

# Finishing

So that fabrics might be prepared to be used by the consumer, in the clothing manufacturing, textiles for home furnishing, technical textiles and others products, oftentimes it is necessary to apply chemical or mechanical treatments to textile materials, in order to improve or confer them some characteristics.

# Finishing

To the operations set integrated in this process, it is designated as finishing. Finishing can be divided into:

- Pre-finishing
- Dyeing
- Printing and Finishes

## Pre-finishing

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## Dyeing

The dyeing aim is to colour the textile material in a uniform way.

These two stages of the process are performed more often on fabric or knit, however those can be also performed on fibre, thread or on some clothing.

# Reactive dyeing

The **reactive dyeing** is a method in printing (fixing) a dye or wax by the use of blending where the colours are created.

The reactive dyeing process presents as major characteristic the melting (a chemical reaction) of the dyes and pigments, in which the fibre is being dyed, restraining the bleeding or the loss and modification of the original colour, during the washing or utilisation.

With a dyeing paste and a heat-activated printing additive, images can be permanently bonded to the substrate (typically textiles but they can include cellulose, fibres, polyester and even proteins).

## Method

**Fibre dyeing:** The most used process for long fibres (wool) and filaments.

It achieves blended articles. In the case of synthetic articles, we can obtain colours through pigments addition even before the filament manufacture.

**Thread dyeing:** The most common process is the pack dyeing, however it's possible to be performed during others spinning processes. More indicated for the manufacturing of jacquard, check or striped fabric. The thread dyeing gives an advantage in getting more levelled colours, in spite of bringing the obligation to verify some processes that represent time and labour costs. Another thread dyeing often used is the warp dyeing that can be performed with open warp or cord warp. Both are very used in dyeing with indigo dye.

**Fabric dyeing:** This is the most developed process in the last years, due to several advantages such as greater levelling over the whole length of the cloth, less dyes waste, fewer processes, once it is together with the fabrics finishing operations. It produces a plain fabric. It can be produced with the rope-form fabric (it occupies less space and the fabric can remain more loosen) or the open fabric (it doesn't form sharp edges and can be worked on continuous process).

### Warp threads dyeing with indigo dye

**Discontinuous or batch process:** Process used for batches with smaller length or lower manufacture. In the same machine, all the processes of preparation, bleaching, dyeing and washing can be performed. It can be executed with open or rope-form fabric, depending on the machine used, and the more common ones are Vat, Jet, Flow or Jigger.

**Semi-continuous process:** The fabric impregnation through a dye bath performed by padding. After this process, the fabric remains settled for few hours, in order to initiate the dye reaction and the after- washing. The process is known as "pad-batch".

**Continuous process:** Suitable for large productions and batches with wider length. The dye reaction on the fibre is accelerated with the vapour or temperature addition. With that, the fabric prepared for dyeing enters in the machine and gets out dyed and washed. The more common processes are "pad-steam", with steamer, for cotton fabrics, and "pad-dry", with the hot air circulation (hot-flue), for synthetic fabrics.

# Dyes Classes

Some dyes classes used in the textile industry are the following:

- Cellulose (cotton, viscose, flax, ramie): reactive dyes, direct dyes, vat dyes, sulphur dyes, naphthol dyes and indigo dyes.
- Polyester: disperse dyes.
- Polyamide (Nylon): disperse and acid dyes.
- Wool: reactive and acid dyes.

Dyes are the water-soluble or disperse products that have affinity with fibres and have as purpose promoting the colour.

## Reactive Dye

### Advantages

They are economically intermediary; high fastness to light and moisture; doesn't need a fixation agent; high reproducibility;

### Disadvantages

It has restriction in the chlorine treatment; it has noxious effects on the environment;

**Fibres:** CO (cotton), CL (flax).

## Azo Dye

### Advantages

The colour is produced into the fibre; high fastness; excellent lustre; red; doesn't use a fixation agent;

### Disadvantages

Expensive; long process; it has noxious effects on the environment;

**Fibres:** CO (cotton), CL (flax).

# Pigment

In biology, pigments are the chemical compounds responsible for animals' or plants' colours. Almost every type of cells, as ones from the skin, eyes, hair, etc. contains pigments. People with a pigment deficiency are denominated albinos.

In the colouration of paintings, inks, plastics, fabrics and others materials, a pigment is a dry dye, usually, an insoluble powder. There are natural pigments (organic and inorganic) and synthetic. Pigments absorb selectively parts from the spectrum (see light) and reflect the others ones.

Generally, a distinction is made between the pigment, which is insoluble, and the colouring dye, which is liquid or soluble. There is a well-defined dividing line between pigments and colouring dyes: a pigment is not soluble in its solvent while the dye is. In this way, a dye can be as much a pigment as a colouring dye depending on the solvent used. In some cases, the pigment is done through a soluble dyeing precipitation with metal salt. The outcome pigment is denominated as "lake". The deteriorative pigment is the one that is not permanent and light-sensitive.

It is about a special case of dyeing, once it is necessary to bond pigments to the fibres surface, with a product called binder that polymerise under heat action. This product should be abrasive resistant and elastic, that's why, most often, it concerns a copolymer with two monomers, one of which confers it the resistance and the other one gives it the elasticity.

You can realize a pad dyeing with the pigment and the binder, and you can dry and polymerise to a temperature of 120-150°C.

## Advantages

It can be applied to any kind of fibre.

It can be applied together with finishing products.

It has a low cost.

It allows the removal of final washes.

## Disadvantages

Rough to the touch.

Weak fastness to abrasion.

# Sulphur Dyeing

Sulphurous acid,  $\text{H}_2\text{SO}_3$ , is an acid formed through the bond between water ( $\text{H}_2\text{O}$ ) and sulphur dioxide ( $\text{SO}_2$ ). Is less strong than sulphuric acid ( $\text{H}_2\text{SO}_4$ ), however its release in the environment, which occurs through the acid rains, is highly harmful and represents a considerable risk for every one.

- Reductive agent – sodium sulphide in alkaline medium;
- Dyeing performed by boiling;
- Rinsing, immediately after the dyeing process, in order to prevent the deposit of insoluble product.

## Pre-finishing

One of the operations performed on the cotton, as a fibre, consists in washing and boiling, having the purpose of eliminating water-soluble substances, greases, waxes and some dyes.

Wool should also be submitted to washing, in order to eliminate all the extraneous substances in the fibre before those one are being processed. After washing and before spinning, it is performed the lubricating, i.e., the introduction of lubricating oil in the fibre to facilitate the thread formation.

Threads can also be subjected to previous treatments, before to be transformed into fabric or knit.

For fabrics manufacturing, warp threads are submitted to sizing in order to give wider strength to threads, considering the efforts of which they are subjected with the shed formation.

In treatments made on fabric, we can refer to singeing to eliminate the cotton fibres pilosity, reducing the trend to pills formation.

Another operation is desizing that, as its name indicates, consists in removing all chemical products, introduced during the sizing, from the fabric.

Mercerising is another treatment applied in cotton fibres, and confers them an increase of lustre, strength, tensile and dyes absorption.

It's also usual to perform boiling and bleaching processes on fabrics. The chemical products used in these operations depend on which fibres the fabric is made of.

# Textile Finishes

Operation, performed after the preparation, dyeing or printing, designates to make the textile substrate more appropriate to its purpose.

Main objectives of finishes:

- Modify the final effect of the article.
- Modify the dyed or printed article's functionality.

The consumer expects that clothing, besides the fashion factor, provides him with:

- A personal style
- Comfort
- High performance
- Security
- Functionality
- Easy care

Nowadays, textile finishes begin to be known as:

- Carded
- Peach-skin finish
- Easy care
- Wrinkle free
- No-iron
- Anti-soiling and water-proof finish (resistant to washing and tumble drying)
- Anti-pilling



- **Mechanical Finishes**
  - Singeing
  - Mercerising
  - Carding
  - Emerising
  - Milling
  - Calendering
  - Compacting/Sanforizing
  - Stentering
- **Chemical Finishes**
  - Washing
  - Softening
  - Anti-bacteria
  - Anti-pilling (enzyme-linked)
  - Anti-felting
  - Easy care / wash-and-wear / no-iron

## Mechanical Finishes

### Singeing/Scorching

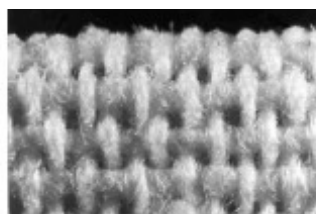
Operation designates to burn (flame) the loose fibres into the articles surface, without burning the basic threads. Used in fabrics, knit and thread (in cotton articles and its blending with synthetic fibres).

Objectives:

- Removal of the loose fibres and piles in the articles surface
- Reduction of pills formation (pilling) in the next operations



Before



After

## Mercerising

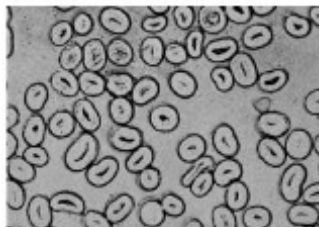
It is a treatment for cotton articles and/or natural fibres composed by cellulose in a concentrated solution of caustic soda (300 g/l), under tension and ambient temperature.

Objective:

- Fibre swelling and simultaneously there is a longitudinal shrinkage, modifying the morphological structure of the fibre and achieving a shinier surface, resistant to wear and washing.

The advantages of this process are:

- Larger dyeing affinity
- Larger dimensional stability of the articles
- Increasing of the lustre
- Increasing of the tensile strength
- Better covering of dead and/or mossy cotton
- Improving to the touch



Not mercerised cotton



Mercerised cotton

## Carding

It is an appropriate operation to “comb the pile” of wool articles, cotton (flannel), synthetic fibres and blending.

Objectives:

- Improving to the touch
- Heat retention



Carding machine

## Emerising

### Normal emerising

It is an operation where an article undergoes emery rollers (abrasive type), allowing a slight pile raising, although is smaller than in carding. Suitable finish for fabric, in spite of being already applied in knit.

Objectives:

- Peach-skin look
- Improving to the touch



### Carbon emery (new technology)

It is the substitution of the abrasive roller by a brush roller with long pile from carbon fibre.

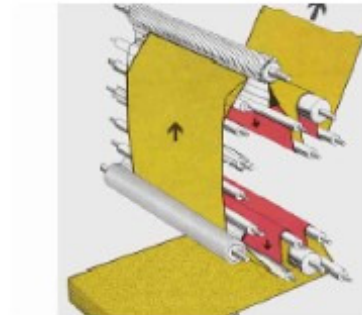
It renders the article soft to the touch with less pile formation, innovating the peach-skin finish and evolving up to the so-called “no-pile” effect.

## Milling

Operation designated to cut the pile or loop from the fabrics (by means of a spiral blade), conferring them a smoother and more uniform surface.

Objectives:

- Levelling of the pile height after carding or loops cut in knit or fleece
- Smoother surface



## Calendering

It is a continuous “ironing” operation, pressing the fabric between a heated metallic roller and another one with some elasticity.

Objectives:

- Ironing effect
- Lustre increasing
- Touch modification
- Transparency modification



## Compacting

Fabrics have the tendency to shrink in washing, due to tensions introduced during the spinning, weaving, knitting, dyeing and in some finishing operations.

This operation consists in applying chemical products or mechanical treatments (compacting, sanforizing and stentering machine) in order that the clothing has the minimum dimensional alterations after being manufactured.

Objective:

- Dimensional stability of textile substrates



Compacting machine  
for tubular knit



Compacting machine  
for open knit

## Sanforizing

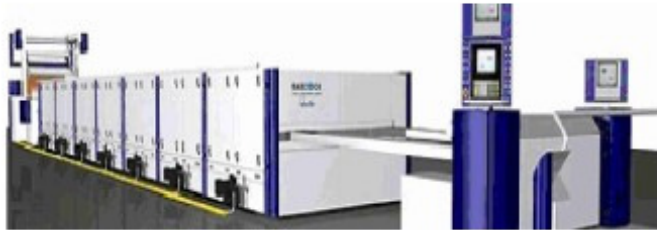
A more efficient method than the compacting since, with an accurate adjustment, it grants us 1% shrinkage in the washing. The previously moistened fabric must be compacted through a rubber clothe curved by a roller. Most often used in fabrics.



Sanforizing

## Stentering

It is used to dry, to give stability to articles, to water-set articles of synthetic fibres, to straighten wefts and it is also used to give different chemical finishes. The stentering machine is the finishing machine by excellence.



Stentering machine

## Chemical Finishes

### Objectives:

- **Reconstitution of lost effects** – The fibre touch and resistance are reduced during posterior treatments (boiling, bleaching, dyeing, printing...)
- **Transmission of new effects** – It is demanded, to natural fibres as much as to synthetic fibres, properties that they cannot achieve, without specific treatments (stability dimensional, wrinkle resistance, anti-felting, hydrophility, moisture-proof, crease resistance...)
- **Support for mechanical processes** – A lot of the effects obtained by mechanical processes demands the utilisation of chemical products (achievement of lustre, carding, emerging...). By another hand, threads, knits and fabric transformation needs products to increase resistance to improve the seaming in the confection.

Traditional chemical finishes were limited to confer a pleasant touch to textiles and some weight (body) to make them more attractive for the consumer.

In the middle of 20th century, synthetic fibres development allows the combination between natural fibres with artificial and synthetic fibres, providing the appearance of textiles with new properties.

These properties begin to be improved with the application of specific chemical products, conferring inclusive to 100% cotton articles some specific characteristics of synthetic fibres.

Then, it is possible to conciliate in a same article characteristics of natural fibres with characteristics of synthetic fibres. Thus, it appears the concept of Chemical Finish.

The **Chemical finish** consists in chemical products application to textile substrates, in order to confer them qualities that they didn't have earlier.

### **Technical Textiles**

They are all the textile structures designated to protective clothing industry, sport and leisure, household textile industry, and others industrial sectors that use them either in its final form or transformed as a complement to theirs products. For that reason, technical textiles cover wider markets than the conventional textiles, once those are designated exclusively to generic clothing and household textiles.

They are denominated as technical because they are conceived to support quality patterns demanded in extreme technical utilisations, which are out of reach of conventional textiles.

### **Intelligent Textiles**

They match to the most recent generation of technical textiles. They are produced by technologies that develop in textile materials capacities for the functions performance, that until today were provided by others products developed by others sciences, namely health and communications.

### **Functional Textiles**

They are which determine certain function, incorporating a raw material type or finishing.

# Fabric Softeners

The raw cotton contains natural softeners (waxes and creases in the cuticle and the primary layer) but these products have to be removed in the first stage of the textile finishing, because they make the cotton hydrophobic. In another hand, finishing with resins presents an inconvenient of worsening clothing touch. Thus, in every finishing treatment, it is practically obligatory the inclusion of one softener, due to its soft touch that is one of the major attractive qualities for the buyer.

Different touch effects can be obtained through the following processes:

- Mechanical Softening
- Chemical Softening
- Biologic Softening

## Mechanical Softening

It is defined as a touch modification through a mechanical action of friction between a stiff structure of equipment and the textile substrate.

Example: emerging, carding, milling and “beat” operations (Biancalani Airo and Biancalani Petra)

## Chemical Softening

Although the mechanical finish is very important, the chemical finish is considered more efficient in obtaining different softening effects. Nowadays, the combination of both processes is more and more used to obtain some effects.

## Biologic Softening

Also designated as “Bio-Finish” and “Bio-Polishing”, it’s a process that allows modifying the touch in cellulose fibres through the action of specific enzymes – cellulases.

Softeners can have the following actions:

- Non-permanent – easily removed during washing (derivatives of fatty acids)
- Permanent – resistant after several washings