaries perform the task of
- Liquor transport (wetting)
- Mobilizing the reaction products (emulsifying, dispersing and complexing)
- Fibre protection (reduction, complexing and stabilizing)

Finally, auxiliary number one, water, ensures the removal from the textile of the reaction products and the chemicals used.
For treating cotton fabrics and PES/Co blended fabrics, the classical pre-step process with the operations sizing, boil-off and bleaching offers the highest reliability and reproducibility as far as the required treatment effects are concerned.

**Auxiliaries**

<table>
<thead>
<tr>
<th>Sizing Method</th>
<th>Wetting</th>
<th>Washing</th>
<th>Emulsifying</th>
<th>Complexing</th>
<th>Dispersing</th>
<th>Stabilization</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leopan®</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Kieron®</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Lutrol®</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Prestol®</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

- ● = very good  ○ = good  ○ = no effect

**BASF auxiliaries for pretreatment**

As an additional pretreatment step, mercerization and caustic treatment serve to:

- Improve the color yield
- Make dead and immature cotton dyeable
- Achieve dimensional stability.

### 5.1 Desizing

The profitability and competitiveness of a weaving mill depends primarily on the weaving efficiency.

#### DM untreated weaving costs

<table>
<thead>
<tr>
<th>R.P.M.</th>
<th>1.10</th>
<th>1.00</th>
<th>0.90</th>
<th>0.80</th>
</tr>
</thead>
<tbody>
<tr>
<td>220</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>420</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>520</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 1.5 end breaks/10 000 picks
- 1.0 end breaks/10 000 picks

#### Influence of warp-end breaks on the weaving costs at different running speeds

From the point of view of the weaver it is understandable that every means is justified, so to speak, that helps him increase the weaving efficiency.

The pretreater therefore often has the difficult job of getting the fabric in a sufficiently size-free condition for subsequent dyeing and printing.

The sizes used can generally be divided into three groups (fig. 6):

1. degradable
2. water-soluble
3. nondegradable water-insoluble (or water-resistant)

The range of available sizes has expanded to the point of being extremely complex. In practice, a useful overview can only be obtained when the sizing products are classified according to fibre type (fig. 7).

The scope of this lecture does not permit us to consider in more detail the individual sizing products and their optimum desizing conditions. We will therefore restrict ourselves to the general statement that depending on the size or size combination one must desize:

- raw or modified starch sizes with α-amylases,
- readily soluble synthetic sizes by a washing process,
- water-resistant synthetic sizes by neutralization or dispersion.

For all desizing processes, a suitable wetting and washing agent is required, e.g. Kieron® OLB Conc.,

- that is compatible with enzymes,
- ensures thorough wetting,
- penetrates the virtually hydrophobic size film.

At this point I would like to mention the frequently very generous inclusion of auxiliaries in the sizing recipe and/or as a lubricant, which makes the use of an auxiliary with a pronounced emulsifying capacity such as Kieron OLB Conc. more or less essential.

<table>
<thead>
<tr>
<th>Characterization</th>
<th>Removing</th>
<th>Type of Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degradable</td>
<td>Enzymatical oxidative</td>
<td>Starch, Modif. starch</td>
</tr>
<tr>
<td>Water-soluble</td>
<td>Swelling</td>
<td>Acrylate, PVA, CMC, Sp. Modif. starch</td>
</tr>
<tr>
<td>Water-resistant</td>
<td>Neutralize + dispersing</td>
<td>Sp. Acrylate, &quot;PES&quot;</td>
</tr>
</tbody>
</table>

### 7 Spectrum of sizing agents

- **Substrate**
  - **Size**
    - Starch
    - Galacto mannan
    - Glue
    - PAc acid-B
    - PAc water-B
    - PVA
    - PES
    - Synthetic
      - + alone
      - o only in combination with synth. size

### 8 Sizing agents for different substrates

In most cases, impregnation with desizing liquor is directly combined with singeing; at singeing speeds that are not infrequently as much as 150 m/min, impregnation must often occur in seconds. In cases where the wetting effect is insufficient and strong turbulence makes foaming a problem, Leopan® M helps ensure the necessary liquor-pick-up of at least 80%.

#### 5.2 Alkaline boil-off

An important, if not the most important, operation in the pretreatment of cotton is the boil-off process. The purpose of alkaline boil-off and the ensuing washing stage is to ensure a high degree of extraction of

- pectins, lignins, waxes, proteins, alkaline earth metals (Ca and Mg)
- and heavy metals (iron, manganese and copper).

To this list may be added low-molecular-weight cellulose fragments, products of size degradation (size residues) and a certain amount of undefined dirt and dust.

Depending on the amount of impurities and the reaction and wash conditions, the loss in weight due to boil-off can reach 7%.

The boil-off effect achieved depends essentially on the following parameters:

- Caustic soda concentration
- Type and concentration of the auxiliary
- Treatment temperature
- Reaction time
- Exclusion of air to prevent a fibre damage (formation of oxycellulose)

### 9 Parameter for the boil-off effect

- **Auxiliaries for alkaline boil-off promote the extraction of impurities by**
  - dispersing them as complexes and emulsifying them.

The prevention of oxycellulose formation by using steam boxes to
Ieliminate air is also an important measure for maintaining the
strength and hence the quality of cotton.

5.3 Peroxide bleach

Compared with other bleaching agents such as sodium hypochlorite
and sodium chloride, hydrogen peroxide offers advantages in appli-
cation and for the environment. The bleaching reaction produces the
"environmentally clean" decomposition products water and oxygen.
In peroxide bleaching, good bleaching effects may be achieved with-
out significant tendering of the cellulose. However, if the bleaching
recipe is not properly prepared, rapid peroxide decomposition may
cause a high degree of damage to the cellulose fibres. This circum-
stance becomes clearer when we consider the decomposition reac-
tions of peroxide in an alkaline medium (fig. 10).

![Reaction courses in peroxide bleaching](image)

5.3.1 Catalytic damage

A further cause of bleaching damage is catalysts in the form of heavy
metals such as frequently occurring iron and copper impurities.
Before looking more closely at the question of how and where cata-
lysts appear on the goods and how they can be removed, I would first
like to discuss a little theory.

What do we mean by catalytic damage and how does it arise?
Catalytic damage presents itself to the processor in the form of
- broken yarns
- tears
- holes
- dye resist areas.

Catalytic damage occurs when, for example, iron particles are bound
up in the cellulose fibres (e.g. during spinning or weaving). When present in this form, metals such as iron can cause damage to
cellulose fibres in wet processes even in the absence of peroxide.
Recent research at the Zurich Polytechnic has shown that there are
two kinds of catalytic damage (cf. Textilveredlung 22 (1987), No. 5).
1. Catalytic damage by oxidative degradation of cellulose in the form
of attack by radicals during peroxide bleaching.
In this case, peroxide is catalytically decomposed by heavy metals.
Wherever the metal is found on the cellulose fibre, a high concen-
tration of radicals builds up, which over a certain period oxidatively
destroys the cellulose fibre to a greater or lesser extent (fig. 11).

![Haber - Weiss - mechanism](image)

11 Decomposition of peroxide by presence of iron

2. Catalytic damage by hydrolytic decomposition of cellulose resulting
from a reduction in pH caused by anodic metal oxidation (fig.
12).

This damage may already occur before the peroxide bleach, e.g.
during the desizing process. As a rule, the hydrolytic decomposition of
cellulose occurs in all wet processes.
The cause is the phenomenon of crevice corrosion, which develops in
recesses or crevices via the liberation of protons and the hydrolysis
of iron ions, and results in a fall in pH.

In the case of iron, the pH may drop to 1 – 2.

5.3.2 How and where can catalysts get into the bleaching bath onto the
cotton that is to be bleached?
Catalysts can appear on textile material containing cellulose fibres
practically any stage from the cultivation of the cotton plant to fin-
ishing.

Examples:
- Sprays containing copper and lead used during cultivation to con-
trol pests
- Rust from the steel bands used to bale cotton for transport
- Rust abrasion in the gin, card and flyer
- Corrosion in water and steam pipes
- Abrasion of copper from the drying cylinders during sizing
- Ferruginous earth that is splashed onto the open cotton bolls dur-
ing strong rainfall or when the cotton fields are irrigated (Brazilian
cotton)
- Commercial-grade caustic soda that may contain more than the
permissible 5 ppm of iron
- Iron-graphite abrasion during weaving
- Contact with rusty machines during transport of cotton goods
- Incorporation of short-staple cotton waste during OE spinning
- Rusty loom reeds; e.g. in countries with a moist climate the reed
rust when the weaving machines are idle for a longer period

![Anodic oxidation](image)

12 Catalytic damage by hydrolytic decomposition

This list is certainly not comprehensive, but at least it gives the most
common ways in which catalyst can get into the bleaching bath.
There are a number of other possibilities that are much more difficult
to localize.

For example, one customer complained about large fluctuations in
the bleaching effect on a particular cotton quality after he had
converted from the unpopular chlorite bleach to peroxide bleach and
acquired the necessary new machine. It took a long time before we
discovered that iron impurities were being sporadically introduced
into the system via the water supply. The iron mainly appeared when
rain swelled the stream from which the company drew its water and
dropped rust to the scrap yard further upstream.

5.3.3 In what ways can catalytic damage be avoided?

Heavy metals can occur as the pure metal (e.g. copper abrasion, iron
swarf, etc.) or as chemical compounds. The chemically bound impuri-
ties are differentiated into water-soluble, completely dissociated
metal salts and water-insoluble metallic oxides or hydroxides.
Pure metallic iron, e.g. a sliver woven into the fabric, can only be re-
moved by hand, for example, by magnetically stopping the untreated
fabric during inspection. In this case, even treatment with acid would
be ineffective because too much acid at too high a concentra-
tion would be needed to dissolve the iron sliver and acid damage would
result.
Heavy metal compounds that are insoluble in water, such as the
Fe₃O₄/Fe(OH)₃ mixture present in rust, can be dissolved by treating
with oxalic or hydrochloric acid. Acid treatment is always an addi-
tional operation within pretreatment. Furthermore, oxalic acid is very
toxic, hydrochloric acid is highly corrosive and there is always a risk
of fibre tendering due to the formation of hydrocellulose when the
acid treatment is not performed properly.

Some customers have tried removing catalysts from the peroxide
bleaching bath by adding complexing agents such as EDTA, NTA or
polyphosphates (pyrophosphate). However, these agents have, in
addition to their capacity for complexing heavy metals, a much great-
of complexing action toward the hard-water metals calcium and magnesium, without simultaneously stabilizing hydrogen peroxide.

The consequence is that when such complexing agents are added to the peroxide bleach, they sequester the magnesium ions necessary to stabilize the peroxide. As a result, the hydrogen peroxide, without sufficient stabilizer to slow its spontaneous decomposition, has a much greater tendency to cause fibre damage.

The situation is different for complexing agents of the polyphosphonic acid type. Selected combinations such as our Lufibrol TX 1520 can be added to the peroxide bleach where they have an antiacatalytic effect if the quantity of heavy metal impurities is not too large. However, since the favourable effect is limited to a certain, undefined quantity of heavy metal impurities, such additions to the bleaching bath should be made only as a preventative measure.

Heavy metal impurities, which are mainly present as iron in the form of rust, must be removed before the goods are bleached with peroxide. This may take place in a separate acid treatment or by adding appropriate auxiliaries during pretreatment operations before the peroxide bleach, such as desizing and boil-off (fig. 13).

<table>
<thead>
<tr>
<th>Auxiliary</th>
<th>Process</th>
<th>Effects</th>
<th>Fibre protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lufibrol® E</td>
<td>Desizing</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lufibrol KB</td>
<td>Boiling off</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lufibrol KE</td>
<td>Boiling off</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lufibrol TX 1520</td>
<td>Peroxide bleaching</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Trilon® FE</td>
<td>Peroxide bleaching</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Prestogen® SBL</td>
<td>Peroxide bleaching</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

○ = very good  ● = good  ○ = no effect

For about 25 years we have had an auxiliary in our range that many of you will know, namely Lufibrol® KB.

Lufibrol KB contains a reducing agent and extracts water-hardening substances in addition to catalysts. It also helps protect fibres from tendering caused by oxycellulose formation. Insoluble calcium and magnesium pectinates are converted to water-soluble sodium pectinate. The product is favoured in steaming processes from which air cannot be excluded, i.e. in which an atmosphere of saturated steam is not guaranteed. Examples are pad-roll chambers and roller-bed steamers (conveyors) with long reaction times (fig. 14).

A final possibility is to add Lufibrol TX 1520 or Trilon FE to the bleaching bath itself to inactivate any catalysts still present during the bleaching process. This method has only limited effectiveness however and, as already described, should be considered as a preventative measure only. But where it is a matter of preventing build-up on the rollers in the bleaching steamer, increasing the degree of whiteness, and imparting a soft handle to the cotton, the addition of Lufibrol TX 1520 to the bleaching bath helps in every case.

Another way of peroxide-bleaching rust-stained cotton knits and wovens without separate prescouring is to bleach the goods cold. Since the damaging radical reaction caused by heavy metals occurs only slowly at low temperatures, no detectable damage occurs to the cellulose in the contaminated (e.g. rust-stained) areas. The condition for successful cold bleaching is that the impregnation temperature of the bleaching bath be kept below 40°C.
5.3.4 One-step pretreatment

This process combines desizing, boil-off and peroxide bleaching in one operation. It is a method that may be possible with certain selected qualities and pretreatment units. We have found, for example, that it is applicable to light cotton and PES/Co blended fabrics prepared at BASF. The option of one-step bleaching may already be allowed for during fabric manufacture by using clean cotton qualities and readily soluble sizes and furthermore by ensuring clean processing during spinning and weaving. In the case of bought-in material, e.g. grey fabric from the Far East with an unknown size composition and poor cotton quality, one-step peroxide hot bleaching is always a gamble. The risk is that one can never know beforehand whether or not the fabric contains the heavy metal impurities that inevitably cause fibre damage.

The Environment and the Finisher-Solutions

The Textile Institute's Finishing Group Conference and Exhibition – The Environment and the Finisher-Solutions, will be held this year on 12th October at the Nottingham Gateway Hotel, Nottingham, UK.

The conference will provide delegates with an essential up-to-date examination of the difficulties posed by modern finishing processes and the impact of environmental legislation. It will then present practical solutions allowing delegates to share the experiences of both the speakers and fellow delegates.

Speakers will include, amongst others, representatives from Courtaulds Textiles, Severn Trent Water Authority and the Textile Finishing Association.

Valuable promotional opportunities will be available through the Exhibition, Wallet Service and Programme Advertising.

For further information please contact Sally Pearson at The Textile Institute, International Headquarters, 10 Blackfriars Street, Manchester M3 5DR, UK.

Saurer Twisting Systems – Products Exhibited at Shanghaitex '93

Embroidery Systems

Saurer EmNet System

The innovative CAD-System for the efficient design processing in the embroidery industry. The Saurer EmNet System offers important economic advantages due to the combination of the so far separate workplaces for designing and punching.

Designing and punching with only one system

Designing and punching on only one system is no longer a pipe dream. The Saurer EmNet System combines these two workplaces which have been separate so far. Due to its modular structure with only one central high performance computer it enables the junction of several workplaces to one CAD-network.

Saurer EmNet System: the optimal combination of creativity and efficiency

Due to the possibilities of the system, new perspectives are created within the classic activities of the designer and the puncher. The comfortable handling of the system creates free space for the user to develop his personal working style.

6. Who is responsible for the occurrence of catalytic damage?

In general, it can be said that anyone, from the cotton planter to the pretreater, may be responsible for contributing to catalytic soiling of the goods and hence to the resulting catalytic damage.

Since anyone may be to blame, no one can be held responsible. What remains is to employ preventative measures and processes that help to remove any catalysts present.

Literature


lytschaden Textilveredlung 22, [1987], Nr. 5

Saurer Twisting systems

Balloonless tw isting machine Hamel 2000 and Hamel 2001 E

The balloonless twister Hamel 2000 with completely enclosed spindles is the only machine allowing twisting without air resistance and without thread balloon. This provides the base to achieve optimum textile-technological properties. The yarn is not exposed to mechanical friction during the twisting process. Thanks to low yarn tension, hardly any thread breaks occur.

The practically unlimited range of application of the Hamel 2000 allows to fulfill changing market requirements.

The exposed machine is capable of producing all ply yarn of natural or man made fibres, including delicate core yarn and inelastic and elastic covered yarn with Elastan core, in one operation and at low cost. It is also possible to produce ply yarn consisting of different yarn components.

The different spindle sizes will allow to achieve the optimum regarding twisting cost. The spindle gauge is 210 mm for all sizes, the max. spindle speed 15,000 rpm.

Thanks to the integral heat extraction system, the low noise level (approx. 80 dB(A) at 14,500 rpm) and to the extremely low fly accumulation, the personnel can enjoy pleasant working conditions.

It is possible to produce take-up packages with ready ply yarn having 100 – 150 mm traverse and a max. diameter of 300 mm, either with low density for dyeing or with normal density.

Lawson-Hemphill announces new YCA brochure

Lawson-Hemphill, Inc., the U.S. quality control and lab testing instrument manufacturer announces the availability of a brochure describing the new high-speed, fully automatic yarn count tester, the YCA. The catalog is available free of charge (P. O. Box 759, Pawtucket, Rhode Island, U.S.A.).

The new Yarn Count Analyzer is a high accuracy tester that allows the operator to run 200 yarn count tests per hour (90 meter samples) for synthetic and spun yarns. All the operator has to do is to preload the unit with 36 yarn ends and call up to correct program which will automatically set speed, length of samples and limits. The YCA can then be left unattended as it automatically tests for yarn count and rejects yarn that does not fall within the tolerance required.

Companies using the YCA can abandon the wrap reel method and dramatically improve the accuracy of their tests as well as cut operating costs since other tasks can be performed while the yarn count is running.