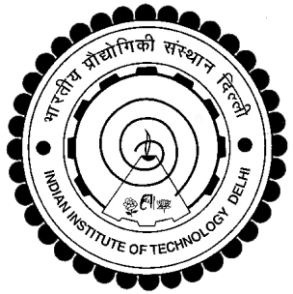


Department of Textile and Fibre Engineering

Indian Institute of Technology Delhi

Technology of Pre-treatment and Finishing

(TXL-241)

Introduction and Mechanical Finishing of Textiles

About the Course

This subject aims to provide you with comprehensive lessons in ***textile finishing*** and prepare you with knowledge and understanding of ***principles and technology of textile chemical finishing*** with emphasis on the **mechanism** and **chemistry underlying of the processes.**

Intended Learning Outcomes

- To understand the know-hows of the finishing techniques.
- Apply their knowledge of chemical mechanisms and technologies to select the correct machinery, processes, processing conditions and technologies to achieve the specific effects required for different end-uses.
- To minimize and solve technical problems involved in the process.

References

- Textile Finishing Edited by Derek Heywood, Society of Dyes and Colourists. 2003
- Chemical Finishing of Textiles, W. D. Schindler and P. J. Hauser, CRC Press 2004
- Principles of Textile Finsihing, Asim Kumar Roy Choudary, Woodhead publishing, 2017.

Indicative Syllabus

Section 1 Mechanical Finishing

- Calendering, Raising, Sueding, Emerising, Shrink proofing.

Section 2 Chemical Finishing

- Softening Finish, Biopolishing, Easy care, Oil/Water/ Soil repellent finishes, Flame Retardancy, Antimicrobial finishes, Wool finishing.

Section 3 Finishing Machinaries

- Low liquor application techniques and machinery, Stenters and dryers.

Evaluation Policy

MARKS DISTRIBUTION:

- Minor: 40
- Major: 40
- Quiz: 20 (2 Quiz – Pretreatment + Finishing)

Attendance Policy:

- Ideally should be 100% (Award Marks: 5)
  - Maximum of 2 days exemption on health grounds (IIT hospital Cert)/

    On Institute Duty.
- If < 75%, 1 grade down
- If < 30% 2 grades down
- No re-minor will be conducted for candidates having <50% attendance.

Effective after add/drop period
08-01-2024

Introduction

Pre-treatment

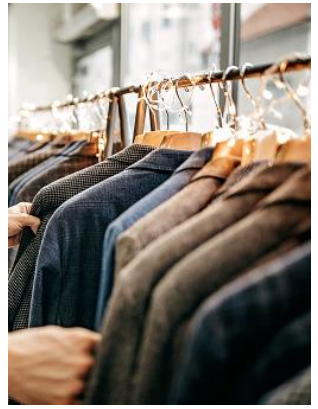
- Removal of impurities
- Make fabric suitable for dyeing and finishing with good absorbency.

Dyeing & Printing

- To impart uniform colour and coloured pattern on fabric.

Finishing

- To make fabric fit for end use.
- Impart Functional Properties



Key Advantages of Finishing

- Improved appearance – ***Lustre, Whiteness*** etc.
- Improved Feel – ***handle*** of fabric and its ***softness, suppleness and fullness*** etc.,
- Improved wearing qualities – ***Anti-crease and Non-soiling***.
- Special Properties – ***Water Proofing, Flame Proofing*** etc.

Other added benefits

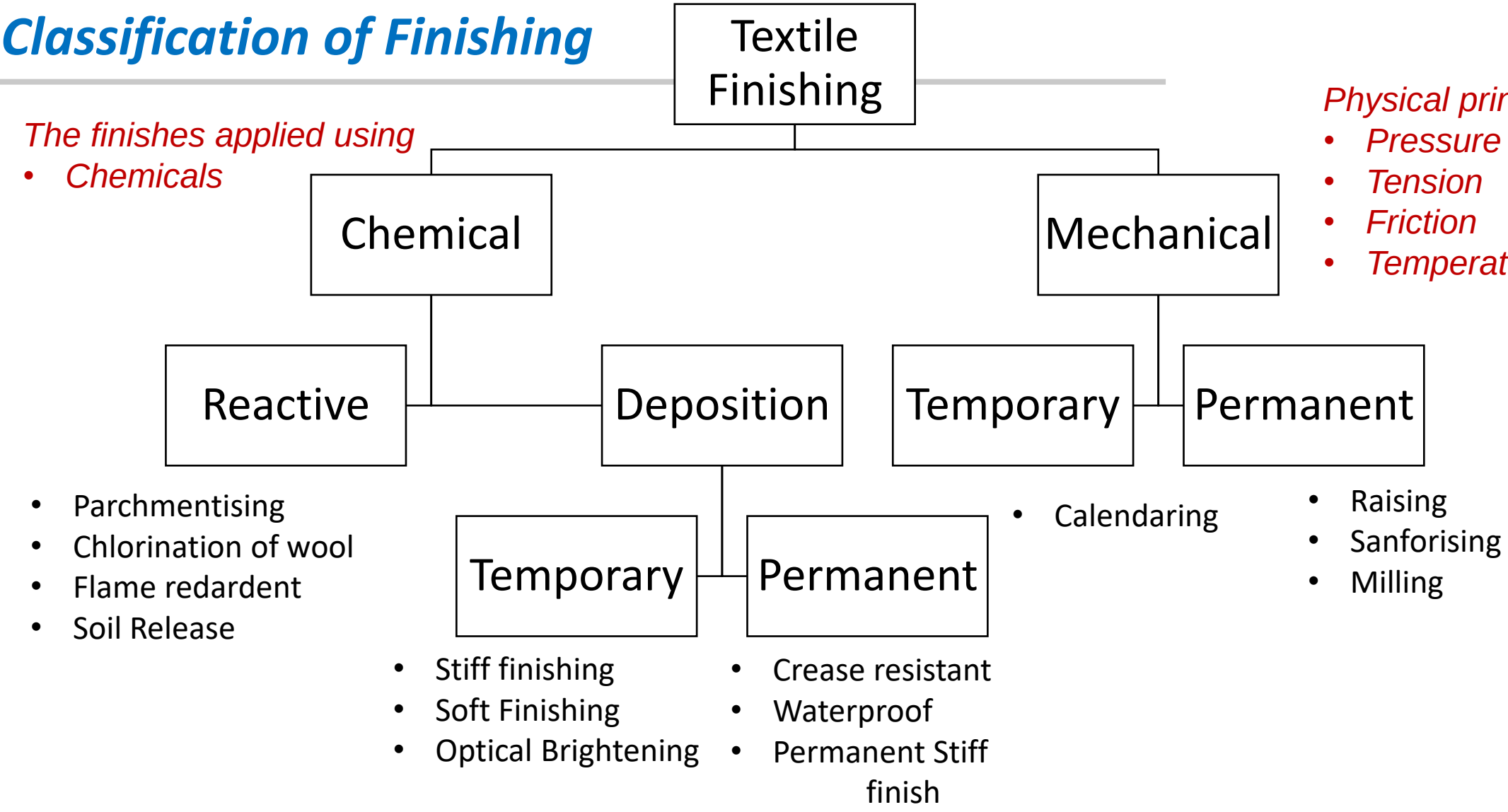
- Covers ***faults*** in the fabric.
- Improves fabric ***weight***.
- Increase the ***selling price*** of the material.
- Improves the ***natural attractiveness***.
- Improves the ***serviceability*** of fabric.

Which fabric and what finish to choose?

The variations of finishing depend on the following factors

- ***The most important factor,*** the desirable properties of the material during its use.
- The type of fibre and its arrangement ***in yarn and fabric***.
- The physical properties of fibres such as ***swelling capacity*** and behaviour when ***pressure or friction*** is applied.
- The capacity of fibres to ***absorb chemicals***.
- The susceptibility of the materials to ***chemical modification***.

Classification of Finishing



Classification of Finishing based on their durability

- **Temporary Finish**
  - *A finish which is not stable and goes off after the first wash and subsequent washing. –* ***Calendaring, embossing, starching****.*
- **Permanent Finish**
  - *A finish which is remains unaffected through all conditions of wearing and washing treatments. –* ***Sanforizing, Mechanical Milling, Resin Finishing, Water/ flame proof finish.***
- **Semi-Permanent Finish**
  - *A finish which is remains unaffected few washes and goes off afterwards.-* ***Stiff finish, schreiner calendaring.***

Mechanical Finishing

- Calendaring
- Emerizing
- Raising
- Shearing
- Shrink Proofing/ Sanforizing
- Weft straightening
- Heat Setting

Calendaring

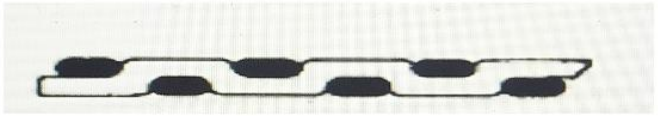
- A flat, compact and polished fabric is produced by passing open width fabric between two adjacent rollers (one soft (***bowl***) and other hard roller) under pressure.
- Suitable for calendaring cotton, linen, rayon and silk materials, synthetic fabrics (under temperature).

The objectives of normal calendaring is to

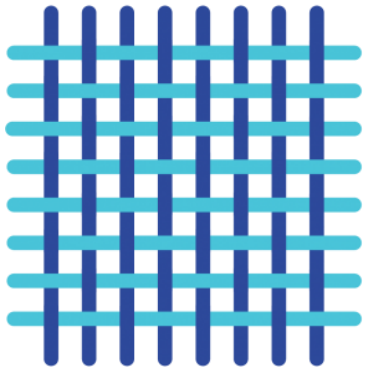
- *Flatten yarns, compress fabric and reduce thickness.*
- *To close interlacements in fabric and improve opacity.*
- *To impart a lustrous, smooth feel to the fabric.*
- *To reduce air permeability by changing porosity of fabric*

Calendaring

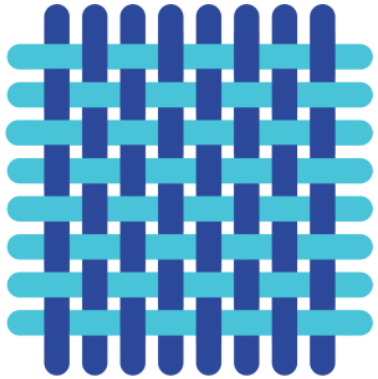
Before calendering process



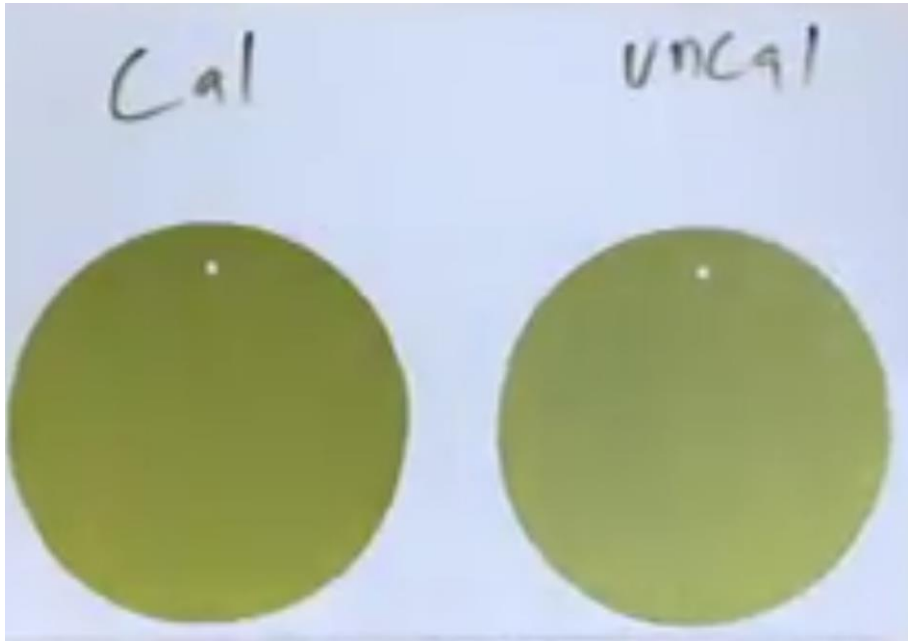
After calendering process



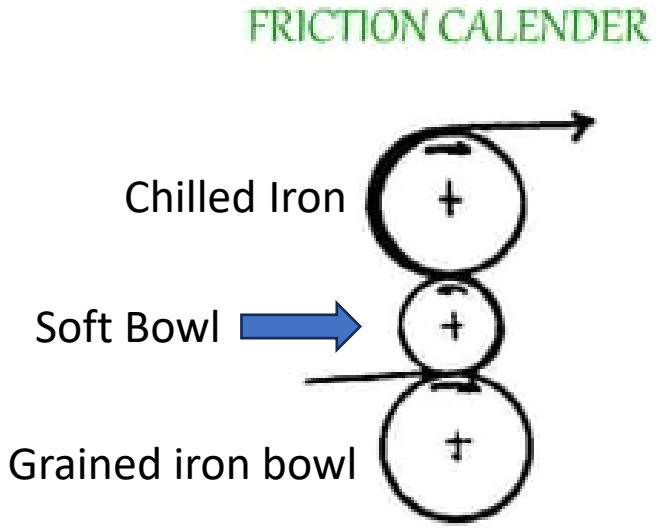
pre-calendered



calendered



Friction Calendaring



The standard three-bowl heavy friction calender consists of

- steam-heated chilled iron bowl on top
- Fibre/soft bowl in the middle
- close-grained cast iron bowl at the bottom

Roller Width	1600-6000MM
Speed	5-100M/MIN
Pressure	5-20T
Working temperature	160 ℃ MAX.

Friction Calendaring

- For friction or glazing finishes top and bottom bowls run in ***differential surface speeds*** needed for the friction effect.
- Smooth metal bowl ***run faster upto 3x*** than the softer composition bowl.
- The fabric enters the nip and tends to ***stick to the softer bowl***
- The faster-moving metal bowl then imparts a glaze or highly lustrous surface to the fabric.
- The cloth handle can become ***quite papery and thin.***

Home Textile – Chintz

Caution

- In Chintz finish of cotton incorrect fabric presentation into machine can lead to poor handle that cannot be corrected.
- More damage is caused by low moisture content.

Engineering Aspects of Calendar

Key Parameters affecting Calendaring

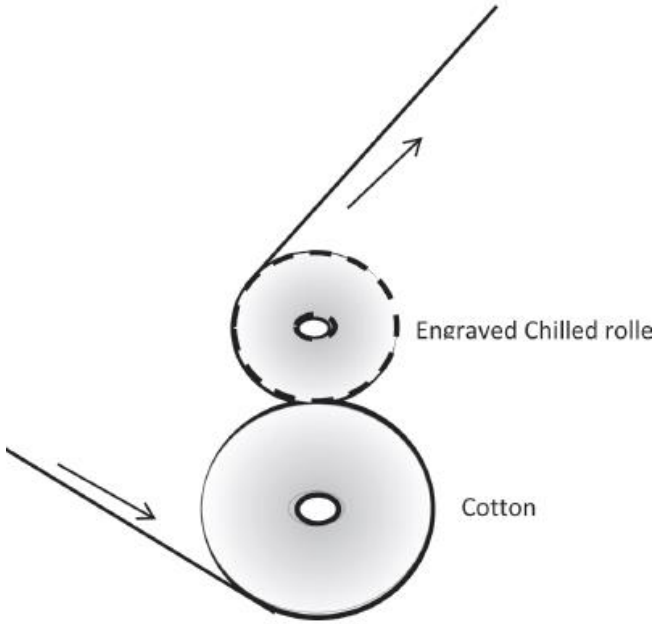
- Moisture Content
- Temperature
- Pressure
- Soft Bowl composition (wool/cotton/linen paper)
- Hard roller composition (Chilled iron, coarse-grained cast-iron roll)
- Number and arrangement of bowl
- Speed of the machine

Types

- Friction
- Schreiner
- Embossing

Schreiner calendaring

- ***Papery thin handle problem*** of friction calendaring is solved by "Schreiner" calendars.
- Fabric is passed through the nip between the heated ***engraved metal roller fine lines*** and a filled/ soft bowl.
- The line impressions are transferred to the fabric to create high sheen effect by ***reflect light differently***.
- Produced, mainly on sateen fabrics and also called as ***silk finish.***

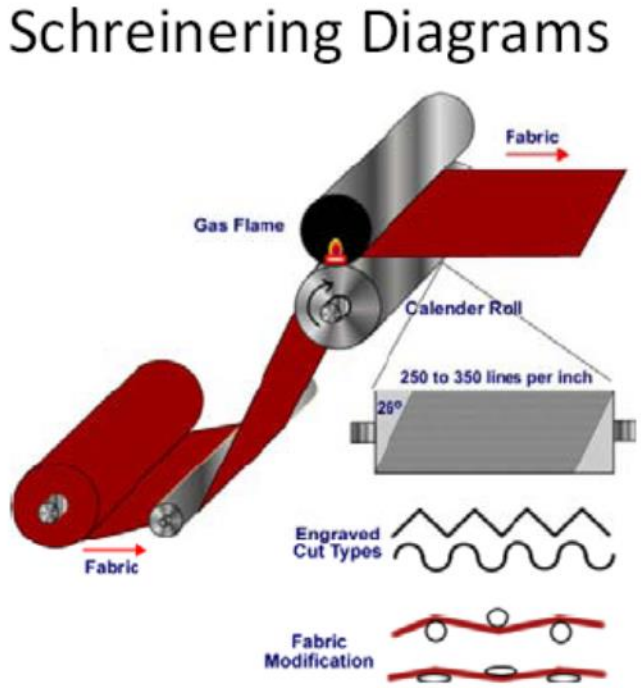


Filled/ soft bowl is not positively driven and rotates in contact with metal bowl

Schreiner calendaring

- Engravings of up to ***500 lines per inch*** at an angle of ***20° to*** the weft.
- Plain fabrics are also given an imitation schreiner finish using a bowl with only ***150 to 200 lines per inch***.
- Engraving is either a V-shape or a U-shape
  - V-shapes give more sparkle of light reflection and reduce fabric tensile strength.
  - U-shape give normal calendar glaze.

Darker the colour of a fabric sample the better it shows the lustre compared to white colour

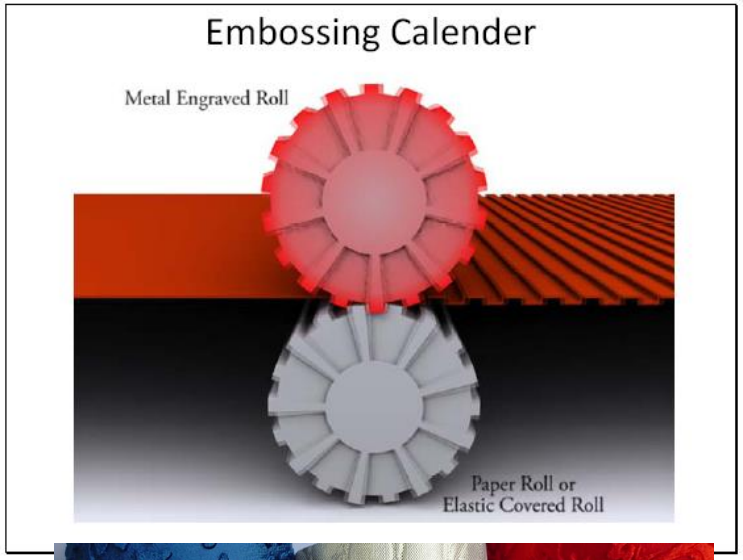


- Moisture content 9–15 % for cotton, (greater than standard regain)
- Temperature – 120–160 °C;
- nip pressure – 3.5–5.0 Bar;
- speed : 2–10 m min^{-1}

Schreiner calendaring

Embossing calendaring

- The embossing calendar usually consists of two bowls; the top metal bowl is engraved with a suitable pattern and the softer composition bowl has a surface that will accept the embossing pattern.
- The filled bowl has to be first impressed with a specific, deeper, reversed version of the design on the steel roller.
- Filled bowl is positively driven at the same peripheral speed, so that the impression remains in register.

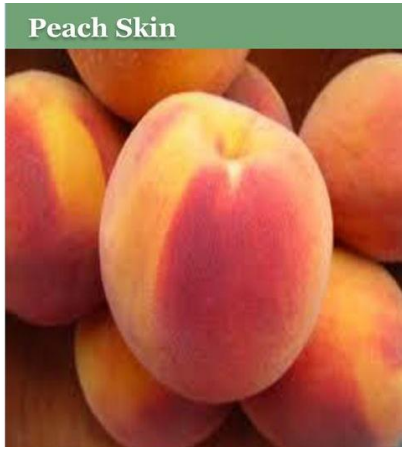


Originally, these calenders were used to produce imitation leather cloth and book cloths.

- ***Thermoplastic synthetic fibers - the temperature of the embossing roll exceeds the heat-set temperature of the fibers.***

Emerizing

- Emerizing also known as ***sueding or sanding***
- A fabric is passed over one or more rotating ***emery/sandpaper - covered*** rollers to abrade and impart a soft luxurious handle.
- After emerising very ***low pile/ short fibres*** protruding from the fabric surface are produced.
- The handle will differ according to the type of ***fibre(s)*** present, the fibre ***linear density*** and the ***intensity*** of the emerising action on the fabric.
- Softness can be greatly enhanced by using fine ***microfibres*** (<1 dtex f^{-1}) together with chemical softening agents to give a peach-skin finish.



Advantages and Problems in Emerizing

Advantages

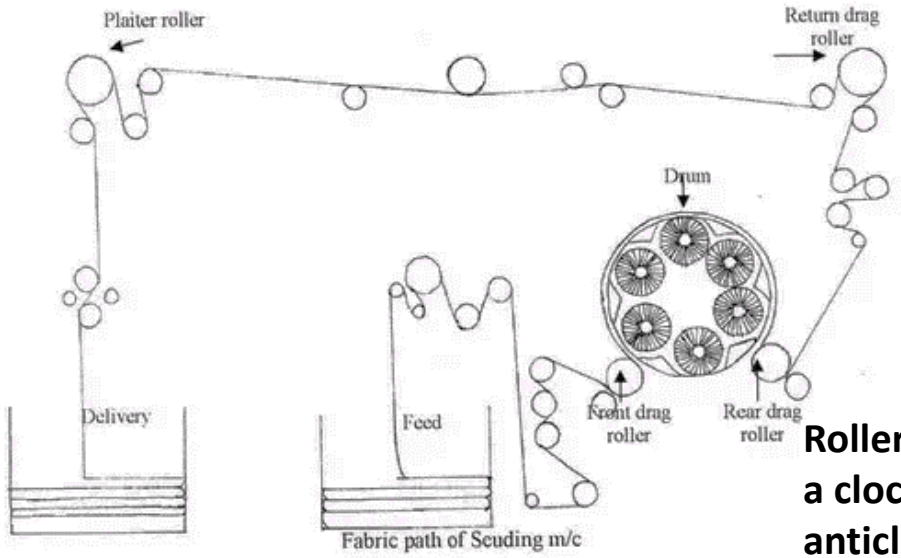
- Better Warmth to wearer
- Fabric becomes softer in hand smoother to feel
- Increase durability of fabric.
- Covers minute areas between interlacing.

Cautions

- Emerizing of microfibre fabrics should be carried out prior to dyeing to avoid unevenness, and especially stripiness after dyeing.
- A further problem arises from the coloured dust generated.
- Emerizing at grey fabric stage will help to remove the dust in subsequent dyeing and rinsing

Types of Emerizing Machines

Multi-roller Emerizing

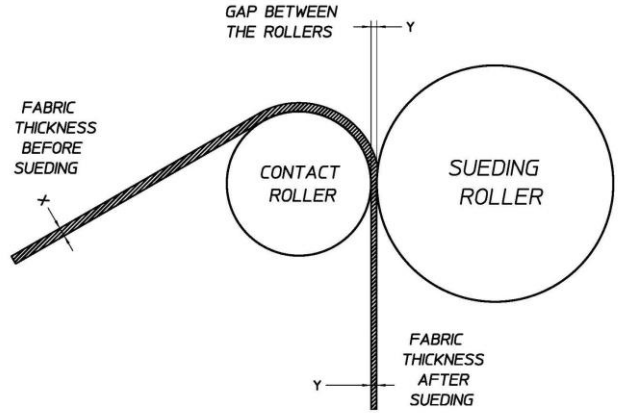


Rollers rotated in a clockwise or anticlockwise direction

- Flexible and versatile, wide variety of fabric structures
- More productive than single-roller emerising.
- Velvet-like, very short pile or nap fabrics

Speed: 15–25 m min^{-1}

Single Roller Emerizing

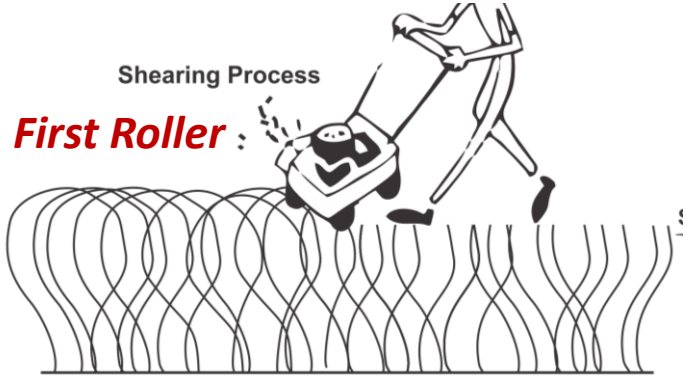


- Fabrics with ***terry loops*** on the face is presented to suede roller.
- Fabric styles where the fabric surface must be effectively shaved to produce a polished or burnished effect

Speed: 7-10 m min^{-1}

Parameter Influencing Emerizing Process

- ***First roller*** run in the counter direction to the fabric passage to exert mechanical action against the weft threads ***lifting the surface***.
- ***Second roller*** operates in the same direction as the fabric passage, ***which emerizes the weft thread***.
- ***Third roller*** runs in the ***opposite direction*** to intensify the process and the following rollers run in the same direction as the cloth to produce the nap.



Because of the abrasive action on the fabric, care is required to ensure that the loss in fabric strength is not excessive.

Parameter Influencing Emerizing Process

The emerised or sueded effect obtained is dependent upon the degree of mechanical action on the fabric and controlled by

- the ***number of rollers*** in operation
- the ***direction*** of rotation of the rollers (that is, with or against the fabric)
- the fabric ***tension***
- the fabric ***wrapping angle*** on the rollers
- the fabric ***speed***
- the ***grade of abrasive grit*** used in the emery-paper-covered rollers

Fabric Properties

Fabric Construction

- The ***weft yarns*** contribute the most towards surface fibre development and ***Long weft*** floats can be utilized to enhance surface fibre development
- Thus, a tight fabric construction in a ***plain weave*** will be much more difficult to suede or ***emerise than a 2/1 or 3/1 twill***.
- ***Microfilament*** based fabrics have low resilience to mechanical action, and the handle is softer after emerising.

Fabric Tension

- The tension should be controlled at a pre-set level and any changes in fabric length should not lead to ***tension changes*** on the machine.
- Care must be taken in emerizing knitted fabrics which are generally more ***dimensionally unstable*** compare with woven fabrics.

Abrasives and emery grades

- The use of a relatively coarse grade (grain or grit size) of ***80–100*** produces a dense, long pile.
- Light-weight ladies' Outerwear fabrics of 100–180 g m^{-2} are sueded with a grain size of ***280–320*** to produce a short, dense nap.
- With the finer microfibres of polyester and nylon, the grain size is increased to ***400–600*** for emerising.
- Higher grain size ***600–800*** exert a polishing action rather than an emerising action on the fabric

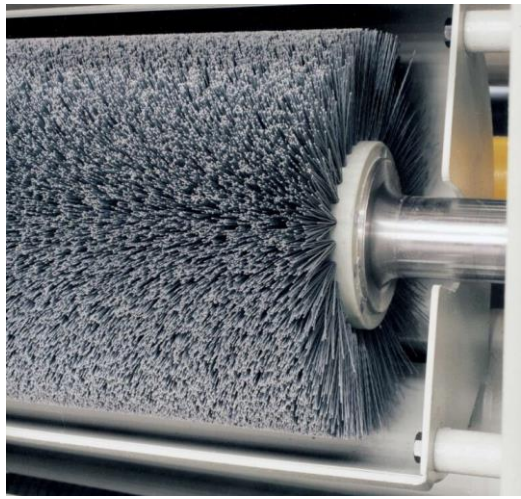
Emery Strip

Caution

- If the abrasion is too fine, then enough heat may be generated in synthetic fibre fabrics to induce fusing and harshening of the fabric,
- while too coarse an abrasive grade could tear or rip a fabric unevenly.

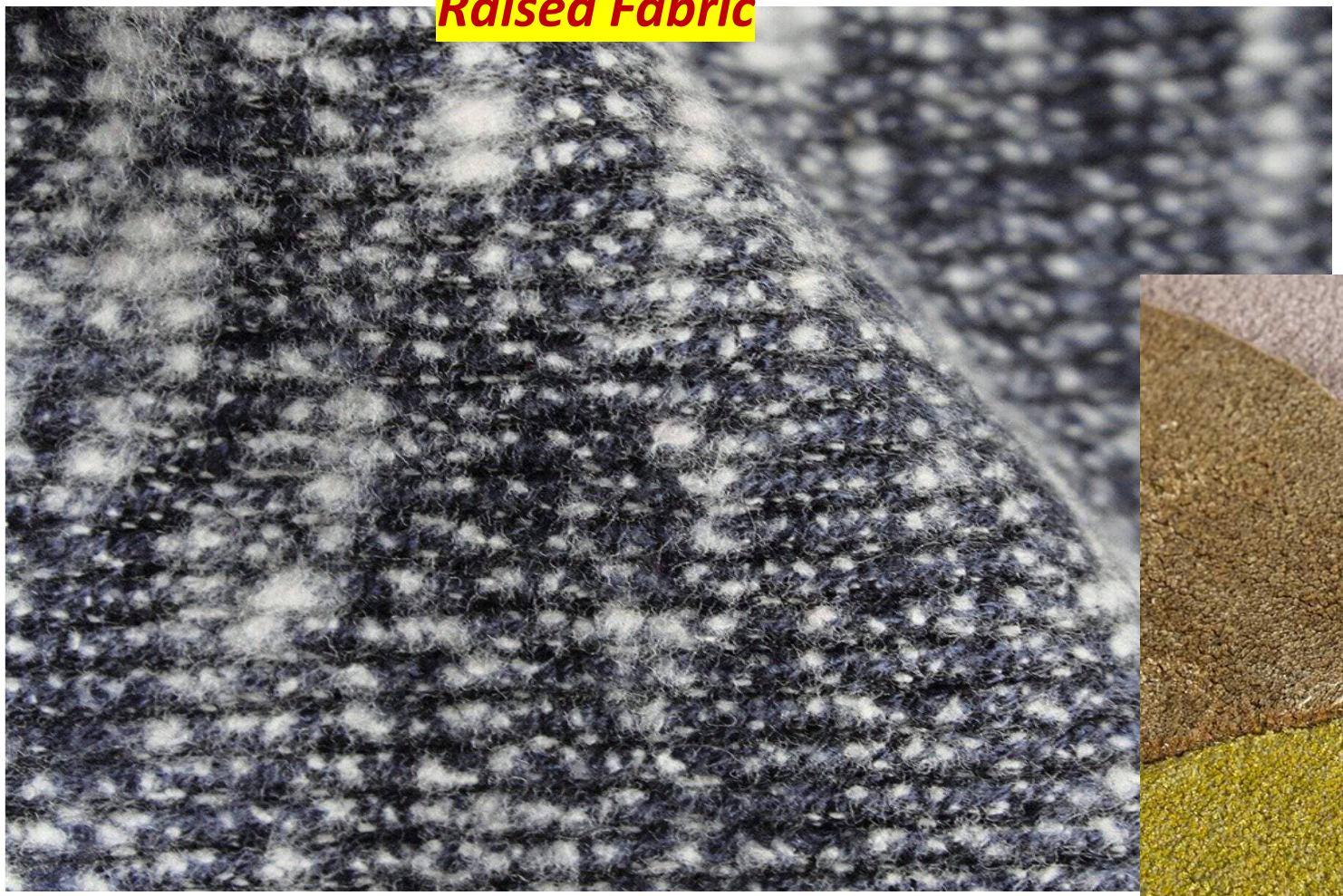
RAISING

- Fibre raising involve the use of ***wires or brushes*** which catch yarns in the textile structure and ***pull individual fibres*** partly from the yarn structure.
- The resulting fabric *is* ***warmer, softer and more comfortable***.
- In staple fibres fabrics, ***pulling*** out a layer of fibres from the structure of a fabric to form a ***pile***.
- Raised loop fabrics are used for ***nightwear or bed sheets***.
- In the case of ***filament yarns***, loops in the fabric structure are ***stretched*** by the raising action but are not usually broken.

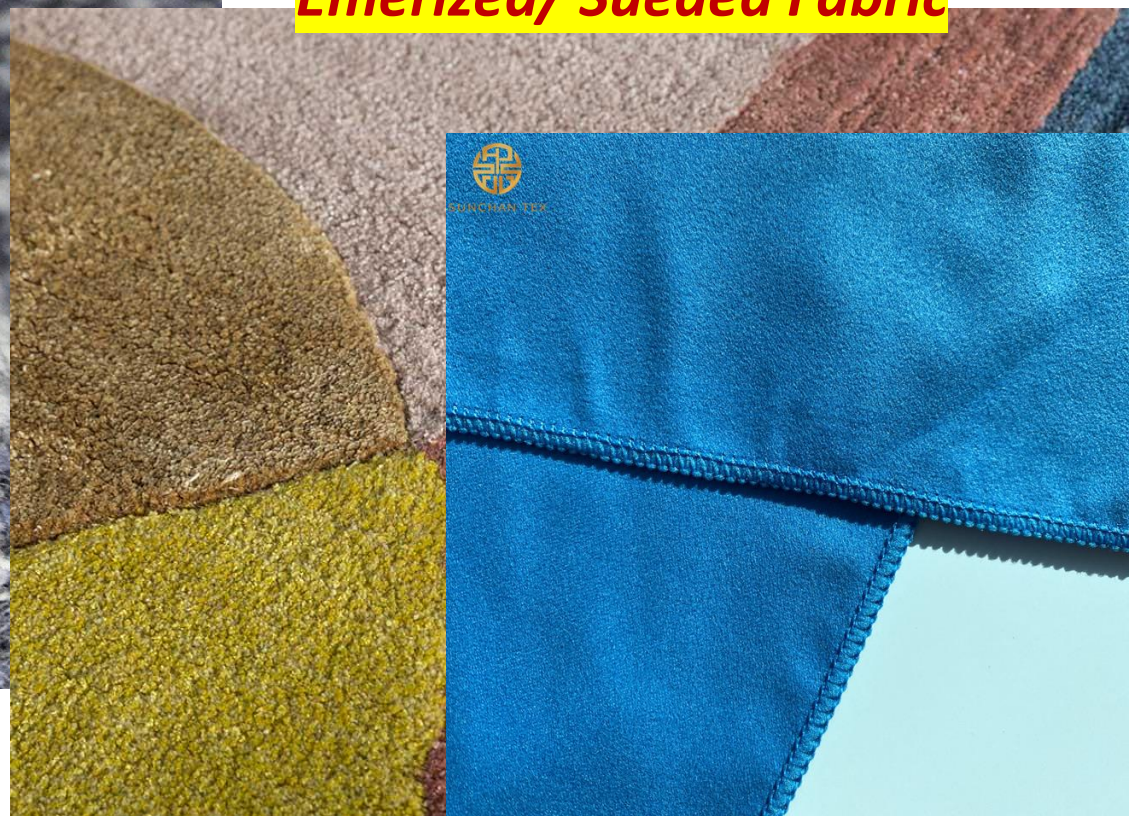


Raising Process

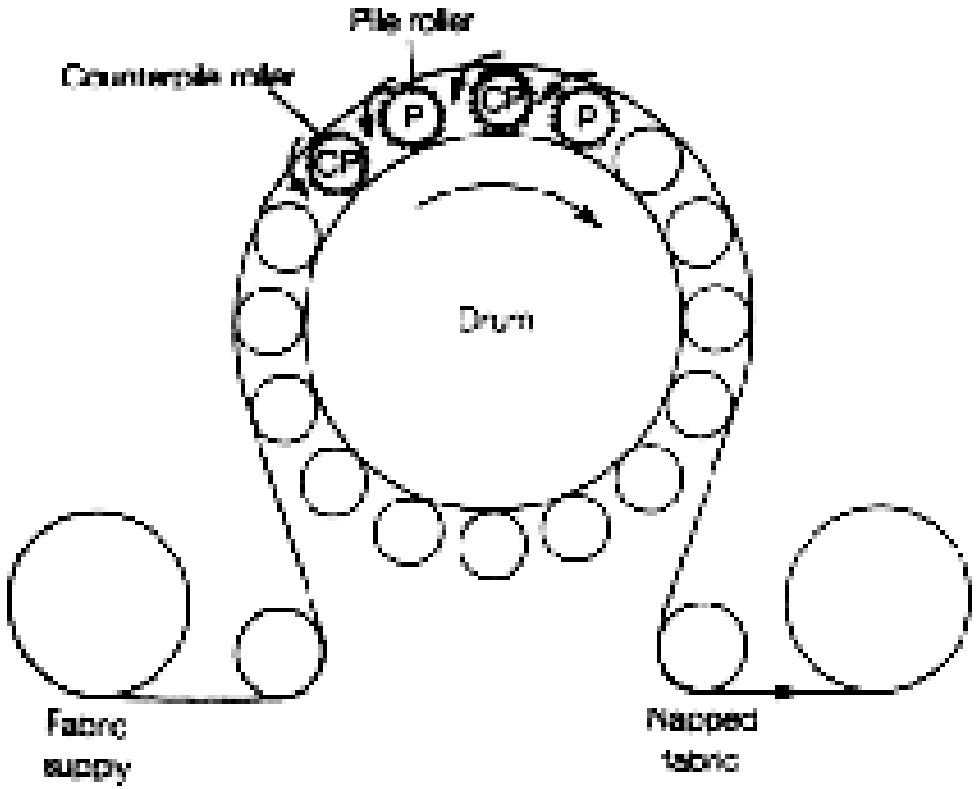
Raised Fabric



Emerized/ Sueded Fabric



Raising Machine



- Both ***pile and counter-pile*** rollers arranged depending on direction of the points in which the wires are bent to fabric direction.
- A typical raising machine is fitted with alternating ***twenty-four rollers, 12 pile and 12 counter pile***.
- Relative speeds of rollers together with that of the cloth govern the raising effect.
- Fabric may require several passes through the machine to obtain the desired effect.

Caution: If the roller peripheral speed is equal to the cloth speed, no raising takes place, and this is the '***no-raise***' condition.

Processing Conditions of Raising

- Variations in ***temperature*** and ***humidity*** conditions can affect the raising effect. Cotton is usually processed in a ***warm, dry condition***.
- If the ***pile*** action is much ***greater*** than the ***counter*** pile, the cloth may tend to cling to the pile rollers. The machine should be reset to a more balanced action.
- Uneven raising should be corrected by ***re-grinding or replacing*** the wire.
- Streaky or patchy raising may be due to traces of ***finishing agents***.

Processing Conditions of Raising

The raising effect is assessed by its influence on properties such as:

(1) tensile strength;

(2) abrasion resistance;

(3) air permeability;

(4) thickness;

(5) thermal insulation;

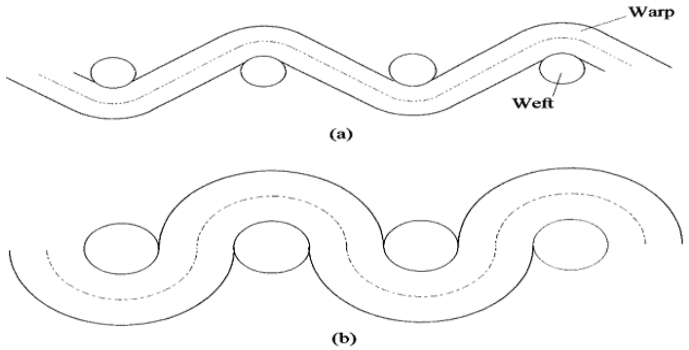
(6) flammability and surface flash (cellulosics).

Shrink-Proofing/ Compacting/ Sanforising/ Zero-Zero

- The fabric shrinking machines, popularly known as *zero–zero and Sanforising ranges*.
- Due to subsequent washing process rearrangement of internal forces happens.
- Cotton fabric swells and shrinks when the fabric is free from tension as a result of relaxation of intermolecular forces.

Shrink-Proofing/ Compacting/ Sanforising/ Zero-Zero

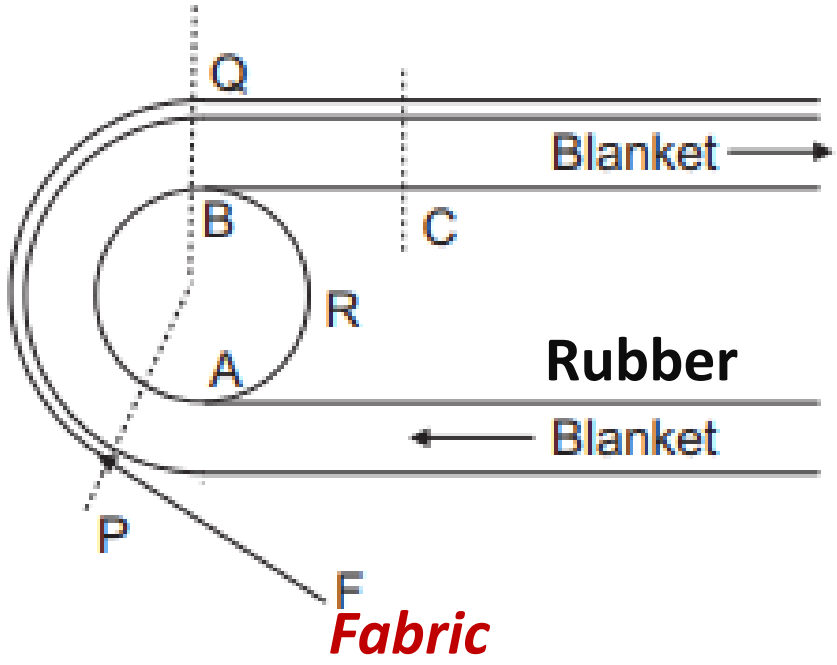
- Sanforising imparts ***dimensional stability*** to cotton fabrics.
- To produce finished fabrics and eliminate length shrinkage the fabric is subjected to '*compressive shrinkage'.*
- Fabric shrinkage is reduced by mechanically forcing the structure of the *fabric to compress upon itself*.



- Sanforising enables residual shrinkage less than 0.75%.
- However, it is important that after preshrinking, the fabric should not be stretched further.

Principle of Preshrinking Machine

- The fabric ***F*** meet the blanket at point **P.**
- Radius of curvature – **PQ > AB**
- The length of the outer surface of the blanket between is greater than inner result in blanket extension. ***P Q > A B***.
- At point **C**, the distance **AB = BC** the outer surface of the blanket will relax and shrink.



"Bending the felt blanket around the guide roller stretches the surface of the felt and increases the circumferential speed correspondingly".

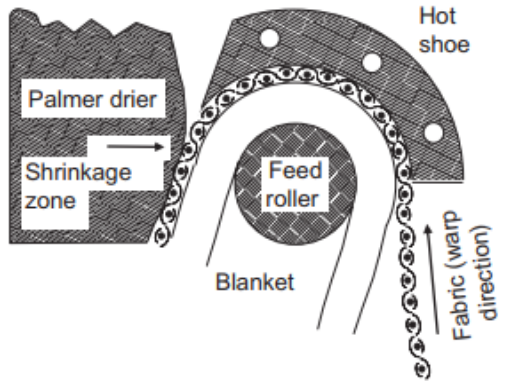
Thickness of Blanket

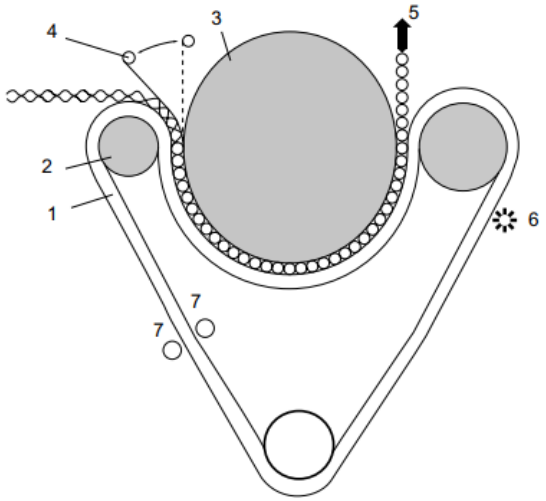
The thickness of the woollen or rubber blanket/felt determines the longitudinal contraction of fabric.

Type of blanket	Thickness (in.)	Use	Contraction possible (in./yard)
Thin	0.275	Bleached shirting	Maximum 3.5
Heavy	0.4	Medium weight fabric	3.5–5.0
Extra-heavy	0.45	Denims	3.9–5.6

Operation of Preshrinking Machine

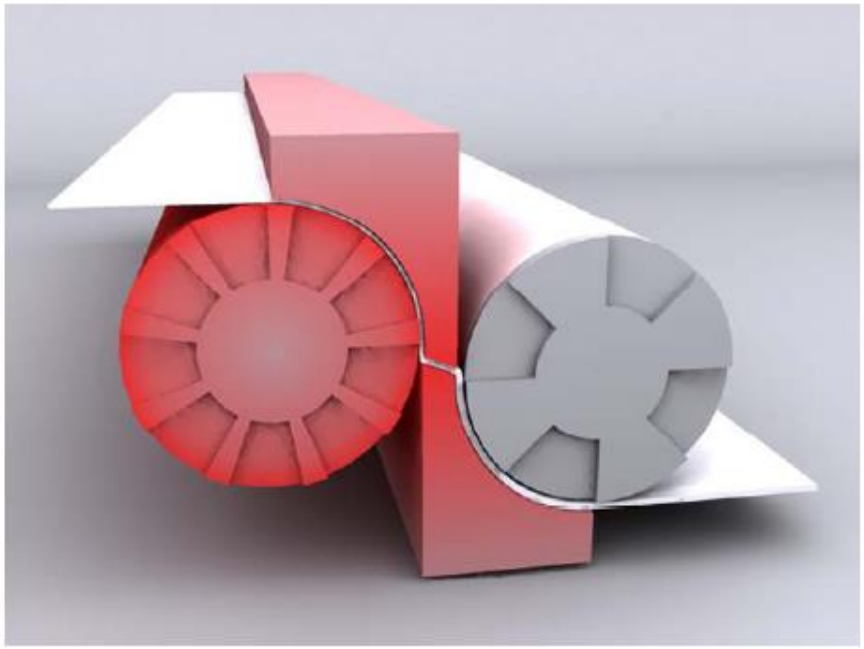
- The fabric is dampened with steam
- The width is adjusted by a stretching action with the help of a small stenter
- The fabric is then held firmly against a heavy woollen blanket, which is under controlled tension.
- As the tension of the blanket the fabric shrinks uniformly in length.
- The fabric is then carried around a heated cylinder where it is dried.
- A sample is tested again to assure that residual shrinkage on laundering to be reduced to 0.75% or less.



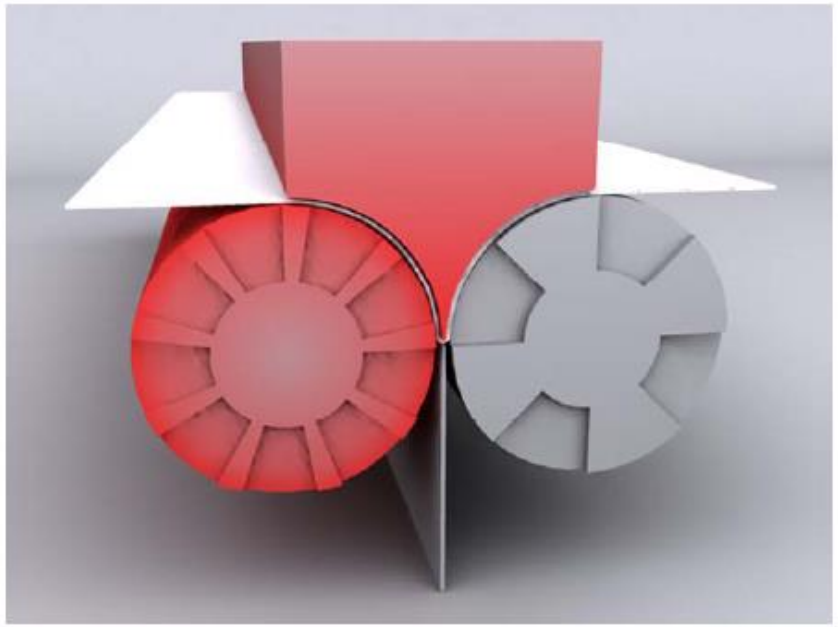


Different types of compactors

Heated Roll and Shoe Compactor

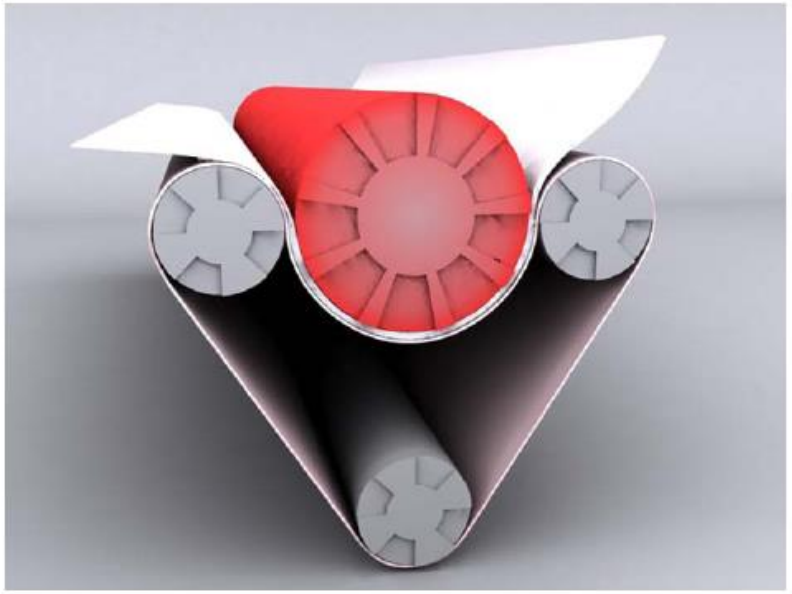


Gull Wing – Blade Compactor

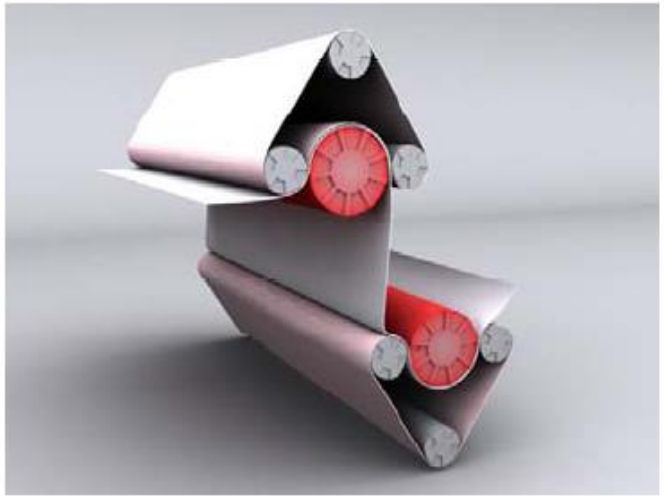


Different types of compactors

Blanket Compactor

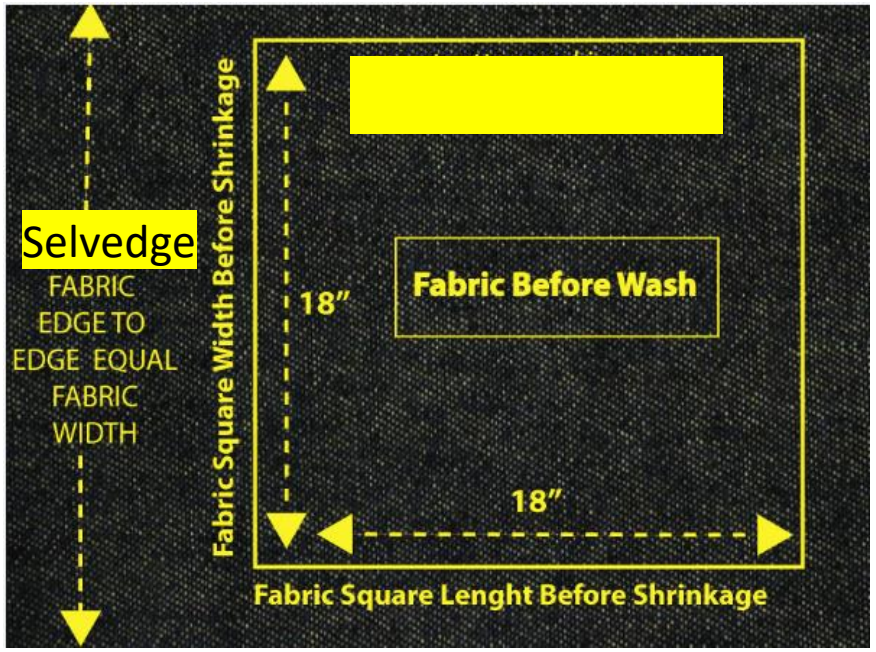


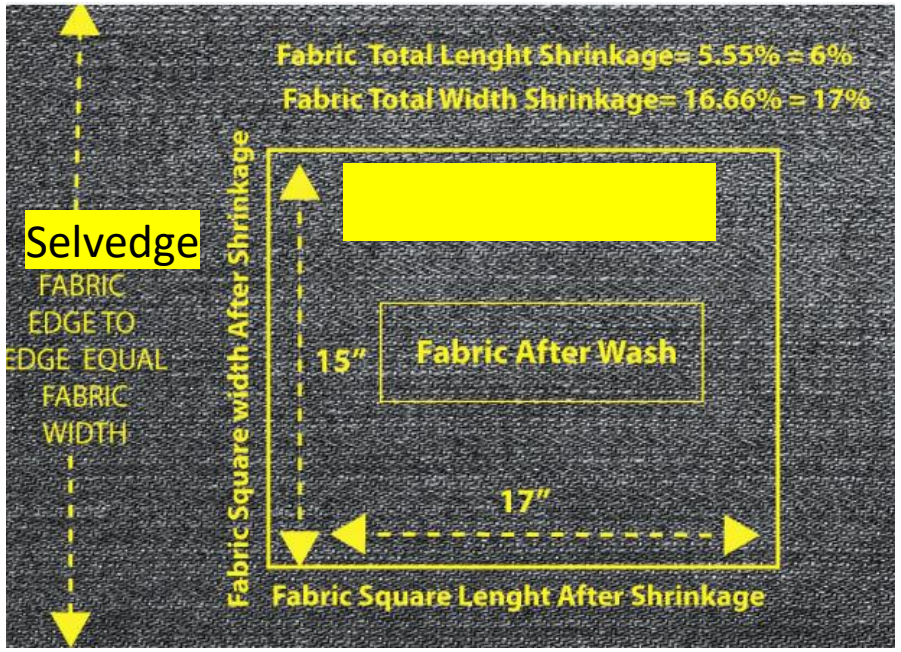
Tamdem Blanket Compactor



Different types of compactors

AATCC 135 and 150, ISO 6330, CAN/CSGB 58 are standards followed.
AATCC 150 – Home laundering



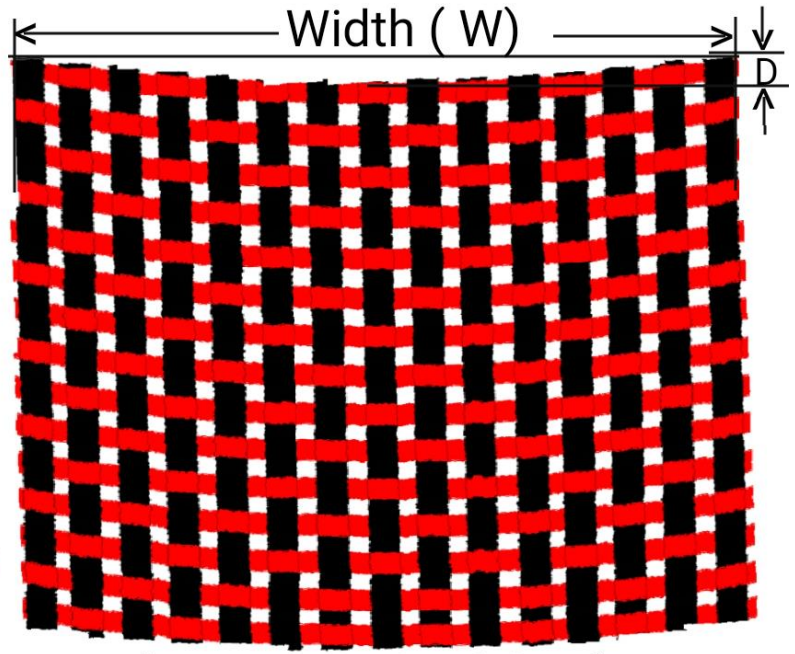


- Shrinkage <2-3% is acceptable and >3% is rejected.

[Width of the square block before shrinking] - [width of the square block after shrinking] / width of the square block before shrinking x 100

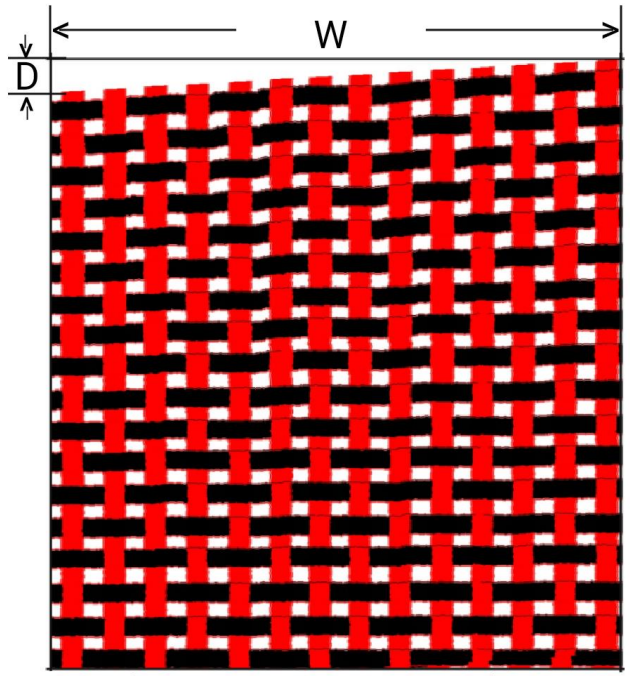
Why we need weft straightening?

Bowing & Skewing are defects which are created when there is a distortion in weft laid across the whole with of the fabric.



(Bowing in the fabric)

Weft or filling yarns are displaced from a line which needs to be perpendicular to the selvedge.



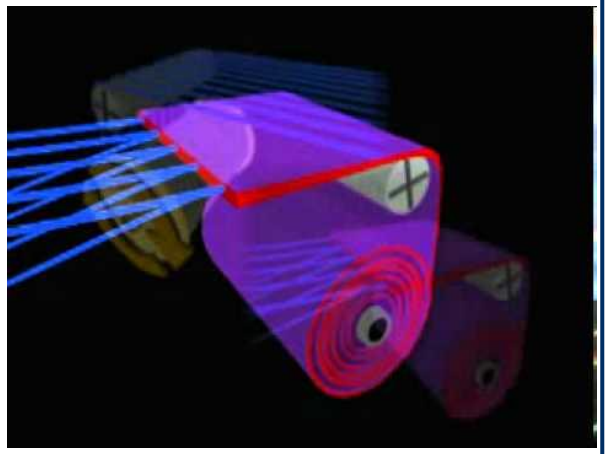
(Skewing in the fabric)

Weft or filling yarns are distorted means pattern on one side of the fabric

Weft straightening

Bowing – Causes:

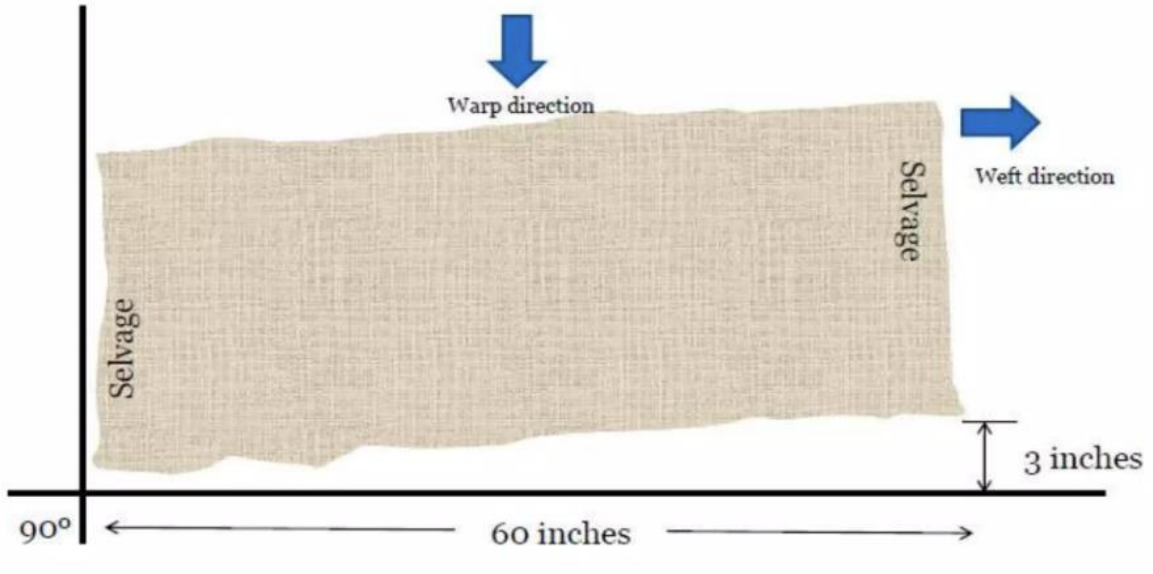
- Bowing of 1” to 1.5” is being generated in the fabric at both selvedges ends due to ***take up action*** when the fabric is being pulled then application of force.
- During all chemical processes fabric has to pass through set of ***rollers*** many times giving rise to bowing.



Skewing – Causes:

- During weaving or processing both fabric ***selvedge*** being pushed by roller with ***different force*** that cause edge cause the movement of weft pattern.

Weft straightening



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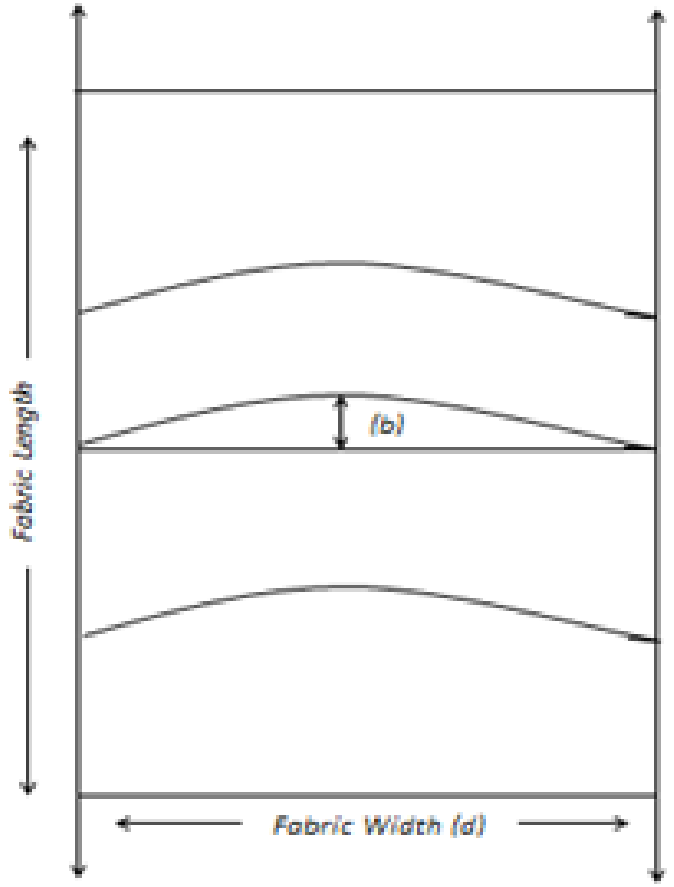
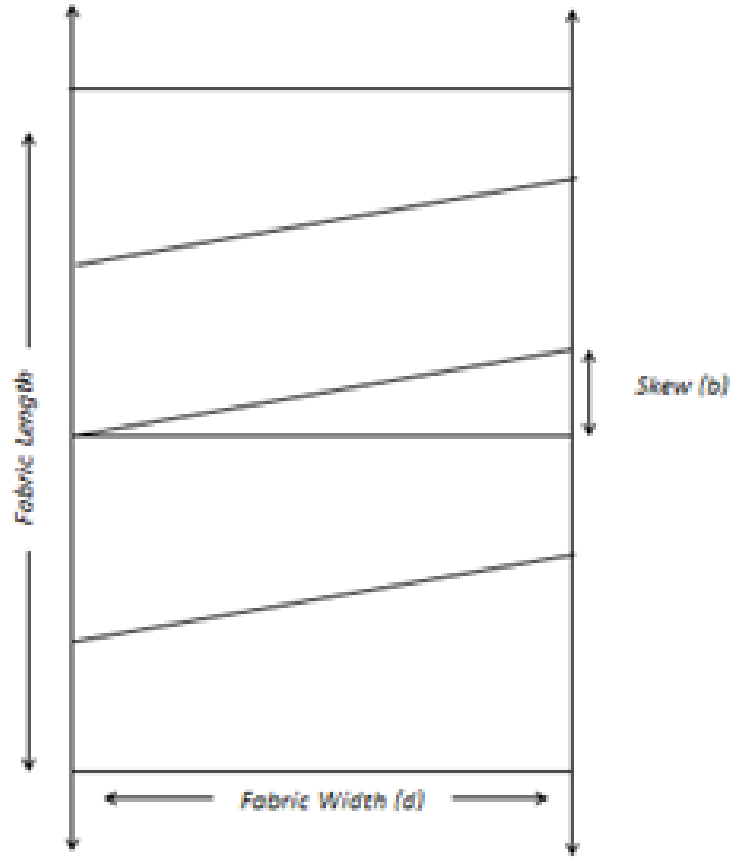
Weft straightening



$$= \frac{b}{d} \times 100$$

Expressed as percentage



We can see length distortion at the center and side of fabric marked as ‘b’ and the total fabric width is being as ‘d’.

Weft straightening

- weft straightener corrects ***diagonal or curved distortions***.
- The mobile frame carrying the rollers begins to ***oscillate horizontally*** to pull from the center to the corresponding edge to correct diagonal distortions.
- The other set of rollers has a ***curved axis*** apply a force which gradually increases from the edges to the center to enable curved distortions to be corrected.

Heat Setting

- The most general reason for heat setting is to achieve the dimensional stability of a yarn or fabric containing thermoplastic fibres like nylon and polyester.
- If the fibre is heated the ***segmental mobility*** of the fibre polymer chains increased to initiate rapid relaxation of stress under ideal conditions lesser than ***melting point*** of fiber (around 200 ^{o}C).
- The process lends ***shrinkage resistance*** and ***wrinkle resistance*** to fabric. Heat setting is generally done after dyeing, but it should be done as a preparation step in a fabric containing spandex or for dye formulations that are sensitive to high temperatures.