

## UNIT 1

Typical sequence of processes. Object and methods Singeing, Desizing, Scouring, Synthetic Fiber Heat setting, Wool carbonizing, Weighting of silk. Wet processing equipment – kier – J box – pad roll – U box – Roller bed – Conveyor steamer – stenter.

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### AIMS AND OBJECTIVES

We here discuss about in general instructions on textile processing. After going through the unit, it will be easy to

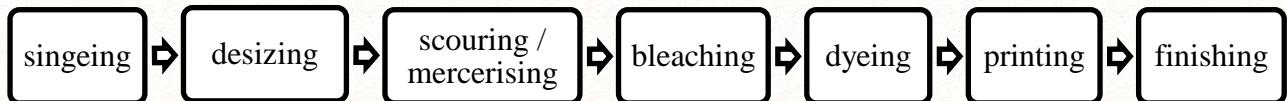
- i. Know about the sequence of processes.
- ii. Understand different steps in processing.
- iii. Describe types of methods used in processing.
- iv. Describe the equipments used in processing.

### TEXTILE PROCESSING

Textile processing can be defined as the process in which the textiles are subjected to various chemical or mechanical treatments in order to provide certain qualities to enhance the fabric and to remove certain redundant materials over the fabric surface.

### TYPICAL SEQUENCE OF PROCESSES

#### SEQUENCE OF WET PROCESSING FOR WOVEN INDUSTRY




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### OBJECTS AND METHODS

The main objectives of the wet processing are to

- i. Remove the loose hairy fibers protruding from the cloth, & to impart a smooth even and clean looking a surface.
- ii. Remove size from the Grey fabric which is applied during weaving and to make the fabric more absorbent for dyeing and printing process.
- iii. Remove the unwanted starch from the fabric known as desizing.

**Singeing** -Removal of loose hairy fibers protruding (or) projecting fibers from the surface of fabric by burning.

**Desizing**-Removal of size or starch materials present in the fabric.

**Hot & Cold wash**- Rinsing the impurities

**Scouring** - Removal of all impurities except natural coloring(Yellowish grey color)

**Bleaching** - Removal of natural coloring matter present in the material.

**Scouring** - Neutralize the fabric, removes chlorine smell and also to improve the whiteness of fabric.

**Dyeing** - To apply color on the textile material

**Printing** - To apply design on the fabric

**Mercerizing**-To increase the luster, Absorbency and strength of material

## **SINGEING**

The Warp and Weft yarns are made up of large number of short fibers by a process of spinning and hence the tiny fibres protrude from the surface. If the cloth is woven from such yarns, it also has the protruding fibres on its surface.

These protruding fibres are removed by a process known as singeing and the machines as singeing machines.

### **Importance of Singeing**

If the cloth is not singed, it will have a matted raw appearance after finishing. The fabrics to be mercerized are singed to develop maximum luster in the fabric. In order to import a clearly defined and sharp design to the cloth in printing, the goods must be signed, otherwise dulling of the pattern and the hairy edges take places. Therefore singeing may be considered an important process from the point of view of mercerizing and printing.

### **Types of Yarns to be Singed**

1. Combed cotton yarns
2. High twisted voile threads
3. Sewing threads
4. Polyester cotton blended yarns
- 5 Hosiery yarns meant for knitting

### **Types of Fabrics to be Singed**

Shirting's, Suiting, Saree, Dress materials, voile cloths, poplins, and polyester cotton blended fabrics etc.

The object is achieved by three singeing machines namely.

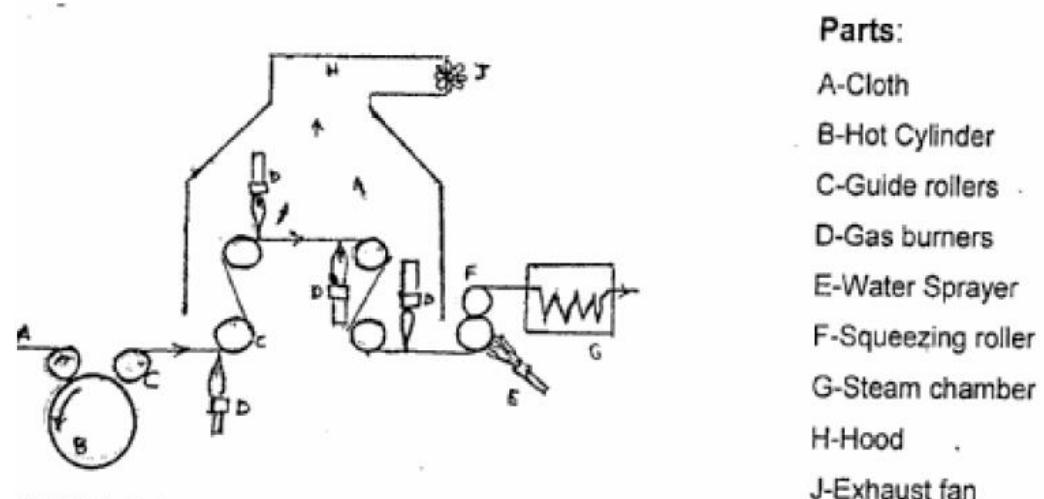
1. Plate Singeing
2. Roller Singeing
3. Gas Singeing

### **1. GAS SINGEING MACHINE**

This machine essentially consists of one or more burners given continuous flat or vertical flame produced by a mixture of compressed air and cool gas. The flame issues

from a narrow slit, which is adjustable with respect to width and thickness of the fabrics. When the cloth is drawn over the flame at high speed, the flame impinges and its surface burns the protruding fibres without damaging the cloth. The speed of transmission of the cloth through the singeing machine has to be suit the amount of the singeing required without the risk of burning the cloth.

When the flame impinges on the cloth surface the fiber ends present in the interstices of the warp are also singed. Then the singed cloth passed between a pair of draw rollers or through the nip of a mangle revolving above the water through, so that all the sparks are extinguished. Alternatively a water spray of water on the surface of the cloth. In order to remove the burnt fibres and exhaust gases, a hood and fan are provided over the machine. It can be seen that by one passage of the cloth through the machine both the surfaces of the cloths are singed.



#### Advantages:

1. Both sides are singed at a time.
2. Uniform singeing of the cloth is obtained.
3. No questions of unwanted lustier as there is no contact with any metal surface as in the case of other singeing machines such as roller and plate type.
4. Fibres in the interstices are burnt.
5. Speed is as high as 80 – 125 meters/min.
6. Flame can be controlled according to the width and thickness of cloth.
7. Different varieties of cloth can be singed.

#### Disadvantages:

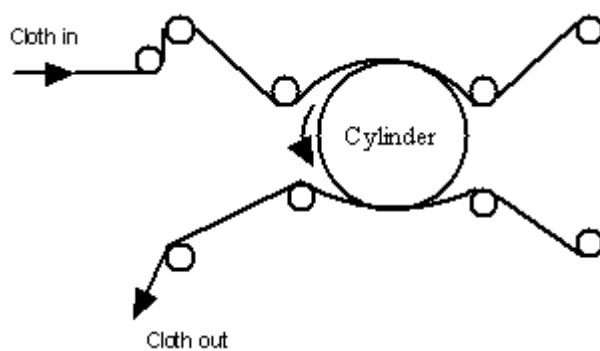
1. There is a chance of fire on the cloth: if the flame is not controlled properly

#### Precaution in gas singeing machine:

1. The supply of gas and to the burner is automatically controlled if the mixtures of gas and air do not burn (or) if the fabric to move.

2. The machine is enclosed with hood and exhaust fan otherwise the dust, fluff will affect the eyes.
3. For observing, class windows to be fitted on the hood.
4. Before singeing the fabric is to be dried.
5. The temperature of singed cloth surface is to be measured continuously with help of thermo couple and pyrometer.
6. The speed of fabric is measured with speed counter and machine is provided with automatic fabric threading device.
7. The speed of the projecting fibres combustion is considerably lower than that of cellulose fabrics.

## 2. ROTARY CYLINDER SINGEING MACHINE:

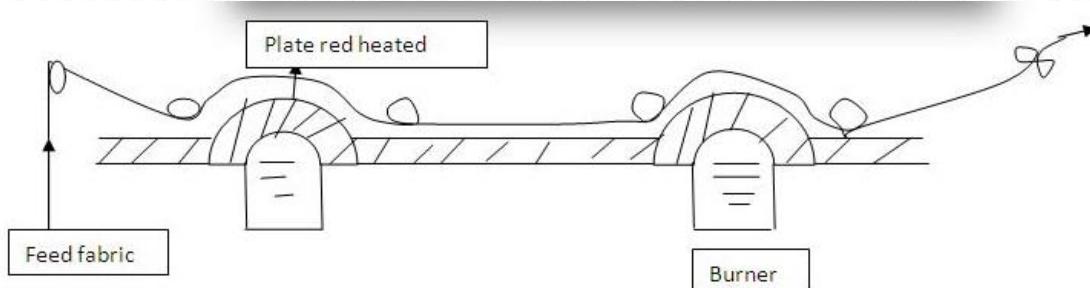


In this type of singeing machine, the cloth passes over and in contact with a heated rotary cylinder made of copper or cast iron. The rotary cylinder has internal firing and revolves slowly, so that constantly a fresh surface of the roller comes in contact with the cloth. The direction of rotation of the cylinder is opposite to the direction of the fabric so that the protruding fibers or nap of the fabric is raised.

This type of machine is particularly suitable for singeing of velvets and other pile fabrics.

If the singeing of both side of the fabric is required, then two cylinders are employed, one for each side of the fabric.

## 3. PLATE SINGEING MACHINE:



In this type of singeing machine, the cloth passes over and in contact with one or two heated and curved copper plate. The thickness of the plate ranges from 1 to 3 inches. The heating of the plates is done by a suitable burning arrangement of a gas mixed with air. The plates are

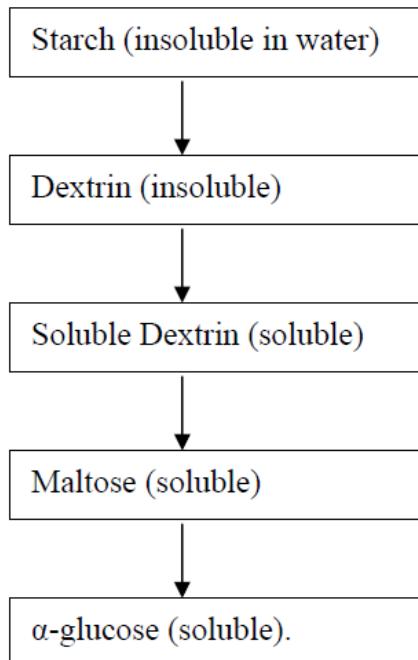
heated to bright redness and the cloth passes over and in contact with these plates at a speed ranging from 150 yards per minute.

The protruding fiber are burnt during the passage. The fiber end present in the interestices of warp and weft are not singed, since they are not made accessible as the actual contact between the cloth and a hard and hot surface of metal, a certain amount of luster in the cloth is produced.

## **DESIZING**

Grey cotton fabric contains naturals as well as those added to the fabric such as size to facilities weaving. Sizing components such as starch, CMC, PVA, vegetable oils, mutton tallow etc. are applied on to the warp yarns to strengthen it before weaving. These components make the fabric unsuitable for dyeing. Although the sizing of warp is a necessary operation to the weaver, this size in the Grey fabric is a source of trouble to the processors, since it hinders the penetration of the dye onto the fabric. Hence this unwanted size has to be removed for better dyeing and printing.

Chemically starch is poly-a-glucopyranose in which straight chain (amylase) and branched chain (amylopection) polymers are present. Both the constituents of starch are insoluble in water but they can be soubise by Hydrolysis of these long chain compounds to shorter ones. Thus under suitable conditions, starch can be progressively hydrolyzed to the following stages:



In desizing, the hydrolysis is carried out up to the stage of soluble dextrin.

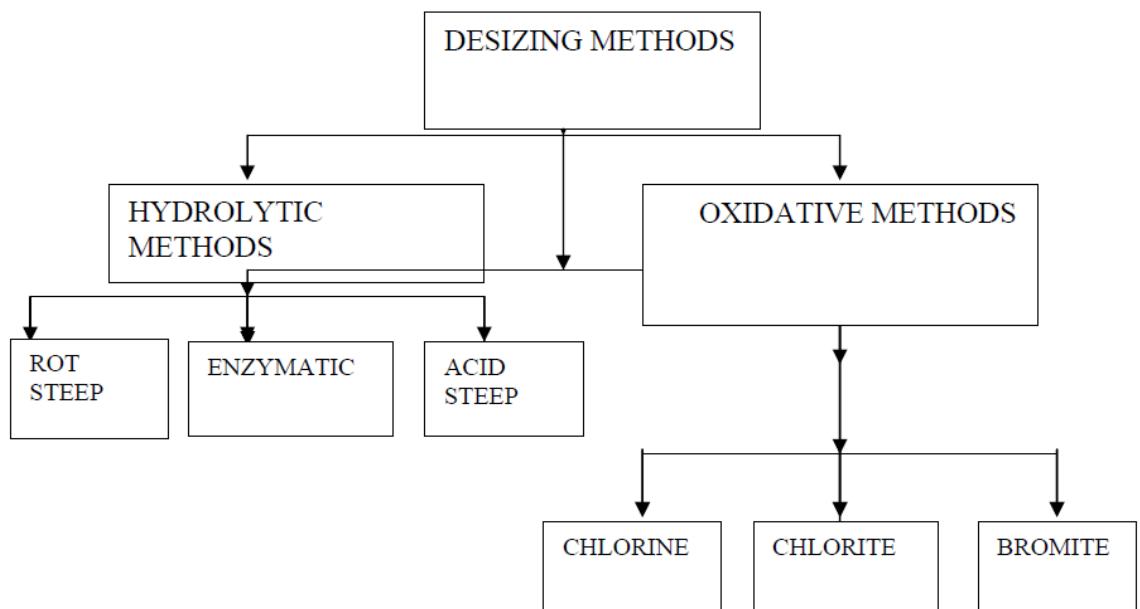
Desizing is a chemical process and the rate of this can be controlled. For example, if the desizing liquor is stronger, the process will be completed in a short time and it can be

made a continuous one. If weaker solutions are used, the process will take more time, and it would be a batch process.

Since the size mixture contains other ingredients for which the starch act as a binder, most of them are readily released and removed when the starch is hydrolyzed and washed off. For efficient sizing operation, 85 to 90% of the added size should be removed during desizing. Desizing should be done uniformly. Non-uniform desizing will give uneven scouring and bleaching and hence irregular.

## CLASSIFICATION OF DESIZING METHODS

The methods available for desizing may be classified as follows:



### HYDROLYtic METHODS

There are three processes. They are

1. rot steep,
2. acid steep, and
3. Enzyme steep.

#### 1. Rot steep:

This is the oldest and the cheapest method of desizing. Here no special chemical is used. The cloth is first passed through a padding mangle in which warm water at 40°C is kept and the cloth is squeezed to about 100% moisture contents (100% expression). The cloth is then allowed to stand for 24hrs. The microorganisms, naturally present in water, multiply and secrete starch liquefying (hydrolyzing action), enzymes, which solubilize the starch present in the size. The cloth is finally washed with water when most of the starch present on the fabric is removed.

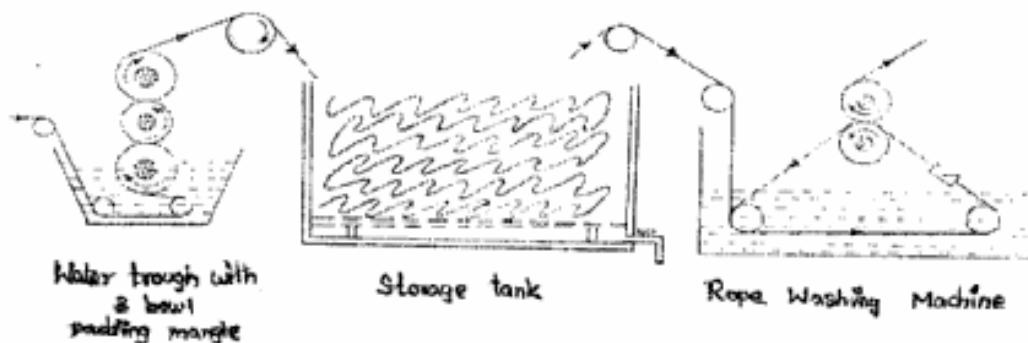
The formation taking place during rot steeping must not be too active, otherwise the cellulose itself may be attack.

**Advantage:**

1. Cheapest Method.
2. No chemicals are required

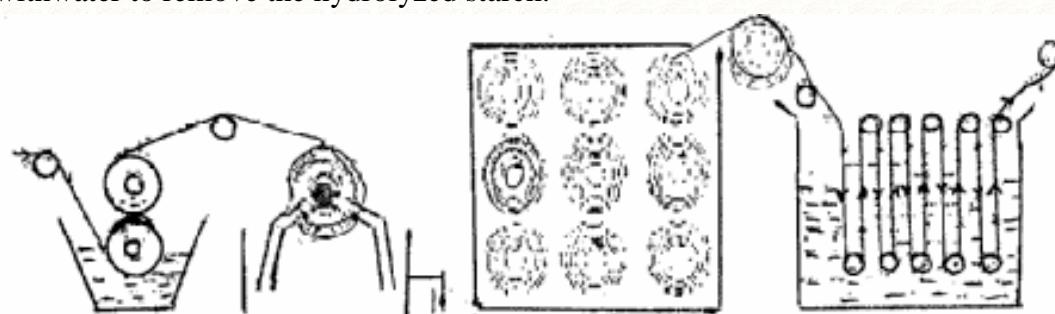
**Disadvantages:**

1. Large floor space is required for this process.
2. Slow process and takes more time for desizing.
3. Mildew may attack and develop on the cloth during storage.



**2. Acid Steep:**

Dilute sulphuric acid or hydrochloric acid may be used to hydrolyze the starch from the sized fabric. 0.25% (w/v) solution of the acid at room temperature (30°C) is sufficient for this process. The cloth is impregnated with dilute solution in a two bowl or three bowl padding mangle. Then the cloth is stored for 8-12 hrs. In a closed concrete pit, the starch is hydrolyzed by the action of acid during the storage period. Then the cloth is washed with water to remove the hydrolyzed starch.



**Parts:**

A-0.5 to 1.0% of  $H_2SO_4$  Or HCl

B-Closed storage with slow rotation

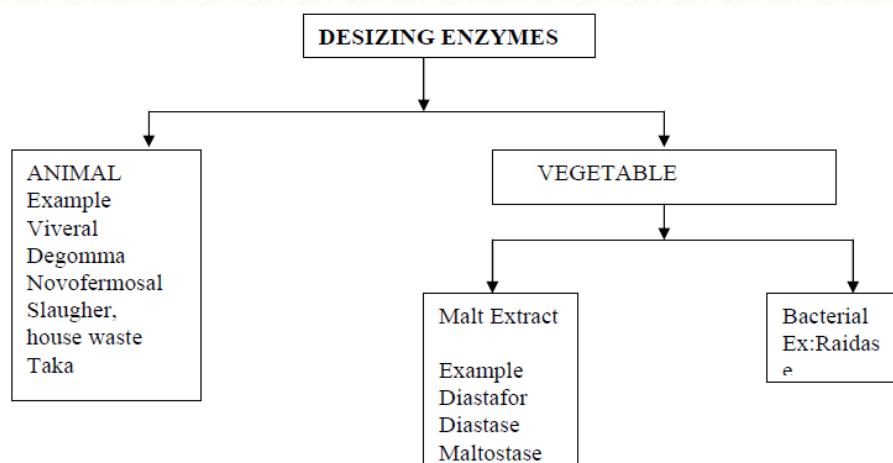
C- Open width soaper

**Precaution:**

The cloth should be stored in a closed concrete pit or wet gunny bags (jute cloth) are placed on the piled fabric. The reason is the following. The hydrolysis of starch is an exothermic reaction and as the reaction process, the temperature of the cloth rises sometimes to a temp 50°C. This temp., in normal conditions, does not hydrolyze the cellulose. But when the cloth is exposed to air during the storage period, local evaporation of water take place. This results in raising the concentration of the acid in the cloth if it is sufficiently high, cellulose is hydrolyzed. Therefore cloth will be weakened at the places where evaporation has taken place. Since this happens at random places, uneven degradation of cotton results. This is detected only after dyeing or printing when uneven dyeing takes place.

### 3. Enzymatic Steep

In enzymatic desizing, enzymes liquefy starch in the fabric. Desizing enzymes may be classified based on the source from which they are obtained.



Enzyme desizing is a very rapid and thorough method of desizing provided that the proper conditions of temperature and PH are maintained. The optimum temperature and PH of the different enzymes are

Enzyme	Temperature °C	PH
Malt Extract	50 – 60	6.0 – 7.5
Pancreatic	50 – 60	6.5 – 7.5
Bacterial	60 – 70	5.5 – 7.5

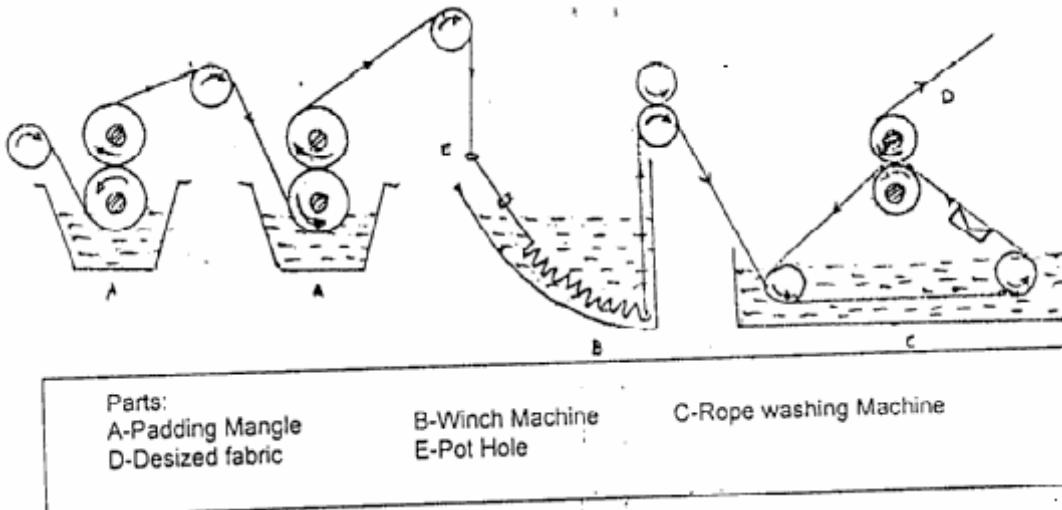
Enzymes suffer from one disadvantage that if the conditions of temperature and PH are not favorable, the desizing activity is destroyed.

### Continuous Desizing

The grey fabric is first passed through hot water and then through 0.5-2% malt extracts solution kept at 60°C to 70°C. The pre-impregnation of the cloth with hot water prevents the cooling of the malt extract solution. This extract is most active in the temp range 60°- 70 °C and PH 6-7.5

Normally when malt extract is used as the desizing agent, it takes about 3-4 hrs for complete desizing to occur. When stronger solutions are used the desizing action can be reduced to about 5 min.

The impregnated cloth with enzyme solution is taken over a winch and allowed to fall in a pit with a soling bottom, where the cloth assumes a wavy shape. After moving a sufficient length of the floor, the cloth is taken over guide roller and then to a washing machine. The length of the floor pit is such that the cloth takes about 5 min. for it travels from winch to washing machine. The impregnator and the washing machine should be synchronized with each other. After washing the cloth is taken to the next process.



### ADVANTAGES:

1. Time of desizing process is less.
2. It is continuous process.
3. Closely constructed fabric can be easily desized.
4. There is no chance for the cellulose getting hydrolyzed

### DISADVANTAGES:

If the conditions of temp and PH are not favorable, the desizing activity of the enzymes is destroyed.

### OXIDATIVE DESIZING

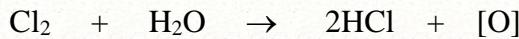
There are three methods of oxidative desizing process they are

1. Chlorine desizing 2. Chlorite desizing and 3. Bromide desizing

In oxidative the starch is oxidized by oxidizing agents. This process is also known as grey chemicing.

### 1. Chlorine desizing

- The active agent in case of chlorine desizing is gaseous chlorine. For the  $\text{Cl}_2$  desizing, open width cloth is impregnated with water and squeezed at required percentage expression.
- The squeezed fabric is passed through a chamber, which is provided with a false bottom, through which  $\text{Cl}_2$  gas is passed. In this case  $\text{Cl}_2$  reacts with water present in the cloth producing nascent oxygen and this nascent oxygen attacks starch, thereby solubilizing it.



- For this method the cloth is impregnated with bleaching solution at  $30^\circ\text{C}$  (room temperature), squeezed and allowed to stand for one hour at room temperature. It is then washed and afterwards with dil. HCl.

### 2. Sodium chlorite desizing

- In this method Sodium chlorite ( $\text{NaClO}_2$ ) is used under acidic condition for oxidizing the starch present in the grey cloth.
- Sodium chlorite in the presence of ammonium sulphate gives good desizing efficiency. Sometimes pH of desizing bath may be adjusted between 4 - 4.5 with the help buffer of Sodium acetate and acetic acid.
- Cotton fabric is padded at room temperature with an expression of 100% with an aqueous solution of 15g/l Sodium chlorite and 10 g/l ammonium sulphate and 1g/l of wetting agent. Then fabric is heated to  $80-90^\circ\text{C}$  for 1 hour. Then it is washed and neutralized.

### 3. Bromite Desizing

- Sodium bromite, is used for the desizing is a salt of bromous acid,  $\text{HBrO}_2$  (like sodium chlorite, the salt of chlorous acid,  $\text{HClO}_2$ ). This has a powerful oxidising action on the starch. This is due to the combined effect of bromous acid,  $\text{HBrO}_2$  and hypobromous acid,  $\text{HOBr}$ .
- On the other hand sodium bromite treatment also reduces the natural impurities present in the material mainly oxidise the some of the natural colouring pigments present which lead to the reduction in the chemical requirement for bleaching.
- The general process with sodium bromite involve the padding with liquor contains, 0.3 % sodium bromite, a wetting agent and stabiliser @ RT. The padding time for 6-20 min. The pH 9-10. Temperature more than  $40^\circ\text{C}$  leads to degradation of cellulose. Then after fabric is washed and treated with hot sodium hydroxide solution to remove the converted starch completely.

### Test for Desizing Efficiency

After the desizing by any of above methods, we now go for checking how far our purpose is achieved or not. We can check the desizing efficiency both quantitatively as qualitatively. The quantitative method to check the desizing efficiency is the weight loss.

### SCOURING

After desizing the cloth contains oils, fats, wax and coloring matters. These oils and fats are higher fatty acids of inorganic of compounds. These oils, fats and wax are hydrophobic or water healing material; these compounds affect the absorbency of the cloth. This leads to improper dyeing, printing and finishing in the subsequent processes. These materials present in cellulose affect the penetration of the dyes onto the fabrics. Therefore they have to be removed from the fabric by another process called as scouring process. It is also called as kiering, kier boiling and boiling out etc. Boiling out is carried out in a boiler in which yarn or cloth is boiled with alkaline liquors. This boiler is called as 'Kier' and hence the terms kiering and kier boiling.

1. To remove natural as well as added impurities of essentially hydrophobic character(oils, fats, wax etc.) as completely as possible and leave the fabric in a highly absorptiveconditions without undergoing chemical or physical damage significantly

2. To make the goods suitable for removing the natural coloring matter of the cotton during subsequent bleaching process.

The scouring process consists in circulating hot alkaline liquor ( $\text{NaOH}$ ) usually under pressure (10-30 PSI or 1.5 to 2 kg per sq.m) through a regularly packed desized fabric for up to 12 hours with temperature of  $100 - 130^\circ\text{C}$ . The temperature of the Kier liquor, the pressure in the Kier, the composition of the Kier liquor, the duration of the boiling etc., depend on the nature of the goods being scored. Goods containing colored yarn, knitted goods of finer quality are scoured under milder condition at lower temp. The coarser and the medium quality goods are scoured under more pressure and high temp. Efficiency of boiling is essential for good bleaching.

### **During Scouring The Following Main Process Are:**

1. Saponifiable oils are converted into soaps.
2. Unsaponifiable oils and waxes are emulsified.
3. Proteins are hydrolyzed into soluble products
4. Pectose and pectin are changed into soluble salts of Pectic or Metapactic acid
5. Simpler amino compounds are dissolved or hydrolyzed to ammonia.
6. Mineral matter is dissolved.
7. Dirt particles are removed and help in a stable form in the kier liquor.

### **HEAT SETTING**

Heat setting is a term used in the textile industry to describe a thermal process taking place mostly in either a steam atmosphere or a dry heat environment. The effect of the process gives fibers, yarns or fabric dimensional stability and, very often, other desirable attributes like higher volume, wrinkle resistance or temperature resistance. Very often, heat setting is also used to improve attributes for subsequent processes. Yarns tend to have increased torquing just after spinning, cabling or twisting. Heat setting can influence or even eliminate this tendency to undesirable torquing. At the winding, twisting, weaving, tufting and knitting processes, an increased tendency to torquing can cause difficulties in processing the yarn. When using heat setting for carpet yarns, desirable results include not only the diminishing of torquing but also the stabilization or fixing of the fiber thread. Both twist stabilization and stabilization of frieze effect are results of the heat setting process. Heat setting benefits staple yarns as well as bulked continuous filament (BCF) yarns.

Heat setting often causes synthetic fibers to gain volume as well. This volume growth is commonly described as “bulk development”. All processes using temperature and/or moisture to give textiles one of the above mentioned attributes are known as heat setting. The term “thermal fixation” is used less frequently. In the carpet industry, the process is exclusively called “heat setting”

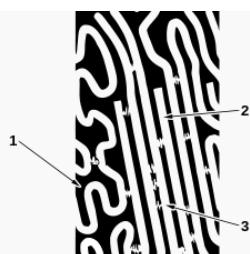
### **Crinkle tendency**

Crinkle tendency is due to the technological conditions of the spun yarn production and the physical fiber properties. Above all, the “technological conditions of the spun yarn production” means the turning moment of the thread. A twisted thread will always try to twist when it hangs freely between two fixed points in the form of a loop. In doing this, it gives up a part of its original twist which becomes spirals whose twisting direction is opposite to the original twist direction. This development of twist in the opposite direction occurs as the twisted yarn attempts to reach equilibrium.

Twisting in the opposite direction is due to the tensions resulting from the yarn twisting that Mueller indicated in the diagram of tension and pressure. The total tension acting against the twisting is increased in relation to increased twisting due to the increasing tension and pressure of the bundle of fibres in the yarn. It may become so strong that the

thread core buckles when it can no longer withstand the compressive strains. The yarn curls, meaning that the yarn tries to reach a state of equilibrium in which twists in the opposite direction from the original twist direction balance the yarn's torque. These twists are also called negative twists. In this state of equilibrium, the inner torsional tensions cancel each other out. The thread always buckles at a spot where the cross section is small due to the unevenness of the thread. During the spinning process this spot took up more twists and is therefore subjected to higher inner tensions, which ultimately break the thread core. Although thicker yarns are less twisted than fine ones, the inner tension rises opposite to the yarn size. Smaller yarn is more weakened by steaming. Further positive aspects of steaming are the reduction of curling and, at the same time, the setting of the physical properties of closeness and extension imparted to the yarn by twisting.

### Synthetic fiber



Fiber strength and elongation

1. amorphous fiber domains
2. crystalline fiber domains
3. bonding force

Synthetic fibers can be divided up into two fiber domains, the crystalline (organized) domain and the amorphous (unorganized) domain. In crystalline domains physical forces of attraction are acting between the closely parallel lines of polymers. These forces acting transversely to the fiber axis make up the closeness of a fiber. If tension is applied to the fiber, these forces hinder the fiber from breaking.

In contrast, the amorphous fiber domains act like links of the fibers. They are responsible for the flectional strength of the fibers. Additionally, the amorphous fiber domains make it possible for water or dye to enter.

crystalline fiber domains → tensile strength elasticity

### cause

amorphous fiber domains → flexibility water absorption colorability

During steaming, the heating of the fiber causes its molecules to start oscillating. The increase of oscillation that can be influenced by the degree and the period of heating dissolves the electric bond forces in the fiber; at first in the amorphous domains, later in the crystalline ones and at last in the polymers. As with wool, the tensions brought in by

spinning are set free. During drying or cooling of the fiber, the binding forces are rebuilt without having tensions in the inner part.

The problem of synthetic fibers is that the reduction of the binding forces only takes place between the so-called deformation point (start of changing the firm - solidified - amorphous fiber domains into a visco-elastic - easily deformable state) and the distortion point (the crystalline fiber domains change into a visco-elastic state, too) which is in a relatively high temperature range.

*Glass transition temperature - and deformation point of artificial fiber*

Material	Deformation point	Distortion temperature
Polyester	80-85 °C	230-240 °C
Nylon 6	80-85 °C	180-200 °C
Nylon 66	90-95 °C	220-235 °C

Several different heat setting processes are known in the textile industry. The most important are

### **Autoclave heat setting**

The oldest heat setting process is autoclave heat setting. Mostly, it is a discontinuous process. Autoclave installations use vacuum and/or pressure. Textile material is brought into the autoclave either on bobbins, in skeins or loose in a container. As nearly all autoclaves are exposed to certain pressures they are usually built in cylindrical shape and mounted horizontally. Most commonly, autoclaves are loaded and unloaded from the end of the cylinder but some may be loaded from one end and unloaded from the other end. Autoclaves mounted vertically exist but are less common.

### **Steamatic process**

For automation in link spinning/winding there is the so-called “in-line steamer”. The first known process of this type is the Steematic process by Resch. In this case the heat setting process happens in between the ring spinning and the winding machines. As soon as the ring spinning frame has finished spinning, the loaded bobbins are transported into the in-line steamer. Those bobbins are steamed there with a vacuum method and dried again within seconds. After steaming and drying, the bobbins are transported on to the winding machine where they are re-wound onto a cross-wound package.

The carpet industry currently utilizes two continuous processes, the Power-Heat-Set process and the TVP process which was derived from the autoclave technology.

### **Power-Heat-Set Technology**

The Power-Heat-Set process, formerly known as Suessen process, was developed in the beginning of the 1970s and was the first continuous heat setting system worldwide. The process itself was revolutionary in that it was the first system not operated with saturated steam and pressure, but with a superheated steam/airmix at atmospheric pressure. Using this innovative technology, completely new carpet collections were created. In the Power-Heat-Set process, the yarns and filaments oxidize slightly on the surface due to the existing oxygen in the surrounding atmosphere and the higher temperatures. This capillary oxide film causes the complete carpet later to be more stain resistant. Dirt particles adhere less to the fibers.

### **SUPERBA TVP process**

In addition to the Power-Heat-Set technology there is the SUPERBA TVP3 process which is also a continuous process. In the TVP3 process yarn is placed on a conveyor belt and inserted through a lock into a pressure tunnel that could be up to 15 m long. Inside the tunnel, it undergoes a heat setting process with saturated steam. At the end of the tunnel the yarn is taken out through a second lock. The yarn which is still hot and moist is dried and cooled after heat setting and fed to the winding process. Up to 72 yarn ends can be processed at the same time.

## **WOOL CARBONISING**

Carbonising is the chemical process which is used to remove vegetable matter (VM) from wool. The VM, which may be seeds, burrs, grass etc., is predominantly made up of cellulose, hemicellulose and lignin whereas the wool is principally protein. The carbonising process makes use of the difference in the stability of proteins and cellulose to the effects of mineral acids. Cellulose is made up of carbon, hydrogen and water with a chemical formula of  $C_6H_{10}O_5$ . It can be seen from the formula that the hydrogen and oxygen are present in the same ratio as they are in water. Therefore, in considering the underlying principle of carbonising, it may be assumed that all the VM consists of carbon and water in certain proportions. If these two substances are separated the latter can be evaporated away leaving the carbon in a brittle form. The most commonly used acid for this purpose is sulphuric acid. In its simplest form, carbonising follows a traditional wool scouring process and consists of acidification, drying, baking, mechanical crushing and dusting, neutralisation and final drying. This basic process of loose wool carbonising has remained essentially unaltered for many years.

Carbonising is primarily used for treating card waste, noils and high VM wools which are destined for subsequent processing via the woollen route. Very little processing of wools for worsted production is carried out. Where the VM content is from medium to low, say a maximum of 2-3%, mechanical removal of the VM is usually adequate with the various

stages of carding, gilling and combing in the worsted process being sufficient to produce a speck free top. The machinery used in woollen processing generally cannot accommodate medium to high levels of VM. Low to medium levels of VM can be accommodated if the spun wool is to be processed into a fabric which will subsequently be carbonised in the piece.

In the first half of the 20<sup>th</sup> century a considerable amount of research was carried out by various workers whose prime aim was to minimise the chemical damage imparted to the wool fibre by the acidic conditions. Various alternatives to sulphuric acid were proposed, such as calcium chloride, hydrochloric acid, aluminium chloride and thionyl chloride to name but a few. Commercial operators have in general, though, stuck with the sulphuric acid process due to its cheapness and ease of control. During the 70s and 80s some fundamental research was being carried out on such topics as acidising conditions, drying and baking, effect of detergents and rapid test procedures at DWI in Aachen as well as in Australia. In more recent times, though, this important area of wool processing has seen no new work published.

## Processing Stages

The conventional technique of wool carbonising has the following basic steps:

1. Scouring of the raw wool with non-ionic detergent.
2. Rinsing.
3. Immersion in a long bowl containing 5-7% (w/v) sulphuric acid, 1-2 g/L detergent at 20-30°C.
4. Double squeezing and/or continuous centrifuging prior to drying.
5. Drying at 60-80°C to a low regain.
6. Baking at 95-120°C to carbonise the VM.
7. Pass through heavy fluted rollers to crush the embrittled VM.
8. Convey to a rotating shaker/de-duster to remove the charred VM dust.
9. Pass through a neutralising bowl usually containing sodium carbonate.
10. Rinsing with a small addition of detergent.
11. Bleaching with hydrogen peroxide at approximately pH 5 with formic acid.
12. Final drying.

The production rate through the process is usually low, typically 500-600 kg/h for an 1800 mm wide line, since sufficient time must elapse for the VM to adsorb the acid from the bowl and for subsequent baking to embrittle the acidified cellulose.

## Recent Developments

In earlier very little research into the carbonising process has been conducted in more recent times. The work done in the latter part of the 20<sup>th</sup> century is summarised below.

- Acidising

- Stainless steel replaces wood for bowl construction
- Use of wetting agents to improve and even out uptake of acid
- Alternative acids (aluminium chloride, HCl, thionyl chloride etc)
- Moisture removal
  - High pressure squeezes
  - Double sets of squeeze rollers
  - Continuous centrifuges
- Drying/Baking
  - Lower temperature drying preceding baking to minimise chemical damage
  - Moisture control systems for more even drying and energy conservation
  - Two stage baking
  - Intermediate crushing
- Burr crushing and dedusting
  - Multiple stage crushing and step dedusting
- Neutralisation
  - pH control
  - Alternative neutralising agents (eg ammonia, ammonium carbonate)

## Typical Problems

- Preparation/Scouring
  - Degree of opening
  - Poor scouring
- Acidising
  - Yellowing of wool
  - Localised damage
  - Ineffective carbonising
- Moisture Removal
  - Poor squeeze efficiency
  - Uneven moisture content
- Drying and Baking
  - Yellowing of wool
  - Poor carbonising of VM
- Burr Crushing and Dedusting
  - Fibre breakage
  - Loss of fibre
  - Poor crushing
  - Poor dedusting
- Neutralisation
  - Wool pH too low
  - Wool pH too high

- Ineffective bleaching

## WEIGHTING OF SILK

Silk is sold by weight. By means of weighting the manufacturer can increase the weight of silk by 3 to 4 times. The weighting substance in the silk includes tannins such as salts or iron, tin (mostly used), chromium, sodium, magnesium and barium. Also sugar (mostly used), glucose, gelatin, glycerin and paraffin's are used.

### How weighting is done

Silk has great absorptive power. It can take up to 50% of tannin. Once that is applied the tannin itself can attract salts of iron and tin by another 50% without any visible indication of being changed in character. For dark colored silks, iron salts are used, for light-colored silks, tin salts are used.

For applying weighting, the silk is first degummed. During degumming process, silk loses approximately one-fifth of the weight. This is done prior to weaving. Then it is immersed in a solution of catechu or some other substance rich in tannin. Then it is transferred from tannin vat to iron or tin baths. After this cloth is taken out and washed in pure water.

### Effects of Weighting

Weighting causes the fabric to lose its strength as soon as the weighting is applied. Heavily weighted silk must be made into garments as soon as it is made. Spots develop in the dyes. Saltwater, perspiration and tears cause spots to be formed which seem as if the silk is eaten by acids. Sunlight also attacks weighted silk and can cause silk to fall to pieces.

### How to Detected Weighting in Silk:

Weighting of silk can usually be detected by the burning test. Separate threads from the warp and the weft are set on fire with a burning match. Pure silk burns very badly and stops burning as soon as the burning match has been removed. Practically no ash is formed (less than one per cent), and the end of the fiber left unburned takes the shape of a little bulb.

Weighted fibers, when burned, leave a considerable amount of ash, and the entire thread may keep its shape after being burned. When only the filling or the warp is weighted, applying the flame to a sample of the cloth seems to consume only one set of threads, the unweighted ones, the others keeping their form because of the heavy ash content.

### Saponification:

Vegetable oils, animal fats and mineral oils are not soluble or miscible with water. The vegetable oil, which is immiscible with water, is glycerin of fatty acids like oleic, satiric, plasmatic ricinoleic acids. When such oil is heated with a solution of sodium hydroxide in water, the oil is split up into its constituents, fatty acid and glycerin of which the

latter is freely miscible with water. The fatty acids react with sodium hydroxide present in the solution forming its sodium salt i.e., Soap, which is also soluble in water. This reaction is called saponification. As a result of Saponification, the insoluble and water-immiscible oil is converted into water-soluble products.

### **Emulsification:**

Waxes present in the size cannot be removed by saponification. There are esters of higher fatty alcohols and fatty acids. These oils are also hydrophobic in character. This can be removed by forming its emulsion in the Kier liquor. Therefore, an emulsifying agent (soap) is added to the kier liquor. An emulsion is a fairly stable mixture of two liquids, which normally do not mix with each other. Waxes + Soap (already formed by saponification) suspension

## **WET PROCESSING EQUIPMENTS**

### **KIERS**

The materials present in the cellulose have to be removed from the fabric by another process called as scouring process. It is also called as kiering, kier boiling and boiling out etc. Boiling out is carried out in a boiler in which yarn or cloth is boiled with alkaline liquors. This boiler is called as 'Kier' and hence the terms kiering and kier boiling.

### **TYPES OF KIERS:**

The following are the different types of kier.

1. Open kier.
2. Closed kier.

Some of them are vertical and others are horizontal. Depending on the methods of heating. Kiers are divided into 3 types viz.,

- i) those heated by direct steam within the kier;
- ii) those heated by indirect steam (closed coil) within the kier and
- iii) Those heated by indirect steam outside the kier

In the first type, the rate of heat transfer from the steam to the liquor is maximum because of its direct contact but there is condensation of a part of the steam which dilutes the liquor and also increases the volume of the liquor, generating hydraulic pressure. Also steam beings with it some amount of air (oxygen) which was dissolved in water.

This oxygen degrades cotton. Hence hydrazine ( $H_2N - NH_2$ ) is added to the water, which consumes the dissolved oxygen as  $H_2N - NH_2 + O_2 \rightarrow N_2 + 2H_2O$

In the second type, the liquor is heated with closed steam coils inside the kier and therefore the efficiency of heat transfer is lower than that in the first type but there is no dilution of the liquor nor increase in its volume and no increase in pressure.

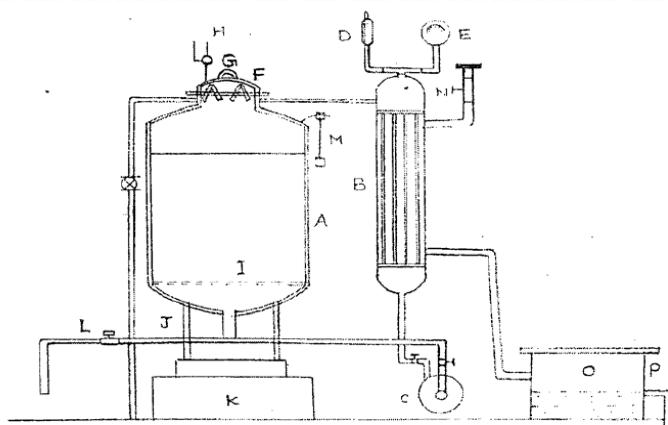
The third type is similar to this except that the liquor is heated outside the kier.

## Open Kier

Certain goods containing colored effect threads i.e. fabrics containing dyed yarns for warp and weft along with white yarns for producing colored woven designs, as in saris, dhotis, shirting checks etc., are boiled in open kier since most of the color of these threads is destroyed in boiling and bleaching. In the handloom industry, most of the grey yarn is also boiled in the open kier or in open vats under atmospheric pressure using 2% caustic soda, 1% soap and 1% sodium silicate (on the weight of the material) using a ratio of 1:20 for 4–6 hours taking care to see that the yarn remains immersed in the liquor throughout. It is left overnight in the liquor, and washed thoroughly with water the following.

### Pressure kier boiling:

A kier is a cylindrical vessel (generally vertical) capable of holding 1 to 3 tons of cloth. A 2 ton kier 2.7 m. (or 9 feet) height and 1.95 (or 6 1/2 ft.) in diameter is commonly used for boiling. Horizontal kiers are also used. Either open kier or pressure kiers are in use. When the lid of the kier is removed, it serves as an open kier working at atmospheric pressure. Kiers are made of mild steel plated 0.6 cm. thick joined by welding or riveting. They are provided with a pressure gauge and a safety valve. High pressure kiers have manholes through which cloth is introduced. As the kier is made of iron, a lime wash (with lime, cement, and sodium silicate) is given to its interior to avoid formation of rust stains on the cloth which comes in contact with the inner kier.



Parts:					
A-Kier	B-Heater	C-Centrifugal Pump	D-Safety Valve	E-Pressure gauge	
F-Lid	G-Handle	H-Block-off Cock	I-False Bottom	J-Supports	
K-Foundation	L-Drain Valve	M-Liquid valve Indicator	N-Steam trap		
P-Outlet for condensed water					

### Loading Of Kier

They grey fabric after desizing is loaded into the kier by piling uniformly either by automatic piling or by manual piling, with manual piling; it is possible to load about 80% of the kier capacity whereas with automatic pliers (which is used in modern kiers) about 70% capacity is utilized. The kier should not be filled beyond 80 and 85% of its rated capacity.

as overfilling may create hydraulic pressure and would also compress the fabric at the top of the kier, hindering the circulation of the liquor thereby increasing the temperature gradient between the top and bottom of the kier. Small quantities of cloth should not be boiled in a large kier; the kier should at least be half-full; otherwise the cloth may entangle.

In the case of hands the good are usually linked together in a continuous chain or headed up in the form of small bundles. It is most important to ensure even and regular packing of the goods in the kier. After the material is piled in the kier, heavy stones are placed on it to prevent it from being tossed up during boiling. Jute cloth may be placed between the material and the stones. Before entering the kier, the cloth may be impregnated with alkaline liquor in a trough and mangled to ensure even treatment of the cloth.

### **Removal of Air from Kier**

After loading the fabric in the kier, liquor is let-in from the bottom of the kier to sweep out air. The material liquor ratio (M.L.R) in a kier is usually 1:4 or 1:5. There should be enough kier liquor for the efficient circulation by the pump. Air is often, removed by heating the liquor; allowing it to come from the bottom, closing the lid and by keeping the air valve open allowing it to come out through the air valve without operating the pump.

After opening the air valve direct steam is turned 'ON' when the liquor boils and expels the dissolved air. Subsequently direct steam is stopped and the air valve closed. Only partial air is removed this way. For satisfactory removal of air, the liquor should be circulated for 15 minutes. And the circulation stopped and restarted when the kier liquor starts coming out from the air valve. Completes immersion of the material and the removal of air is most essential in order to prevent formation of oxy cellulose which is rapidly produced by the action of air on cotton.

For kier boiling, a mixture of 1 to 1.5% caustic soda solutions, 1% sodium silicate, 1% soap on the weight of the materials is used along with any heating assistant, boiling under 1.5 kg per sq cm (20 to 30psi) pressure for 6 to 10 hours is adequate for most goods but this varies depending on the type of fabric. Most goods which are to be sold in the white state are boiled twice, first with sodium hydroxide and then with sodium carbonate. It takes normally 2 hours to reach the required pressure in the kier.

### **J - Box**

In continuous process J-box is used for cotton scouring. It looks like English letter j. so it is called J-box. In J-box cotton is scoured open width and rope form.

### **General recipe of scouring in J-box:**

- Alkali : 4 to 6 g/l
- Wetting agent : 4 to 5 g/l
- Impregnation temperature : 70to 800c.
- Impregnation time : 40 to 90 second.
- Pick up : 90 to 100%
- Storing time in J box : 1 to 2 hours.
- Temperature in J box : 98to 1020c.

Rinsing with water and finally hot wash (not less than 800c) and cold wash is done.

**Description and Working Principle:**

The scouring process in J-box can be divided into four units. They are

- a) Impregnation box
- b) Pre-heater.
- c) J-box.
- d) Washing unit.

**a) Impregnation box:**

Fabric is passed into impregnation box in open width form and through the guide rollers and padded by caustic soda and wetting agent. The temperature for impregnation should be maintained at 70 to 800c for about 40 to 90 seconds. Then the fabric is squeezed and passed on to the next unit.

**b) Pre heater:**

In this unit the material is passed to the thermostatic controlling system at temperature of about 90 to 1000c for about 30 seconds. Then the material is passed to the J-box

**c) J-box:**

The capacity of normal J-box is about 12000 to 15000 pounds. The material from the J-box is passed to the washing unit passing through squeeze roller.

**d)Washing unit:**

The water soluble impurities or products that were left on the material are removed by washing. First of all the materials are washed in hot water at the temperature above 800c, then it is cold washed and finally dried.

**Advantage:**

1. The process is a continuous process. So consumes less time.
2. The process is economical.

**Disadvantage:**

1. The result of scouring is not good as compared with kier boiler.
2. The process is not hydrophilic as kier boiler.

**STEAMERS**

Printed dyes are usually fixed by steaming process, the steam provide the moisture and rapid heating that brings about the transfer of dye molecule from the thickener film to the fiber within a reasonable time. The terms 'ageing' and steaming refer to the same process of fixation. The time and conditions required for fixation in steam vary with the properties of the dyes and fibres used, ranging from 10 seconds to 60 minutes in steam at 200° to 100°C. Technical and economic factors have encouraged the use of higher temperature and shorted time and the change from batch to continuous processes.

**Continuous steamers:**

The high temperature Festoon steamer works with saturated or super-heated steam at a temperature of up to 180 C. The steamer consists of an inverted box, which is open at the bottom (top of the box). The steaming chamber consists of hallow walls and a hollow ceiling in which constant level of water is maintained. The hollow wall contains heating pipes which boil the water the help of steam or oil as a heat transfer medium. A saturated steam produced rises, expels in the air and heats the wall. The insulated exterior wall prevents the heat loss and also prevents condensation of water drops. Heated pipes are fitted in the double wall roof to prevent the formation of water drops. A slit is provided to the inner wall at the apex of the roof from which steam enters in the inner chamber. Inside the steamer about 18" above the bottom edge there is an extraction device to draw excess steam and prevents it from escaping.

The steam is continuously purified to remove the harmful printing paste, additives like urea, benzene, alcohol, solvents etc. The fabric is lifted in a tension free state over a conveyor into the steamer. Saturated steam may be used to preheat the fabric. The cloth is transferred in a tension free state to a continuous chain of rollers. The loops of fabric can be readily adjusted to any length. The cloth leaves the steamer at the same end as it is entered it. During steaming the printed surface of the cloth does not come into contact with any metallic parts.

An advantage of this steamer is that it is not dependent of the quantity of the steam supplied by the boiler, since steam generation and distribution occurs in the steamer itself. Continuous processing of all types of fabric constructions, all types of dyes can be used in this process. Simple running control and extremely good reproducibility of steaming conditions are some of the other advantages.

**Batch steamers:** For expensive fabric and small quantity there are obvious advantages in using steams of low capacity, that can be quickly raised to working temperature and that produce no creasing, stretching and other damage to fabric. Batch steamers also advantage when colour yield are improved by steaming at above atmosphere pressure for example in the case of deep colours on polyester fabrics.

The following are the various dye fixation processes after printing of polyester fabrics.

### **1. Atmospheric steaming:**

This method does not require a pressure vessel, but in order to obtain moderate-good yields of dye a "Carrier" must be added to the print paste. Steaming up to 1 hour is carried out at atmospheric pressure.

### **2. Pressure steaming:**

A steaming treatment of from 20 – 30 minutes at a pressure of 2.0 X 105 – 1.4X105 N/M<sup>2</sup> (30 – 20 lbs/in<sup>2</sup>) is given method no carriers are necessary but the steamer must be capable of operating safely at much pressures.

### **3. High temperature steaming:**

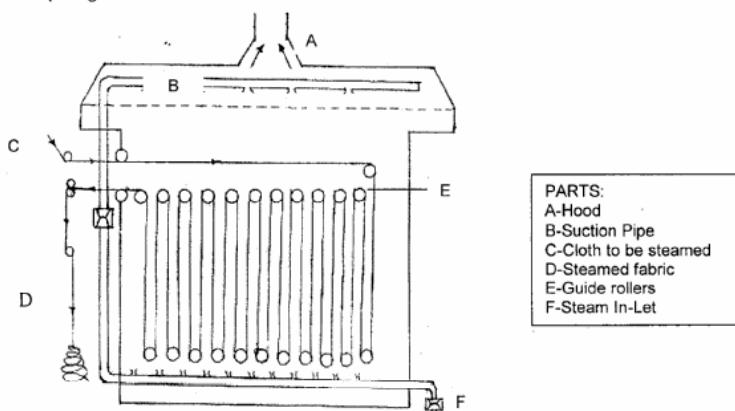
The ICI high temperature steamer uses superheated steam to obtain accelerated dye fixation. The print paste contains an addition of urea which aids dye transfer to the polyester fiber. High temperature steaming is a continuous process and no pressure seals are necessary. For

'Terylene' or polyester fabrics, temperature up to 180°C are usually employed with a treatment time of one Minutes.

#### 4. Dry Heat (backing) Fixation:

An addition of 100 parts of urea per 1000 parts of print paste and the use of an emulsion thickening is recommended. This method operates at the highest temperature range of 180°C - 200°C and at times of 120 – 30 seconds respectively.

The rapid ager:



The Rapid ager consists of a small iron chamber with the guide rollers at the top and bottom. A wooden hood is provided at the top of chamber to carry off fumes during steaming.

The printed cloth enters and leaves the ager through the same aperture. Two heated pipes parallel to the weft thread of the cloth are fitted near the aperture to prevent condensed water drops from steam falling on cloth. The steam is supplied from perforated pipes fixed at the bottom of the ager. The condensed water formed from the steam runs down the sides of the chamber and collects on the floor and is cleaned of from time to time. Goods printed with vat dyes, vat resists Rapidogen resist etc. are steamed in the rapid ager for 5 to 10 minutes at 100 to 102°C the consumption of steam in this ager is very high and therefore the operation is expensive. Rapid ager is not suitable for light weight goods because of the stress extended on the fabric.

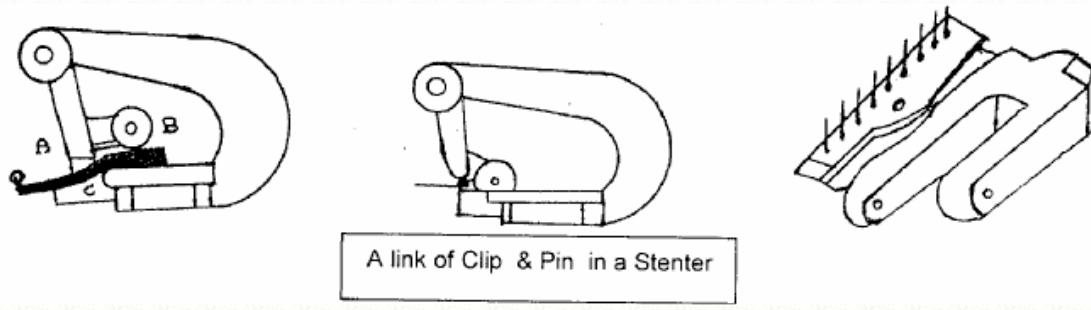
### STENTER

The fabric after scouring and bleaching process shrinks widthwise and the weft becomes distorted during this process. The main function of stenter is to stretch the cloth widthwise and to recover the original width. It also straightens the weft threads and passes it at right angle to the warp. But in majority of the cases, a stenter does stretching and drying. There are two types of stenters.

1. Clip stenter,
2. Pin stenter.

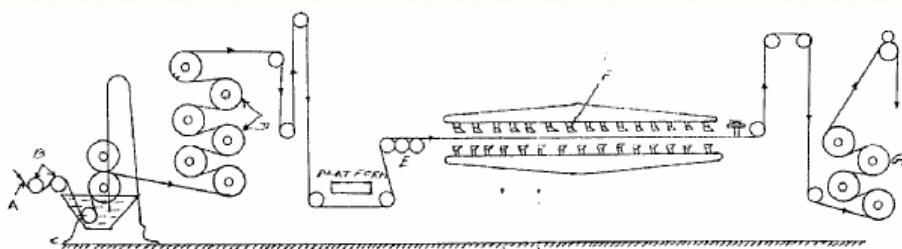
**Clip stenter** is used for cotton and linen fabrics. They can be run at a higher speed than a pin stenter. **Pin stenter** are used for delicate fabrics like woolen, worsted, silk, rayon and synthetic which are discarded by the grip of clips. Single layer pin stenters are used for silk, rayon and synthetic fabrics. Multi layers pin stenters are used for woolen goods. These goods being thicker, require greater amount of heat and hence a longer passage through the machines.

the stenter stretches the fabric and also dries. The cloth is dried, stretched and free from cases. There is a control over the width and also over length wise of stretching during drying which is not in any drying unit. A hot air stretching range is shown in figure. The cloth passes under the platform to the entry end of the stenter, where two attendants remove any creases and control the feeding into the clips or the standers may have some automatic method of feeding the fabric to the clips. In the stenter the cloth is gripped by the clips at either selvedge. The chains of clips for the first 10 feet of rails gradually diverge from each other and thus apply the stretch gradually.



The cloth is carried by the clips in the stretched condition for the length of about 80 feet. Hot air is blown on to the cloth by a powerful fan through sheet iron and trucking and adjustable nozzle. A large multi-tubular heater is used for heating the air. Sometimes steam is used as a heating medium (Cylinder drying). According to the quantity of air required the heater is built up of a number of separate sections. It is therefore possible to work at the same time, both with steam and with exhaust steam. The air can be when partially heated in the front section fed by exhaust steam and raised to required temperature in the smaller section behind which are fed with steam.

Hot air is delivered through nozzles above and below the cloth, or on to the underneath side only. The nozzles can be adjusted to deliver the air towards or against the direction in which the cloth is moving towards the selvedge of the centre and the nozzles are fitted with adjustable dampers on leaving the clips, the material heavy texture, it is passed over. There are 4 drying cylinders to remove any moisture which may remain in the selvedges, where they have been gripped by the clips.



Parts:  
 A-Fabric      B- Tension Rollers      C-Starch mangle      D&G- Drying Cylinders  
 E-Expanded Type Guide Rollers      F-Hot air Blower

The hot air from the chamber is recalculated through the fan and heater thus there is economy in steam consumption. The output of this machine depends on the weight of cloth and the amount of moisture to be dried. Usually these machines are made with a 90 feet length of clip and the speed range up to about 120 yards/ minutes.

### **POINTS TO REMEMBER:**

1. Textile processing can be defined as the process in which the textiles are subjected to various chemical or mechanical treatments in order to provide certain qualities to enhance the fabric and to remove certain redundant materials over the fabric surface.
2. Singeing is the process to removal of loose hairy fibers protruding (or) projecting fibers from the surface of fabric by burning.
3. Desizing is the process to removal of size or starch materials present in the fabric.
4. Hot & Cold washing the process to rinsing the impurities
5. Scouring is the process to removal of all impurities except natural coloring (Yellowish grey color)
6. Bleaching is the process to removal of natural coloring matter present in the material.
7. Scouring is the process to neutralize the fabric, removes chlorine smell and also to improve the whiteness of fabric.
8. Dyeing is the process to apply color on the textile material
9. Printing is the process to apply design on the fabric
10. Mercerizing is the process to increase the luster, Absorbency and strength of material
11. The three machines used for singeing namely plate singeing, roller singeing and gas singeing
12. There are three methods of oxidative desizing process they are chlorine desizing, chlorite desizing and bromide desizing
13. There are three processes of hydrolic methods they are rot steep, acid steep, and enzyme steep.
14. Carbonising is the chemical process which is used to remove vegetable matter (VM) from wool.
15. The materials present in the cellulose have to be removed from the fabric by another process called as scouring process. It is also called as kiering, kier boiling and boiling out etc. Boiling out is carried out in a boiler in which yarn or cloth is boiled with alkaline liquors. This boiler is called as 'Kier' and hence the terms kiering and kier boiling.
16. The different types of kier machines are open kier and closed kier.
17. Certain goods containing colored effect threads i.e. fabrics containing dyed yarns for warp and weft along with white yarns for producing colored woven designs, as in saris, dhotis, shirting checks etc., are boiled in open kier since most of the color of these threads is destroyed in boiling and bleaching.
18. Printed dyes are usually fixed by steaming process, the steam provide the moisture and rapid heating that brings about the transfer of dye molecule from the thickener

film to the fiber within a reasonable time. The terms 'ageing' and steaming refer to the same process of fixation.

19. The time and conditions required for fixation in steam vary with the properties of the dyes and fibres used, ranging from 10 seconds to 60 minutes in steam at 200° to 100°C. Technical and economic factors have encouraged the use of higher temperature and shorted time and the change from batch to continuous processes.
20. The main function of stenter is to stretch the cloth widthwise and to recover the original width. It also straightens the weft threads and passes it at right angle to the warp.
21. Clip stenter is used for cotton and linen fabrics. They can be run at a higher speed than a pin stenter.
22. Pin stenter are used for delicate fabrics like woolen, worsted, silk, rayon and synthetic which are discarded by the grip of clips.

### **EXPECTED QUESTIONS:**

#### **Section A**

1. \_\_\_\_\_ can be defined as the process in which the textiles are subjected to various chemical or mechanical treatments in order to provide certain qualities to enhance the fabric and to remove certain redundant materials over the fabric surface.
  - a. Textile processing
  - b. Fabric preparing
  - c. Fibre preparing
  - d. none
2. \_\_\_\_\_ is the process to neutralize the fabric, removes chlorine smell and also to improve the whiteness of fabric.
  - a. processing
  - b. Scouring
  - c. all the above
  - d. none
3. \_\_\_\_\_ is the process to removal of loose hairy fibers protruding (or) projecting fibers from the surface of fabric by burning.
  - a. a. Bleaching
  - b. mercerization
  - c. Singeing
  - d. none

#### **Section B**

1. Define textile processing?
2. Explain about singeing?
3. What is desizing and scouring?
4. Discuss about heat setting and carbonizing?
5. Discuss about stenter?
6. What is steamer?

### Section C

1. Explain the equipments used in wet processing?
2. Explain the sequence of textile processing?
3. How to weighing silk?