

NECESSITY OF PREPARATORY PROCESS

- Correct process sequence has a direct bearing on the quality of further processing operations such as dyeing, printing, finishing etc.
- 60% of all the problems occurring in subsequent processing generally originate from a wrong and inadequate selection of process sequence.
- Most important to obtain fabrics" free from exterior impurities" in order to achieve smooth and trouble free results in the subsequent finishing systems.
- Operations that prepare the textile product for subsequent finishing treatments such as dyeing, printing and finishing.
- Precise requirements of fabric preparation depend on the kind of fibre and it proportion contained in the blends, fabric construction, size type and loading and the end use.

IMPURITIES

The loom state fabric contains three types of impurities:-

- ✓ **Fibre impurities:** may contain long threads or loose threads, small protruding fibres or fibre ends embedded in the interstices of warp and weft.
- ✓ **Added impurities:** may contains sizing ingredients such as starches, PVA, gums, waxes, softeners etc. applied to warp yarns .
- ✓ **Natural impurities:** may contain hemi cellulose, oils, fats, waxes, pectin's, proteins, mineral matter and natural coloring matter.
- ✓ **In- process impurities:** can be classified as fragment of cotton seeds (popularly known as kitties), leafy particles, sand and oil stains

MAIN PRETREATMENT PROCESSES

- ☐ Cropping and shearing
- ☐ Singeing
- ☐ Desizing
- ☐ Scouring
- ☐ Bleaching
- ☐ Mercerizing

CROPPING AND SHEARING

- Is an operation consists of cutting the loose strands of fibres from either surface of a fabric.
- Good cropping is the simplest way of reducing the tendency of blended fabrics to 'pill'.
- For cotton fabrics, care should be taken to see that the shearing blades **do not scratch the surface of the fabric**, which otherwise can cause dyeing defects during subsequent dyeing.
- Polyester staple fibre fabrics are cropped and singed mainly to control the pilling tendency.

While shearing and cropping the following should be removed **(objectives)**

- Long threads originating from the fabric surface.
- Loose and long threads mechanically deposited on the fabric surface.
- Cotton fluffs or linters mechanically deposited on the surface of fabric.
- Metal impurities if any present are detected and manually removed.
- The shearing machines are also provided with magnetic metal detectors which detect the metal impurities present in the fabric.

SINGEING

Singeing is required due to:-

- ❖ Presence of **hairiness** in the yarn (protruding fibres)
- ❖ **Hairy fibre** act as **capillaries** in coloration and spoil the appearance of the dyed fabrics.
- ❖ In roller printing **these fibres** cause **slippage of doctor blade** resulting in faulty prints.
- ❖ **They mask** the luster of the fabric white mercerized fabrics.
- ❖ **These fibres** leads the fabric to **harsh feel** particularly after starch finishing

BLEACHING



INTRODUCTION

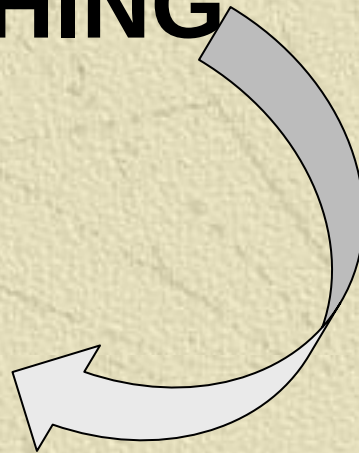
Cotton fiber is contaminated with coloring matters.

Causes for discoloration:

- ❖ ***Related to the pigment of the cotton flower***
- ❖ ***Growth conditions can cause various degrees of yellowness***
- ❖ ***Tips of leaves coming in contact with the moist boll***
- ❖ ***Contamination from processing machines***

- The discoloration is undesirable
- *Reduces visual aesthetics & impair successful coloration*
- *The process for removal of unwanted color from textile substrates and brightening them is known as **BLEACHING***

WHITENESS



TYPES OF BLEACHING

CHEMICAL AND PHYSICAL BLEACHING

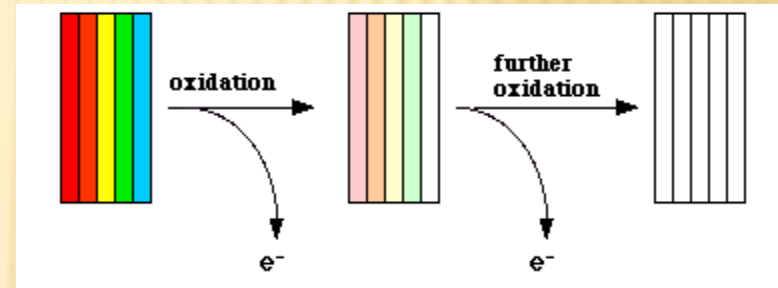
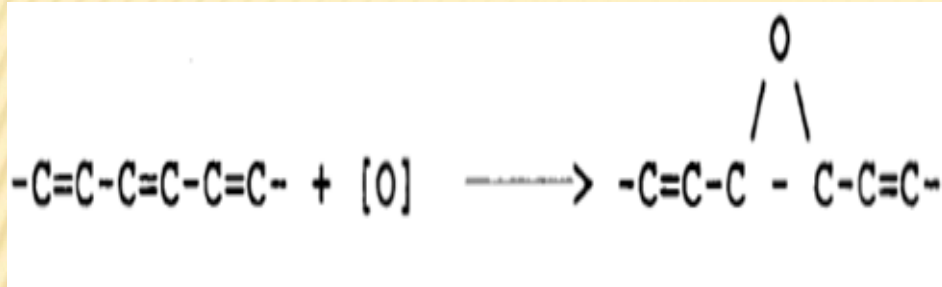
- *Chemical bleaching involves use of **oxidizing and reducing** agents for breakdown of the coloring matters easing their removal.*

Destruction of double bonds in conjugated system

- *Physical bleaching is the process of enhancement of brightness of textiles by introduction of **optical brighteners** without involvement of any chemical breakdown .*

CHEMICAL BLEACHING

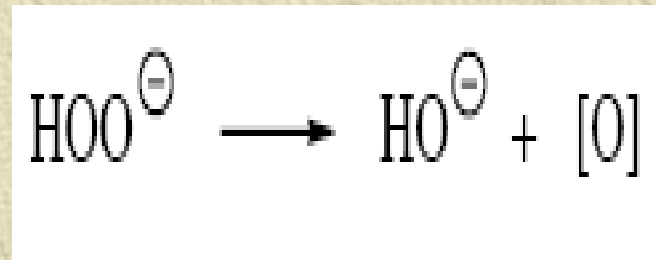
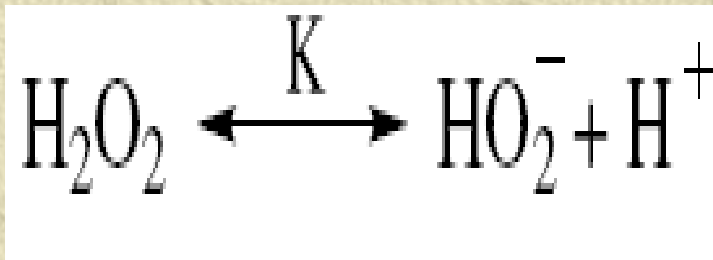
➤ *Oxidative bleaching of cotton*



- ❖ Hydrogen peroxide [H_2O_2]
- ❖ Sodium hypochlorite [NaOCl]
- ❖ Sodium chlorite [NaClO_2]

PEROXIDE BLEACHING

- *Peroxide bleaching is carried out using hydrogen peroxide [H₂O₂] as the oxidizing agent.*

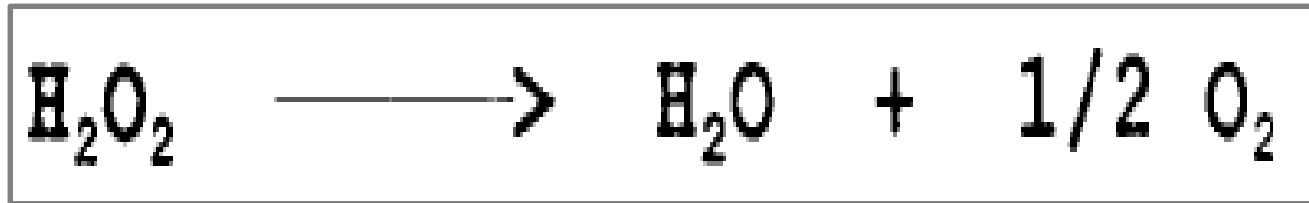


- ❖ *The active bleaching specie is obtained from **ionization of hydrogen peroxide.***

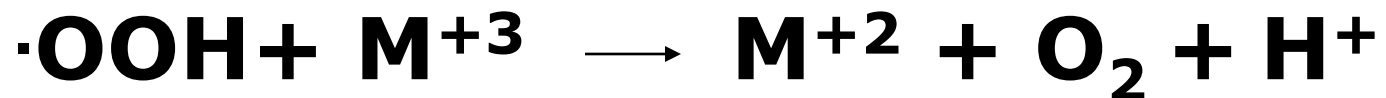
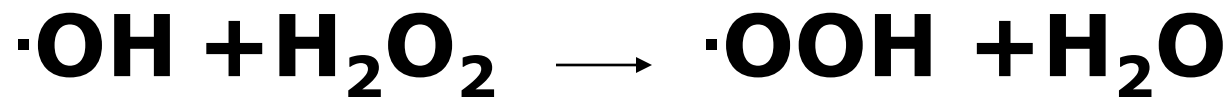
PERHYDROXYL ION [HOO⁻]

✦ *Decomposition of H_2O_2 in bleach baths*

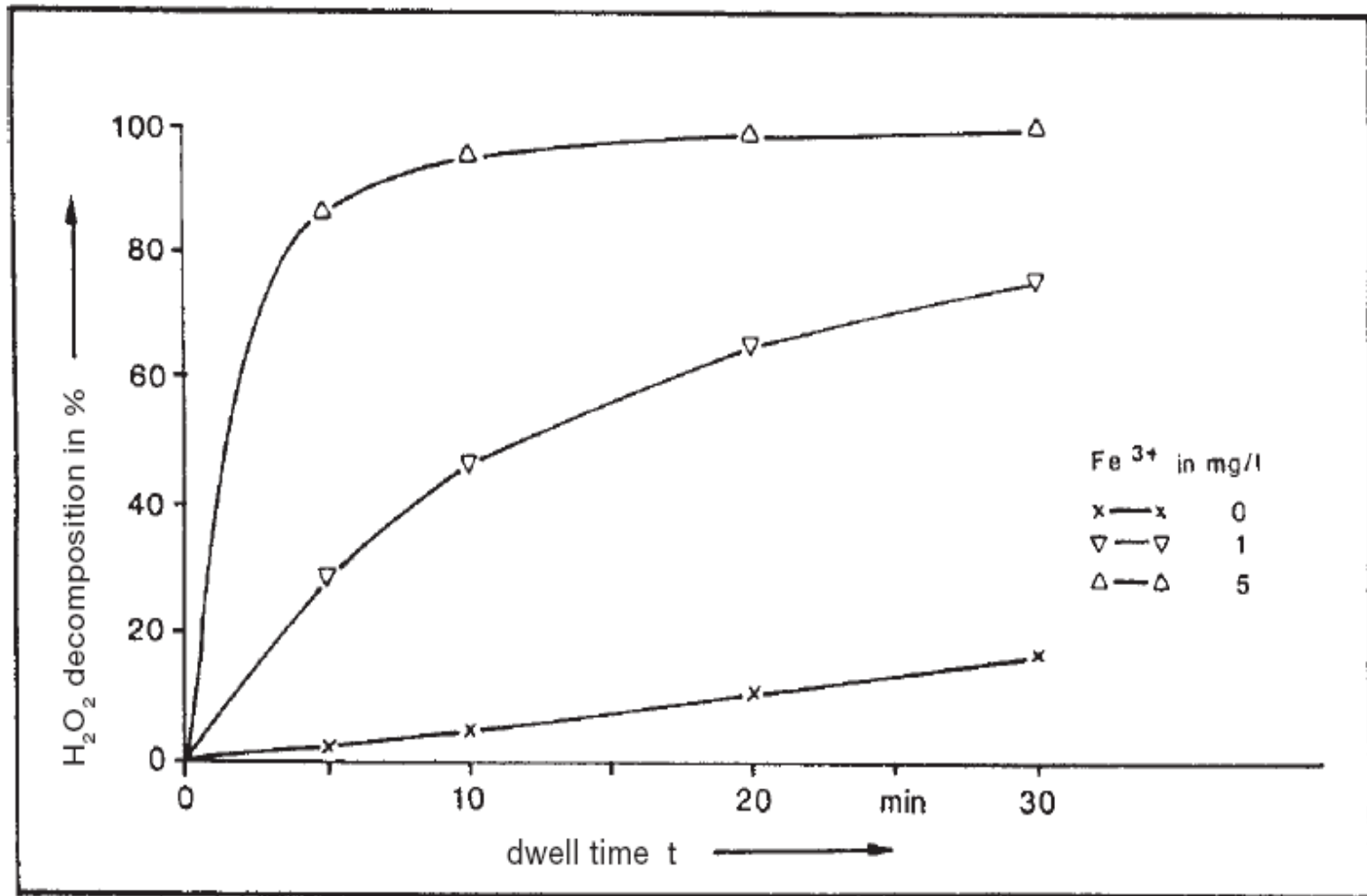
✦ *Cause for fiber damage*



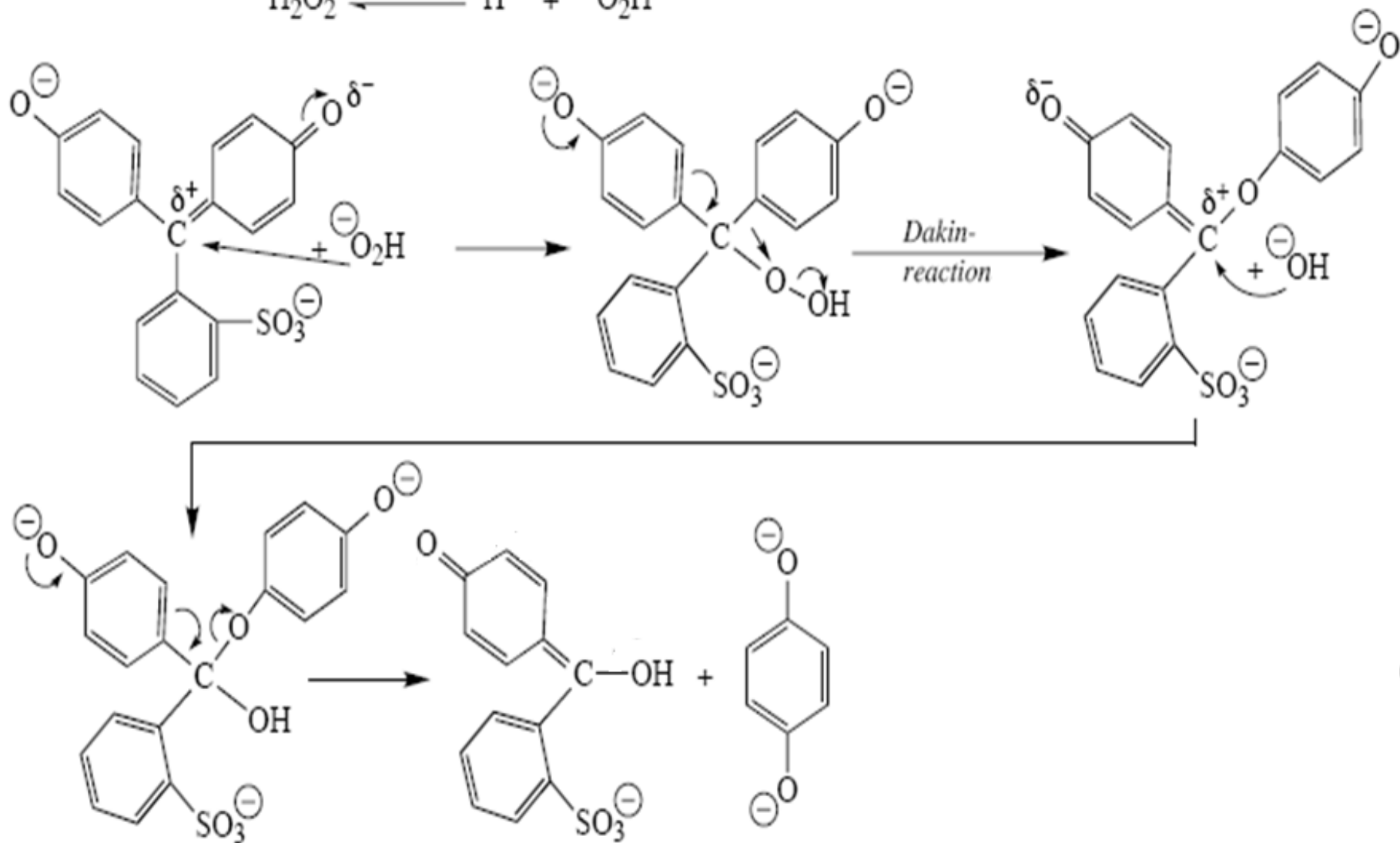
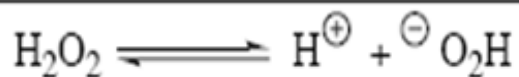
Peroxide decomposition is Catalyzed by metal impurities



Metals increase peroxide decomposition



PEROXIDE BLEACHING MECHANISM



Factors Affecting Peroxide Bleaching

- ✓ *Effect of pH:* Perhydroxyl ion is desired bleaching specie, adding caustic soda neutralizes proton and shifts the reaction to the right.



PH	ACTIVE SPECIES	EFFECT
10	Hydrogen peroxide	No bleaching
10.2 – 10.7	Perhydroxyl ion	Optimum bleaching
> 11	Perhydroxyl ion & oxygen gas	Out of control

Effect of temperature/time:

% H₂O₂ Concentration

- ✓ Stabilized hydrogen peroxide does not decompose at high temperature
- ✓ Bleaching is carried out at high temperature **[90 – 100 C]**.
- ✓ *Bleaching time depends on temperature used in bleaching.*

Chemicals used	Concentration (%)
Hydrogen peroxide (35%)	3 - 5
Caustic soda	0.3 - 0.8
Sodium carbonate	0.6 - 0.1
Sodium silicate	2 - 3
Magnesium sulphate	0.5
Wetting agent + Sequestering agent (EDTA)	0.1 - 0.5

Effect of stabilizers:

➤ *Peroxide bleaching of cotton is carried out at high temperature in the presence of alkali.*

Radicals and free oxygen as a result of severeness

➤ **To control the rate of decomposition of hydrogen peroxide in the bleach bath stabilizers are added.**

❑ *Provide buffering action to control the pH /alkalinity*

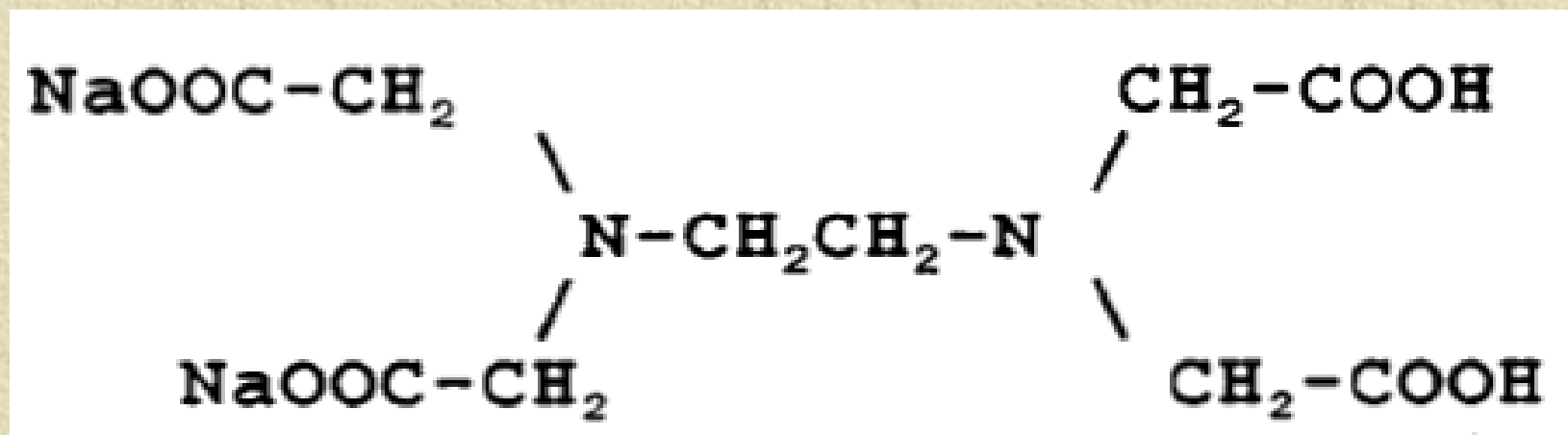
❑ *Complex with trace metals which catalyze peroxide decomposition*

INORGANIC STABILIZER (SODIUM SILICATE)

- *Sodium silicate forms complex compound with perhydroxyl ions which are liberated slowly at higher temperature during bleaching process.*
- ✦ *Stabilization by silicates is enhanced by the presence of magnesium ions. Sodium silicate and magnesium ions form colloids, which act as buffers.*
- **Silicate deposition on equipment and on substrate**
- **Abrasion and harsh feel**

Organic stabilizers:

Operate as sequesterants to complex with polyvalent metal ions which catalyze peroxide decomposition and disturb bleach bath stability.

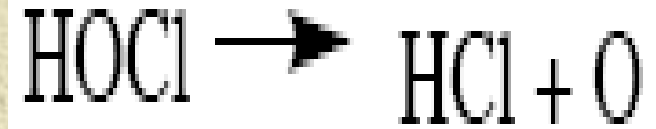


***Example:* Ethylene Diamine Tetra Acetic Acid [EDTA]**

HYPHOCHLORITE BLEACHING

[NaOCl]

✦ Reactions in bleaching solutions with NaOCl



✦ *Hypochlorous acid (HOCl)* is active bleaching specie.

Factors that affect hypochlorite bleaching.

➤ *Bleach bath pH*

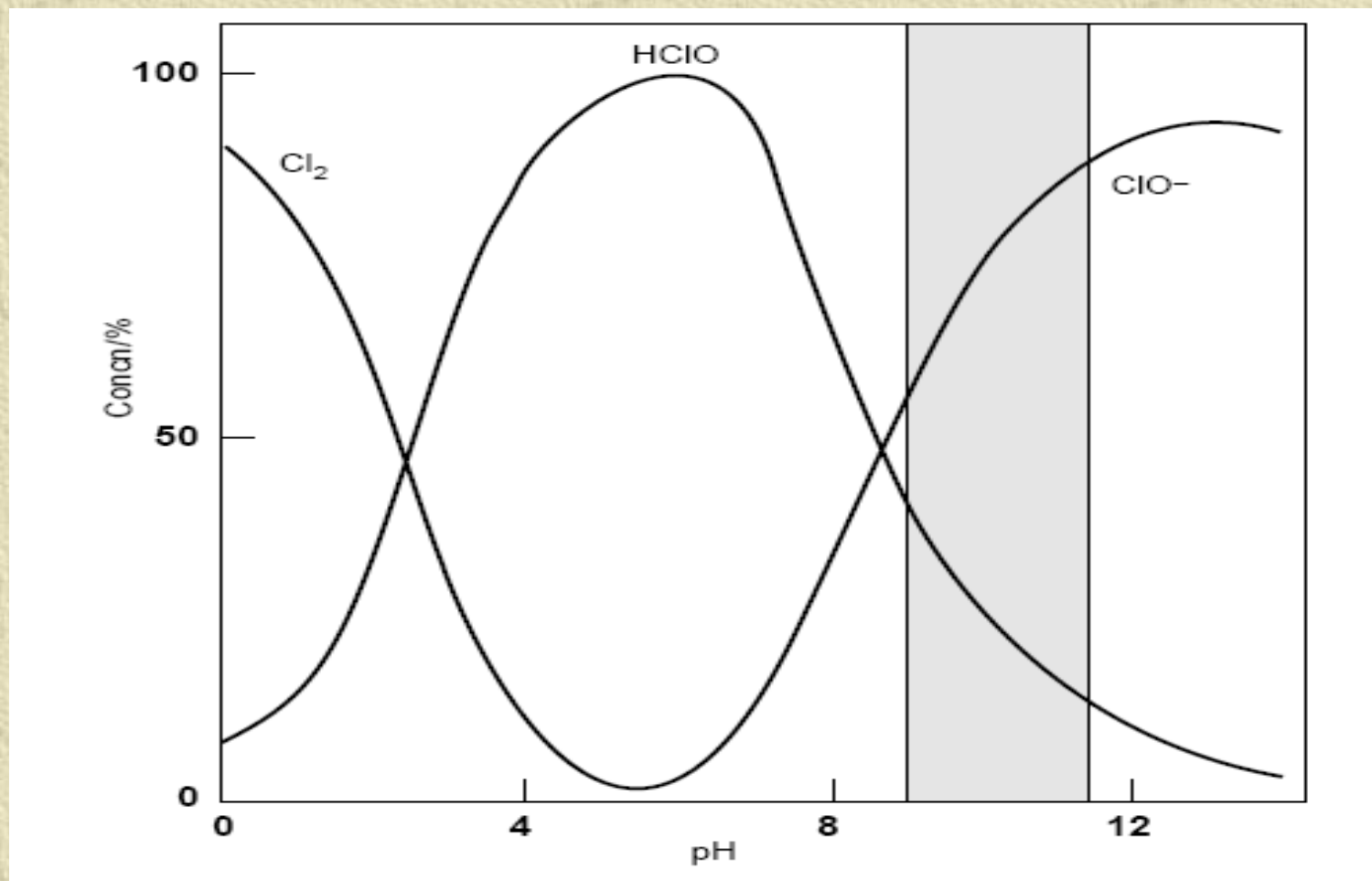
➤ *Temperature/time*

➤ *Concentration (available chlorine)*

pH	Active species	Effect
>11	OCl ⁻ with minimal HOCl	No bleaching
5- 8.5	HOCl	Rapid bleaching and fiber degradation
< 5	Chlorine gas	No bleaching
9 - 11	Optimum HOCl	Optimal bleaching without fiber degradation

Generally bleaching of cotton is carried out with 1-3g/l available chlorine at a pH of 9 –10 at about 40⁰C for 1 h.

Fabrics bleached with hypochlorite will develop a distinctive chlorine odor (removed with an aftertreatment [ANTICHLOR]): *Treatment in a bath containing sodium bisulfite and acetic acid.*



CHLORITE BLEACHING [NaClO₂]

❖ Reactions in bleaching solutions with NaClO₂



✨ *HClO₂ (chlorous acid) --- active bleaching species in chlorite bleaching with NaClO₂.*

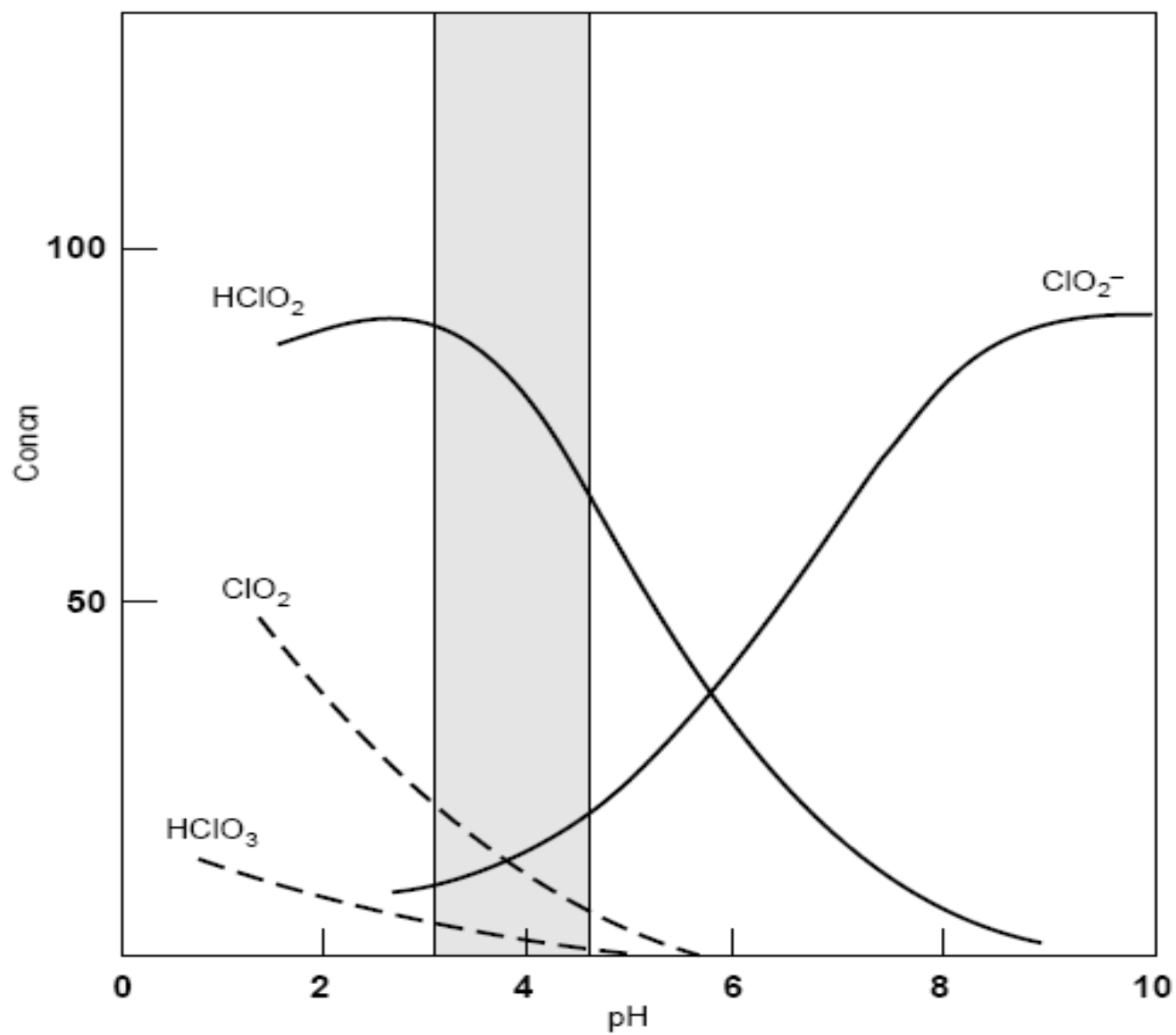
✨ Similar factors in hypochlorite bleaching affect chlorite bleaching process.

- Bleach bath pH
- Temperature/time
- Concentration (available chlorine)

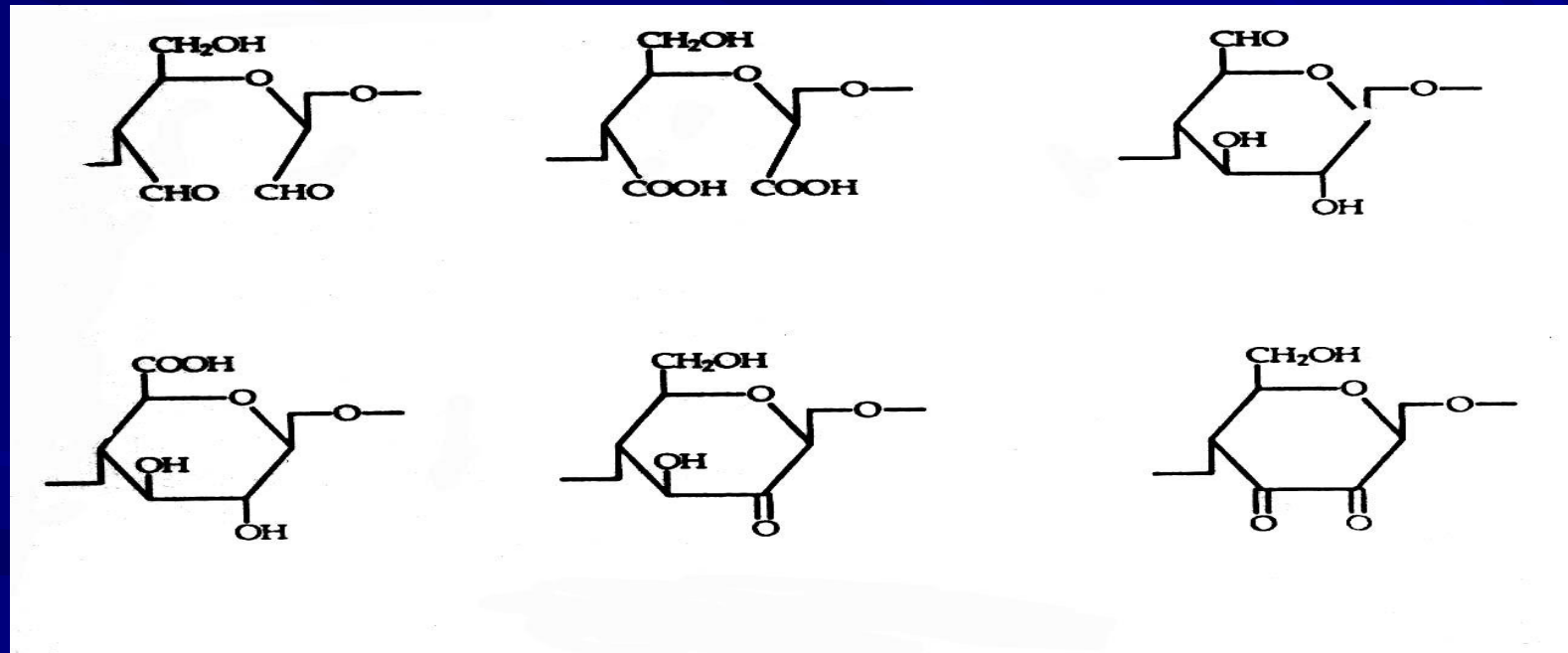
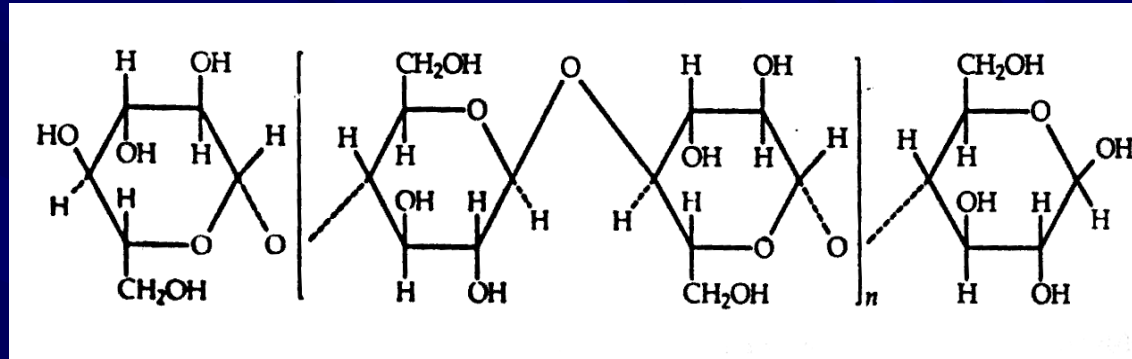
pH	Active species	Effect
Below 3	HClO ₂ at maximum	Damage to cotton fiber (hydrolysis)
3 – 5	HClO ₂ at optimum	Optimum for bleaching [3.5 – 4.5]
> 5	ClO ₂ ⁻	No bleaching (no active bleaching specie)

Little or no bleaching takes place at temperatures below 50 °C, however the bleaching rate increases considerably up to 90 °C.

Generally bleaching of cotton is carried out with 2.5-5g/l available chlorine at 80 – 90 °C for 1/2 h.



PROBLEM WITH OXIDATIVE BLEACHING



FORMATION OF OXYCELLULOSE RESULTING FIBER DAMAGE

- ✱ *Hydrogen peroxide is the most widely used bleaching agent from the point of view of obtaining high degree of whiteness.*
- ✱ *Problem with regard to fiber damage particularly in the presence of metal ions.*
- ✱ *There is a limited use of chlorine based bleaches nowadays mainly due to formation of high toxic chlorinated compounds.*

Reductive bleaching using reducing agents [SO_2 and hydrosulphites]

No permanent white when fabric is exposed to oxygen in the air.

PHYSICAL BLEACHING

- ✦ After chemical bleaching textiles do not appear **perfectly white**.
- ✦ *Trial to increase degree of whiteness by chemical bleaching can result over-bleaching and fiber degradation.*
- ✦ Certain organic compounds in their presence in textiles increase **brightness of textiles** without chemical degradation of impurities.
- ✦ *Compensating the yellow coloration of the textile materials; increasing the total amount of light reflected from the textile surface.*

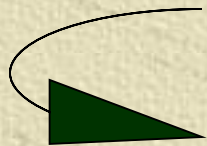
Increase in degree of whiteness

BRIGHTENING MECHANISM

- *Absorption* of light in **shorter wave lengths** (300 - 400nm) (UV range) & *re-emission* in **longer visible wavelengths** (400 - 500nm) (bluer range).

➤ **FLUORESCENCE**

- ✧ *The ultimate effect is increasing total amount of light reflected & increase the brightness/degree of whiteness.*



OPTICAL/FLUORESCENT BRIGHTENING AGENTS

Similar to dyestuff structure contain conjugated double bonds

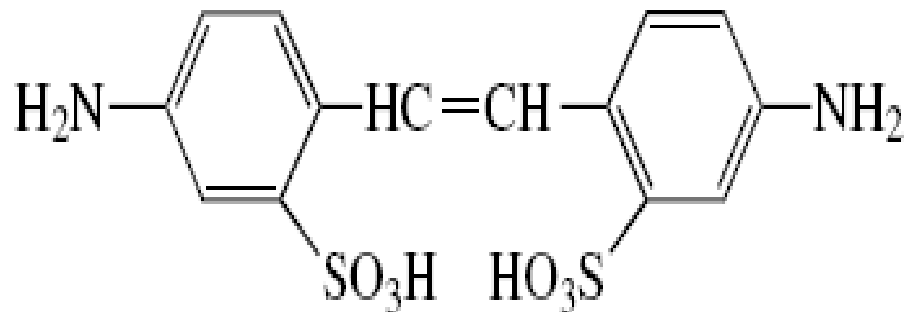
COLORLESS DYES

Like dyes their affinity for different fibers is different

Anionic type optical brighteners are used in brightening of cotton.

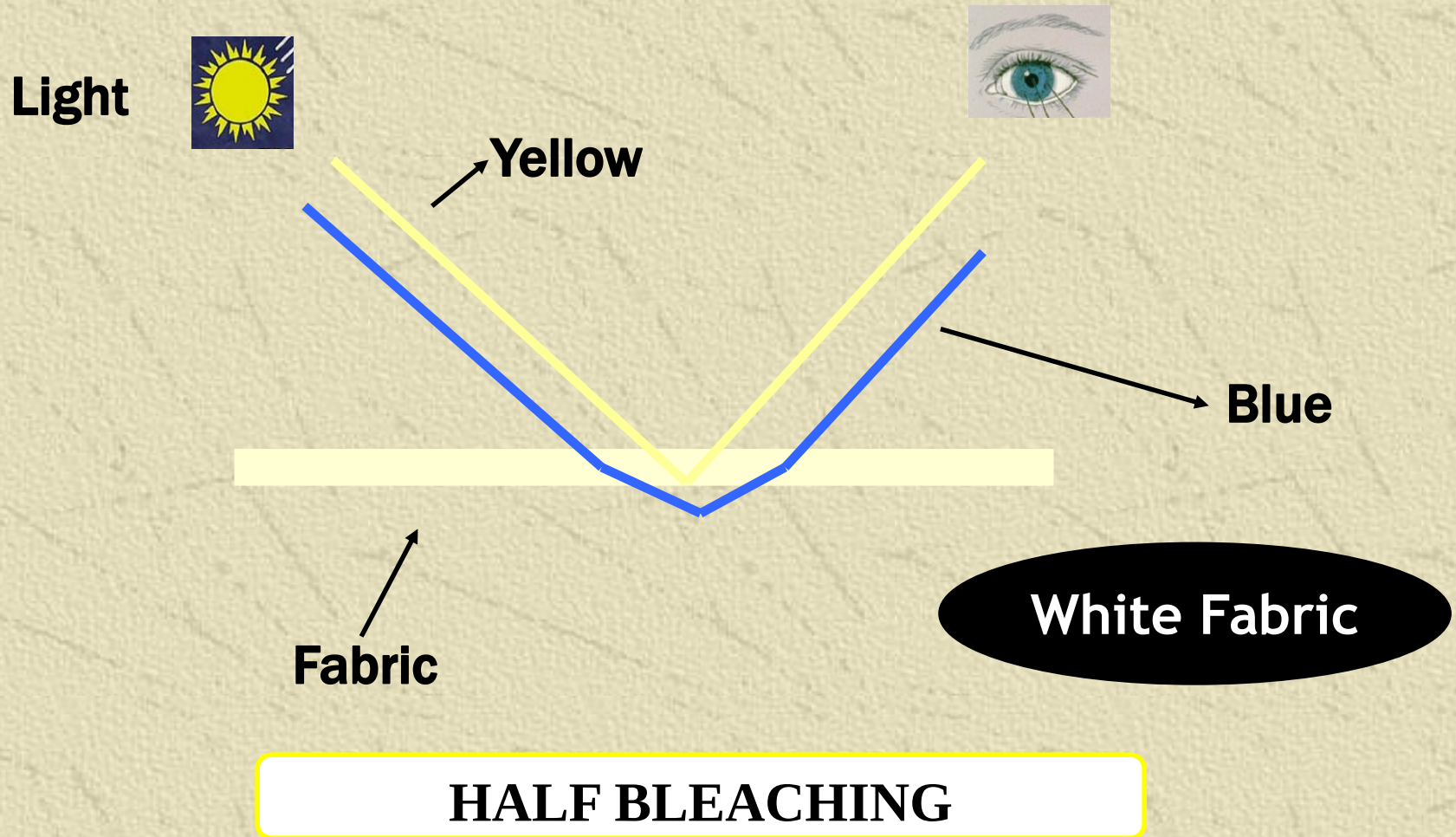
Exhaustion is controlled by adjustment of proper temperature, pH and addition of electrolytes (NaCl).

Most widely used OBA's

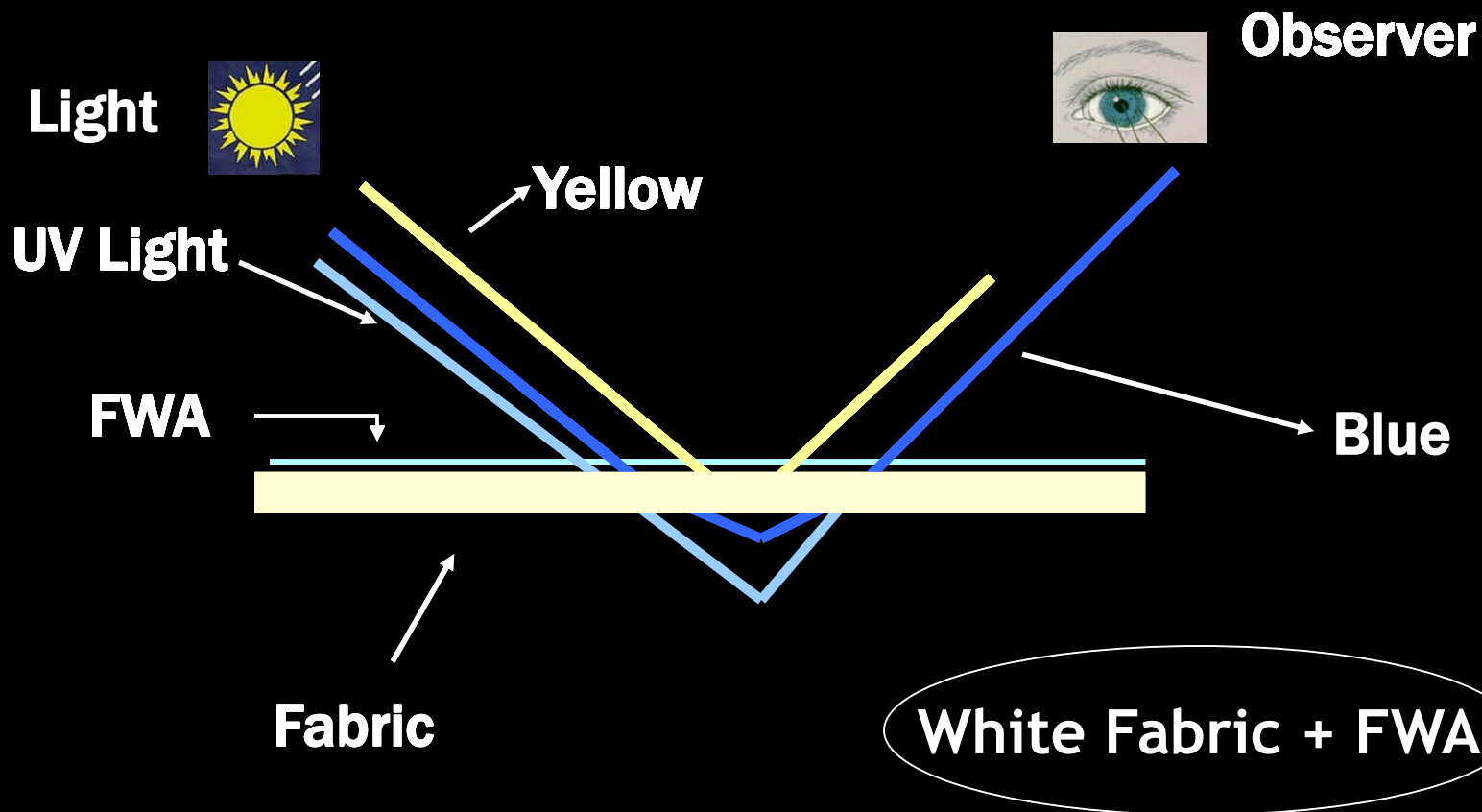


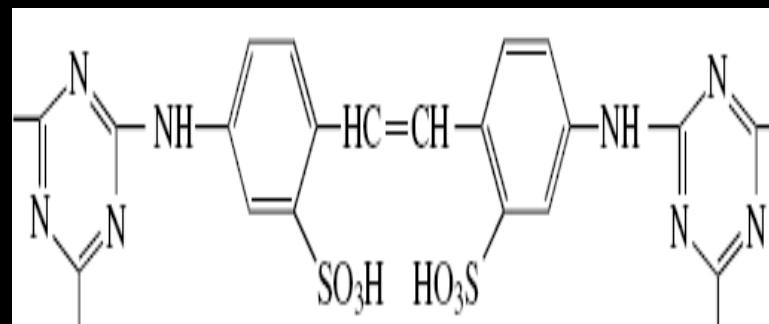
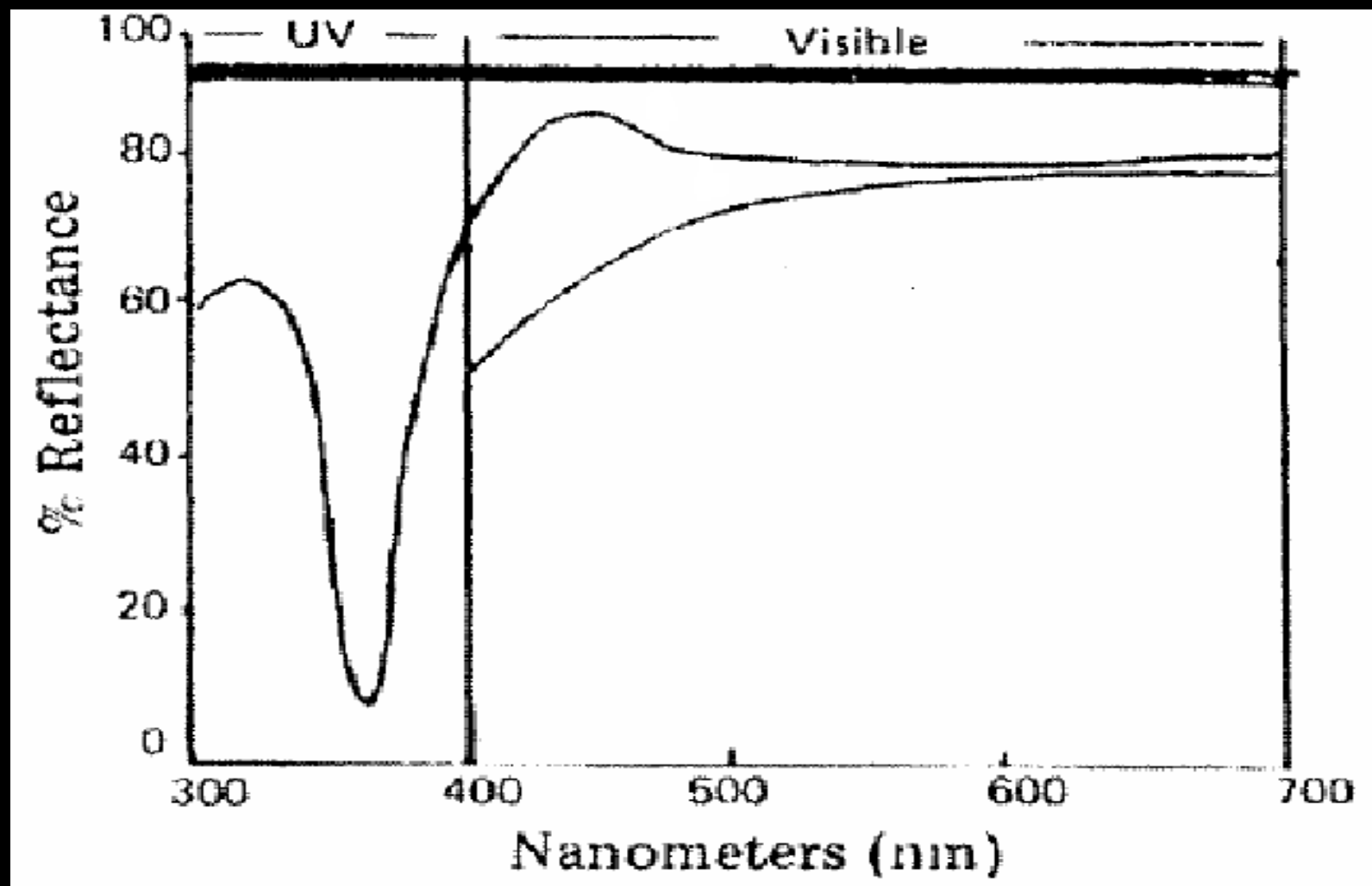
Stilbene derivatives [diaminostilbenedisulphonic

✨ The unique feature of OBA/FWA is **excitation and release of light energy**. The compounds **absorb UV rays and get excited**. The reflection of light is at **longer wavelengths (blue)** which compensates for the yellow color.



FULL BLEACHING





Applied as a separate bleaching or in combination with chemical bleaching

TEST FOR BLEACHING

DEGREE OF WHITENESS

- ✦ *Yellow impurities adsorb blue light*
- ✦ *Measurement of the amount of blue light reflected by the goods, against a white standard*

CERAMIC TILE

- ✦ *The standard ceramic tile is measured and set to equal 100. The other specimen are rated against this standard.*

- Wetting Test



Grey Fabric

Treated Fabric



FLUIDITY MEASUREMENT

- *Damaged cellulose has low molecular weight than undamaged cellulose.*
- *Solutions from undamaged fibers are less fluid than from damaged fibers.*
- *Fluidity is measured by dissolving cotton in cupriethylene diamine hydroxide and determining the solution's viscosity.*
- High fluidity results low viscosity and indicates the extent of bleaching.

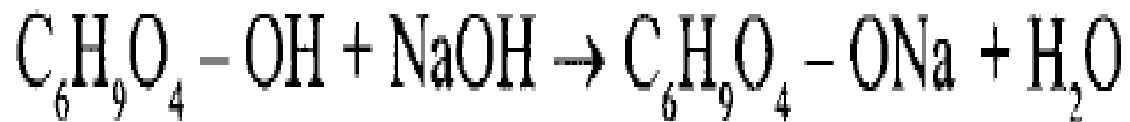
MERCERIZATION

INTRODUCTION

- ✦ *Mercerization is named after John Mercer (1850), who discovered cotton fabric immersed in aqueous solution of cold caustic soda exhibited swelling and shrinkage.*
- ✦ ***Mercerization** is defined as the treatment of cotton with a concentrated solution of caustic soda (NaOH).*
- ✦ ***Conventional mercerization** requires high concentration of caustic soda (up to 35%), treatment near RT (15 – 18 C) for an average dwell period of 55sec applying tension.*

CAUSTIC SODA SOLUTION ON COTTON

- ✧ *Formation of alkali cellulose*
- ✧ *Change in cellulose conformation*
- ✧ *Change in cross section as result of swelling*
- ✧ *Shortening of fiber length*



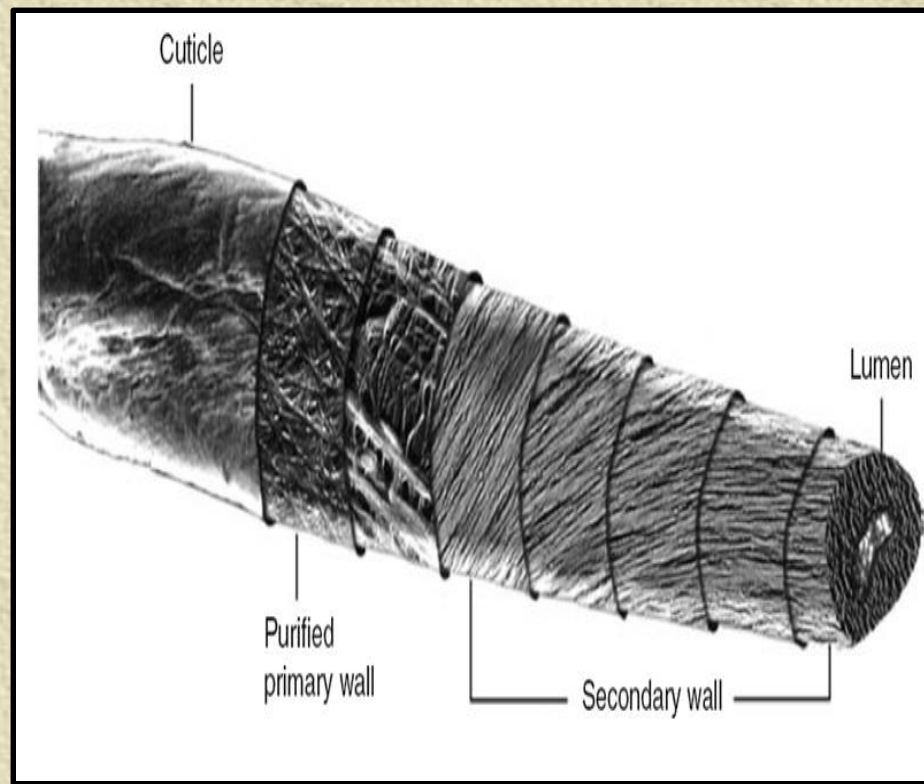
✧ *Deconvolution*

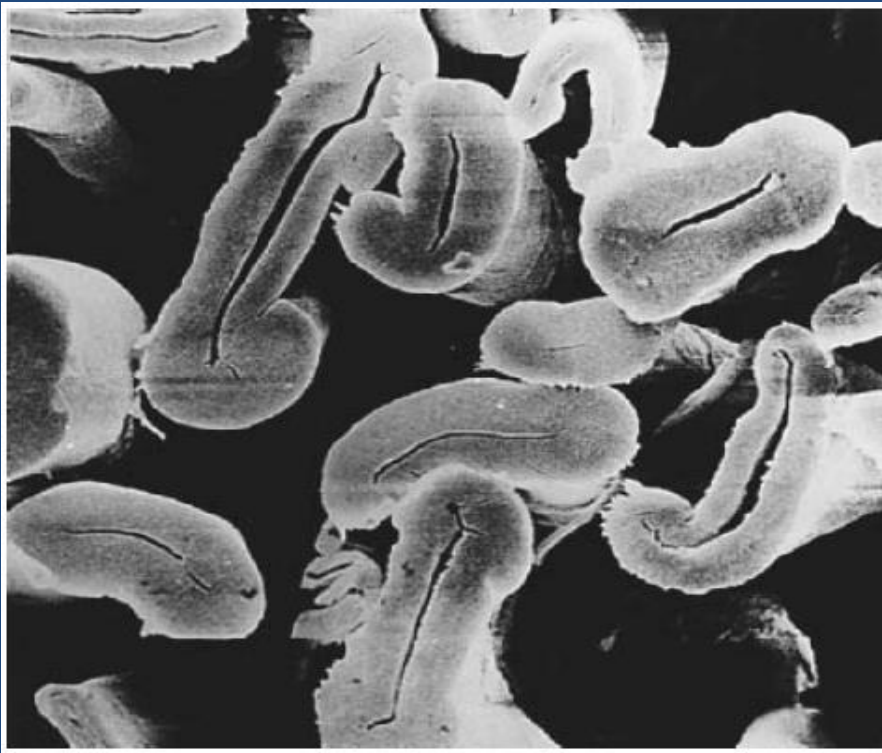
✧ *Loss of spiral windings*

✧ *Absence of lumen*

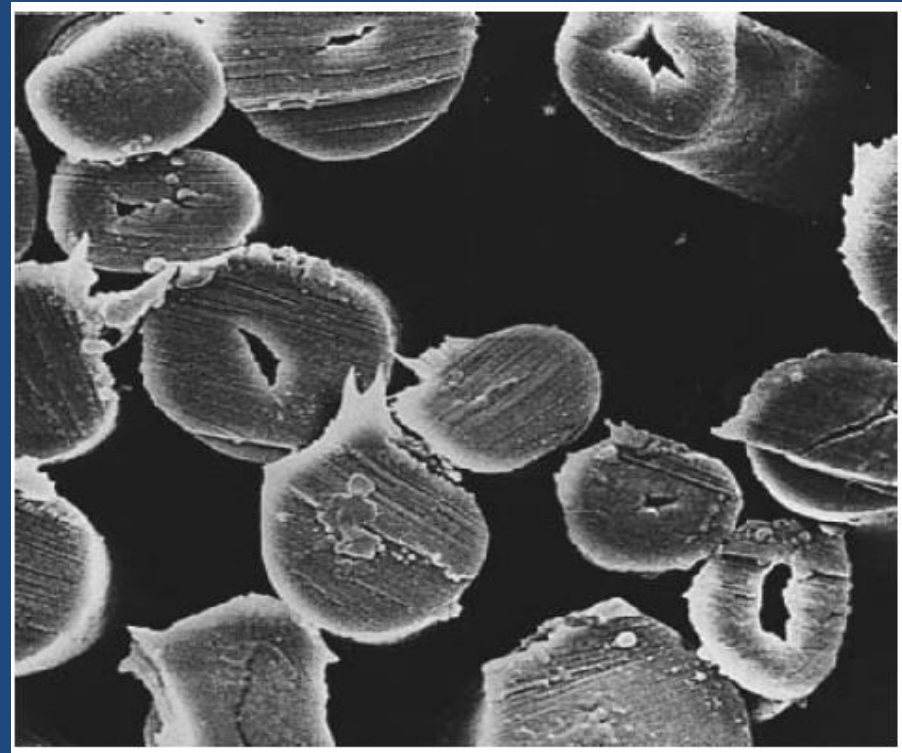
✧ *Breakage and reformation of new hydrogen bonds*

✧ *Removal of weak links*



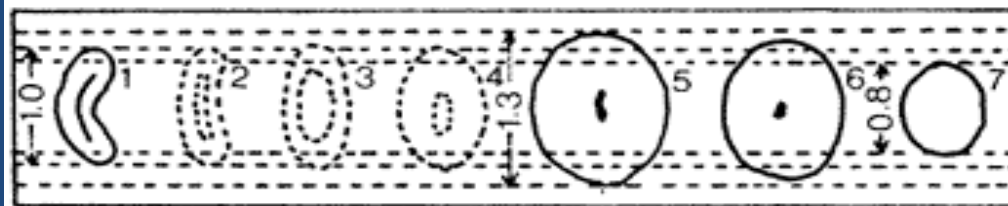


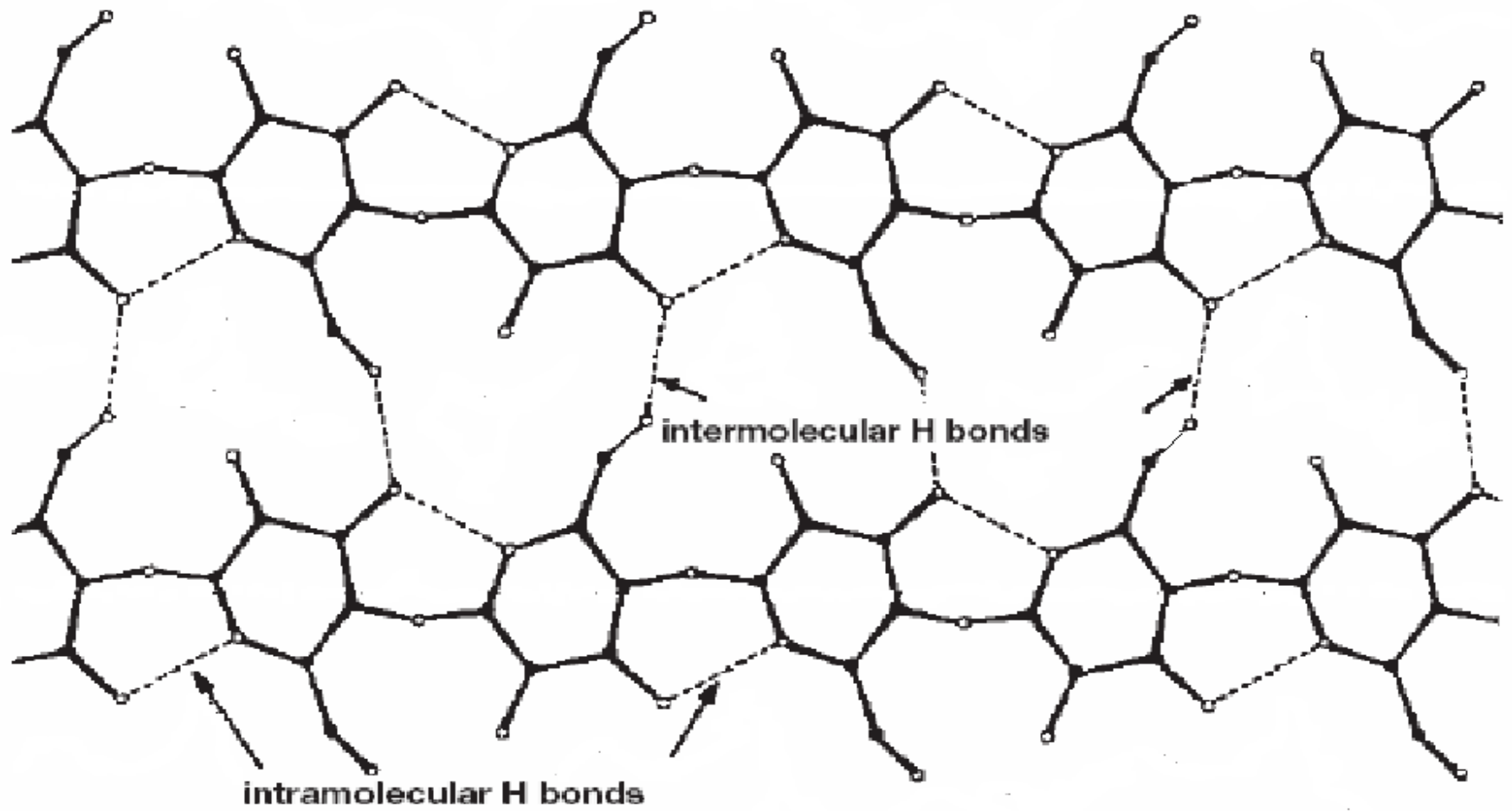
Before Mercerization



After Mercerization

1. Cross section before mercerization
- 2→5. Swelling process in 18% NaOH
6. Rinsing process after swelling
7. Final state





CONDITIONS FOR MERCERIZATION

✦ *Concentration of caustic soda*

DEGREE OF HYDRATION OF ALKALI ION

✦ *Temperature and time*

✦ *Tension*

COMPACTING INHIBIT FURTHER CAUSTIC PENETRATION

✦ *Addition of wetting agent* (particularly in grey mercerization)

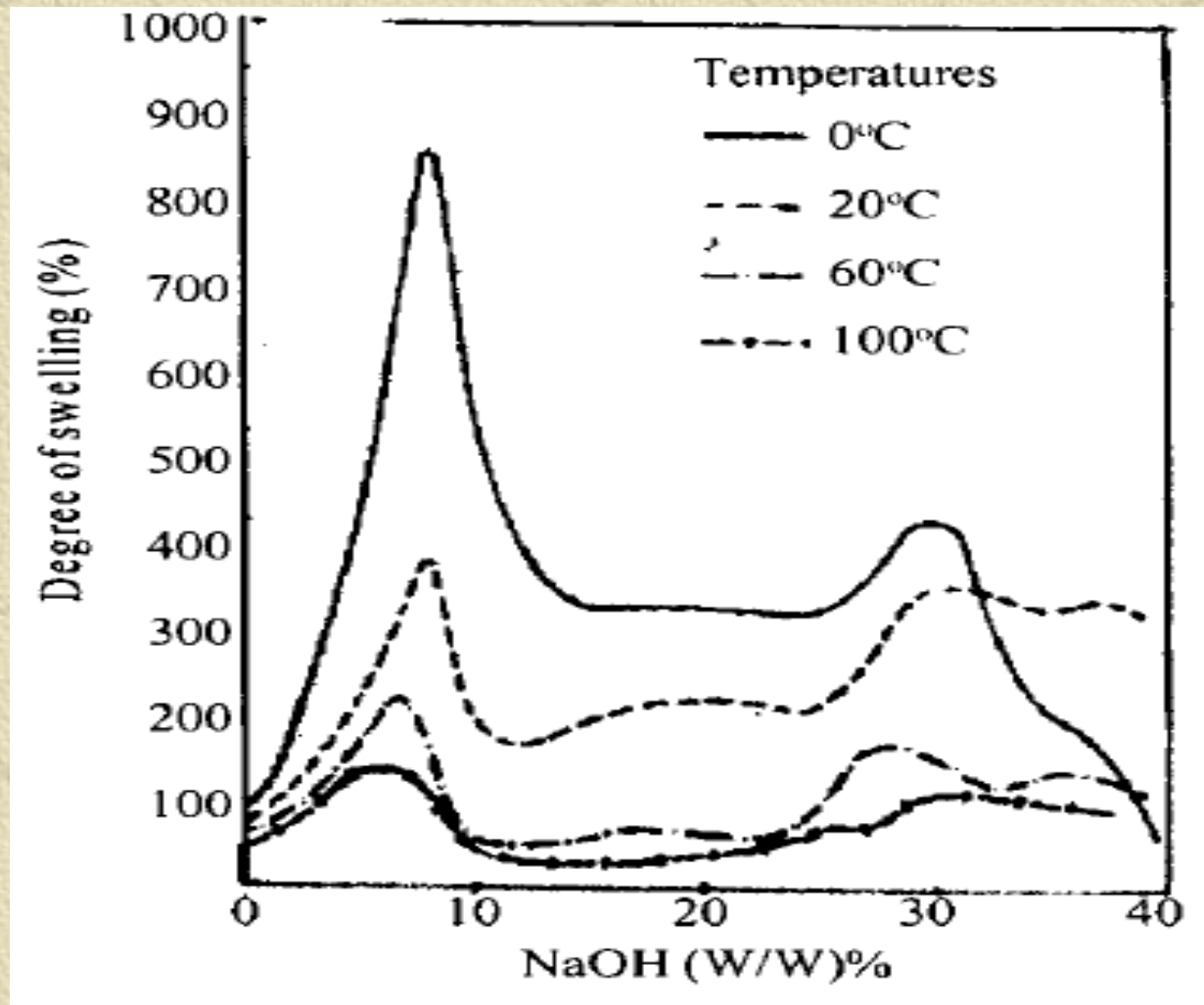
Higher than optimum caustic concentration causes a reduction in swelling

Exothermic Nature of alkali-cellulose formation

Swelling diminishes at higher temperatures (above RT) but fast caustic penetration

TENSION & SLACK MERCERIZATION

CAUSTIC CONCENTRATION AND TEMPERATURE



EFFECT OF TENSION

Mercerization Without Tension [Slack Mercerization]

- ✦ *The cotton fiber swells, the cross section becomes thicker and the length is shortened; the fabric becomes denser, stronger and more dimensionally stable.*

Mercerization Under Tension [Tension Mercerization]

- ✦ *The coiled fiber is straightened & the lumen disappears. Fibers become smoother & permanently round and rod like in cross-section.*



MERCERIZATION PROCESS

IMPREGNATION

STABILIZATION

RINSING

- (a) Application of caustic soda solution** around (19 to 26%) at a temperature of 15 to 18 C.
- (b) A dwell period of 55 sec on an average**, so as to permit diffusion of alkali into the fiber.
- (c) Warp tension during alkali treatment and stretching the weft (width) of the fabric during washing** are necessary to prevent excessive shrinkage.
- (d) Washing-off of the traces of alkali**

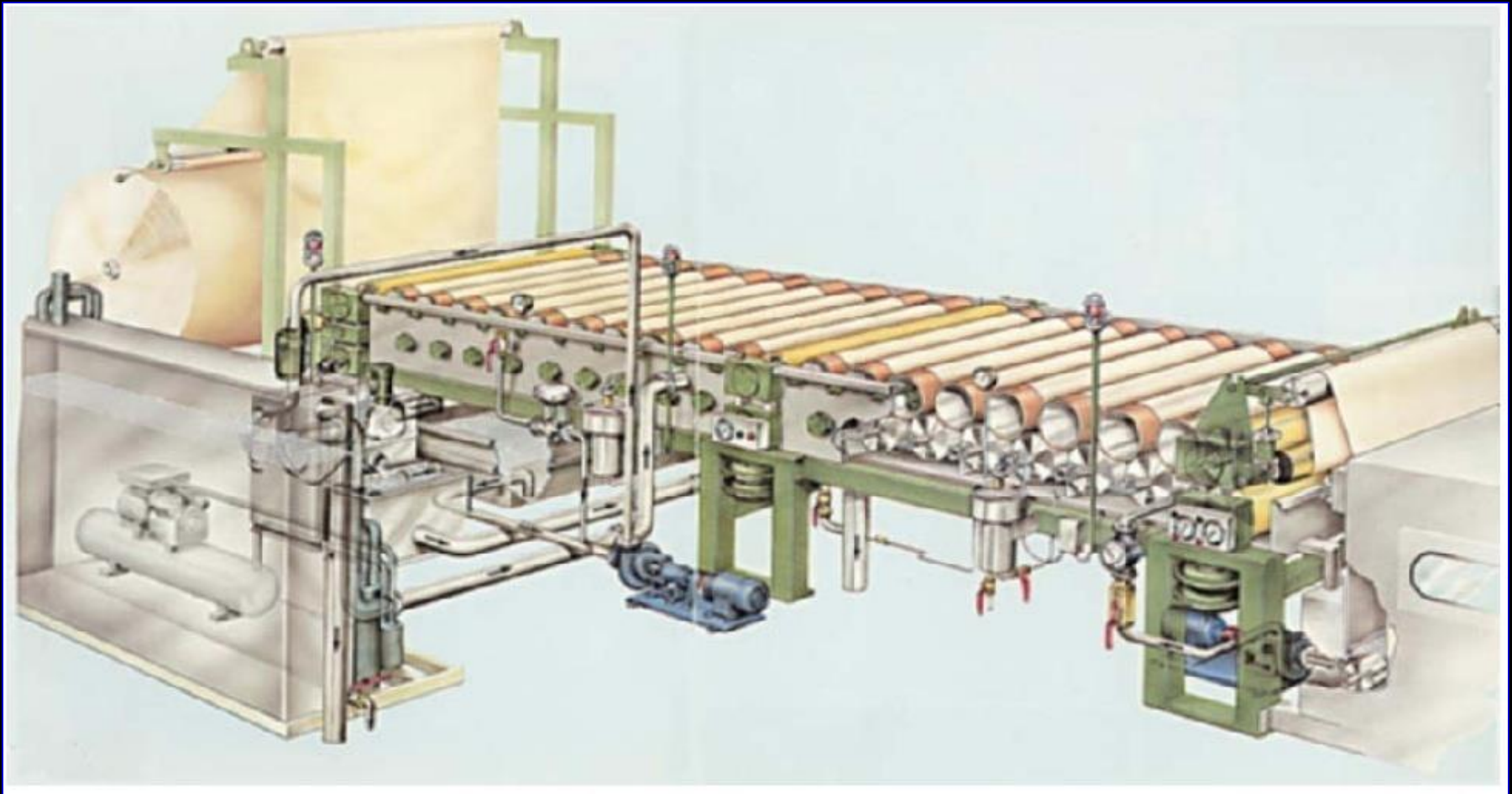
TENSION OR CHAIN MERCERIZATION

Fabric is clipped/pinned onto chains & stretched filling-wise maintaining warp tension

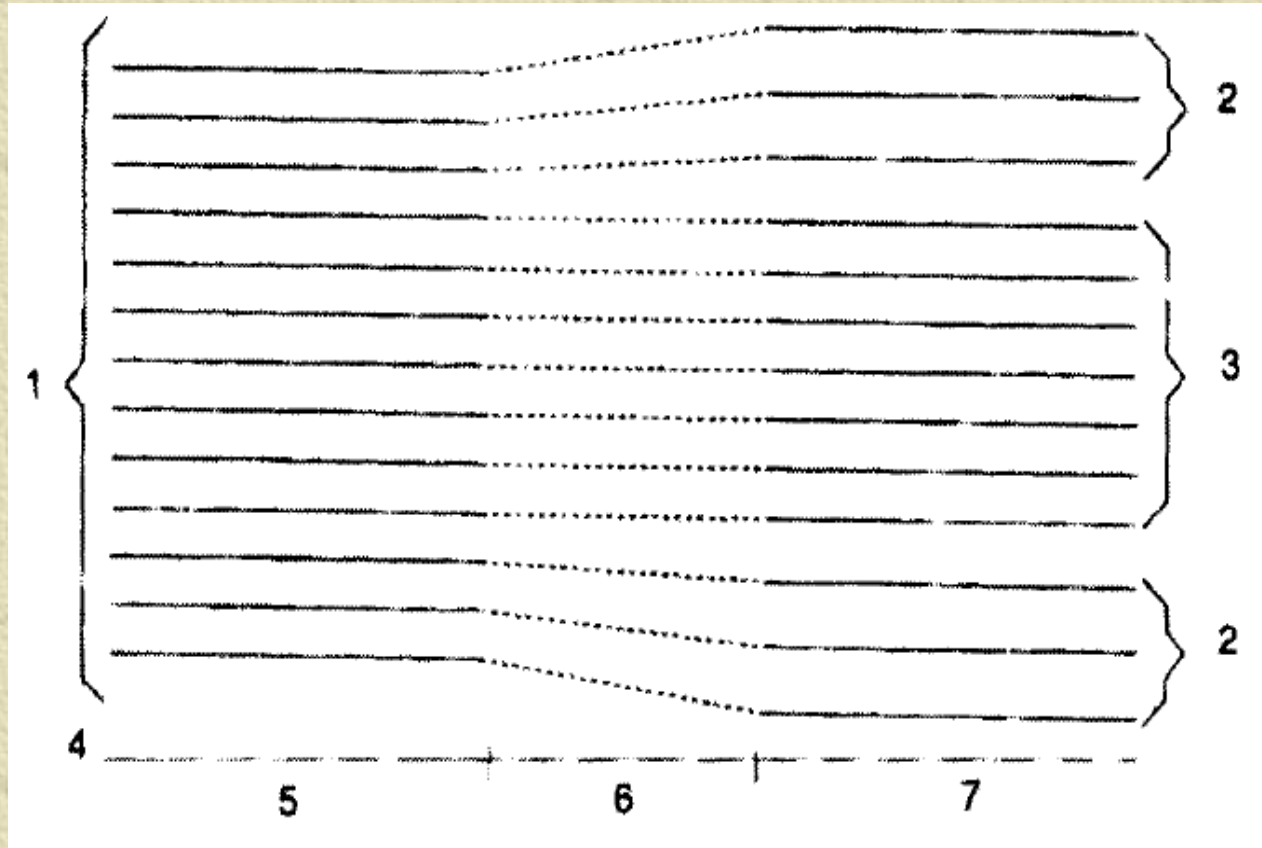


SLACK OR CHAINLESS MERCERIZATION

Fabric maintained in contact with rotating drums throughout the process



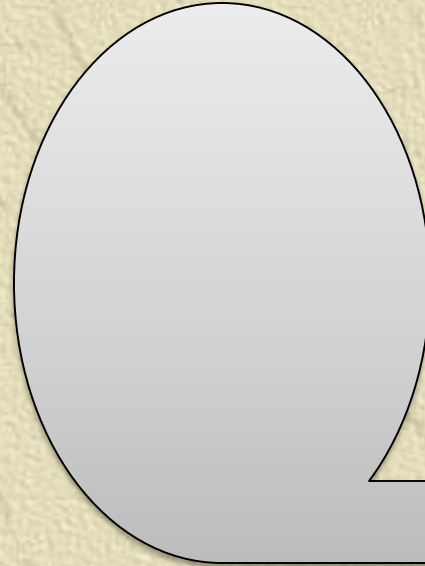
CHAIN MERCERIZATION PROBLEM



NON-UNIFORMITY

CHANGES DUE TO MERCERIZATION

- Swelling and shrinkage
- Structural modification



- ✦ *Increased luster*
- ✦ *Increased tensile strength*
- ✦ *Increase moisture absorption, dyeability*
- ✦ *Dimensional stability*
- ✦ *Improved hand*

EFFECTS



SWELLING AND SHRINKAGE

- ❖ *Water and alkali penetration into cellulose*
- ❖ *Conversion of cellulose into alkali/soda cellulose*
- ❖ *Swelling of cotton with a corresponding shrinkage*
- ❖ *Deconvolution and more round fiber diameter*



STRUCTURAL MODIFICATION

- *Due to swelling hydrogen bonds in cellulose are broken*
- *Molecular chains move apart from each other*
- *Molecular rearrangement & formation of newer bonds*

CRYSTALLINITY & ORIENTATION

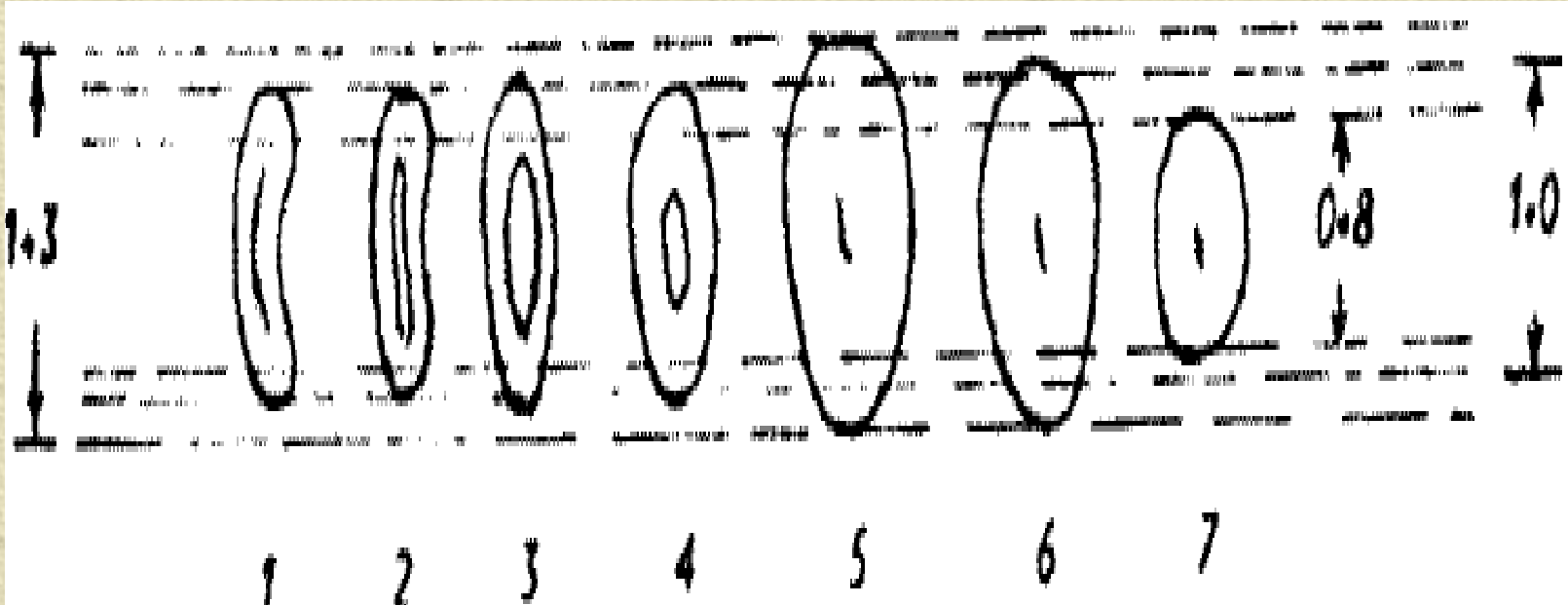


✧ *Caustic soda solution swells cotton fibers breaking hydrogen bonds and weak Van der Waal forces between cellulose chains.*

✧ *The expanded chains rearrange and re-orient and when the caustic soda is removed, chains form new hydrogen bonds in the reorganized state.*

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Reduced light scattering due to lower surface area

LUSTURE

The increase in orientation of the crystallites with respect to fiber axis attributed the decrease in lengths of crystallites and fiber deconvolution.

Mercerization increases the tensile strength of cotton fibers by eliminating the weakest links in the fiber.

Increased density also enhances the strength.

INCREASED COHESION

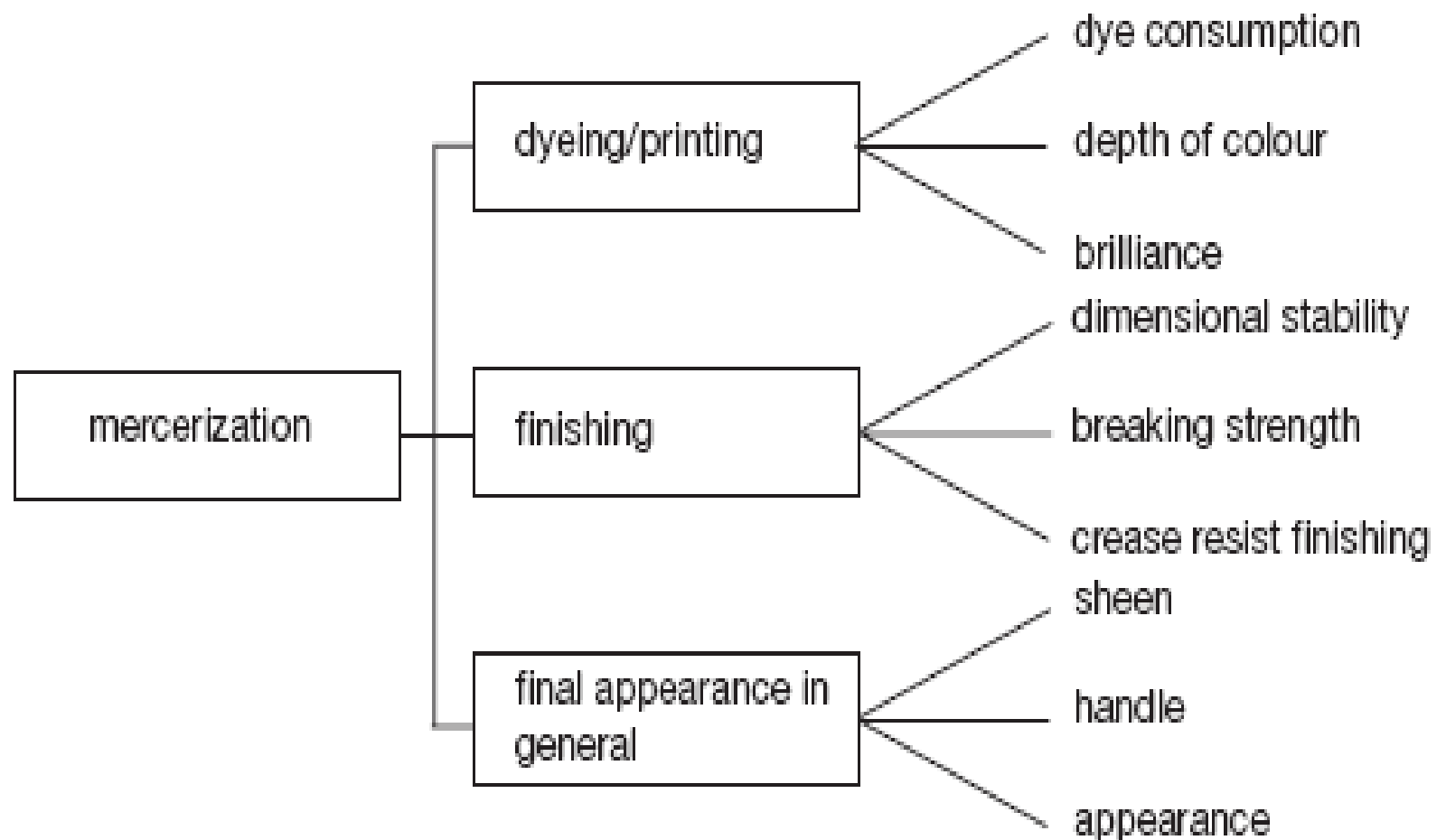
ABSORPTION, REACTIVITY AND DYEABILITY

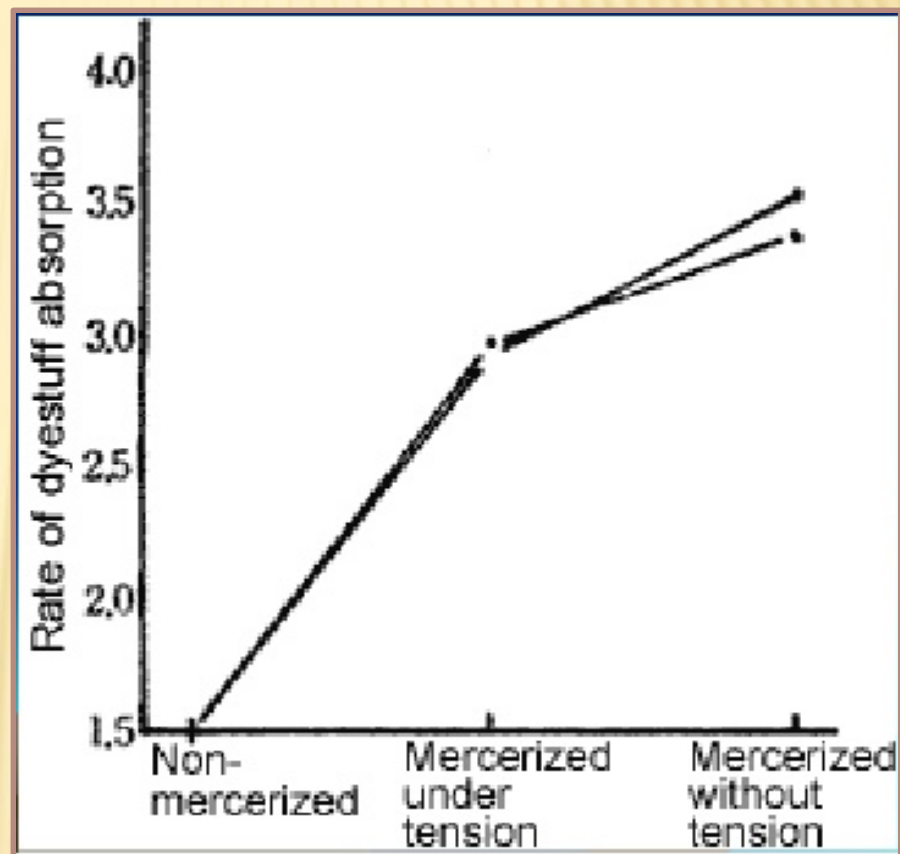
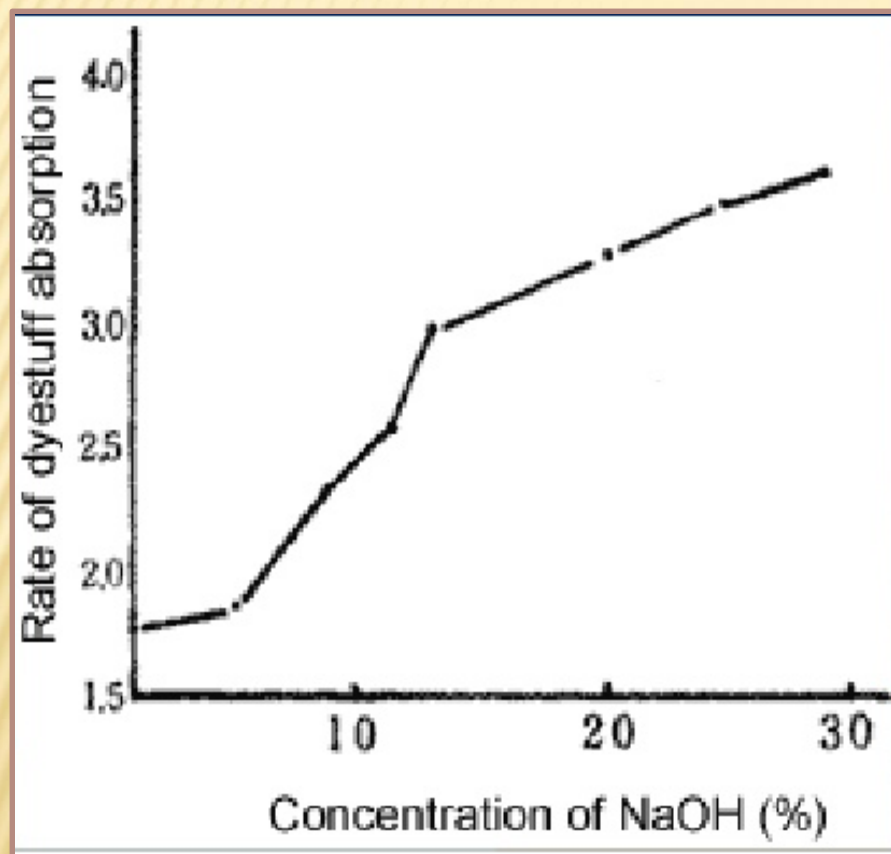
- ✦ *Breakage of hydrogen bonds increases number of available hydroxyl groups*
- ✦ *Amorphousity due to decrystallization*
- ✦ *Increase in moisture absorption, dye uptake & reactivity*
- ✦ *Increase in depth of shade due to lusturity*
- ✦ *Level dyeing due to removal of immature cotton*

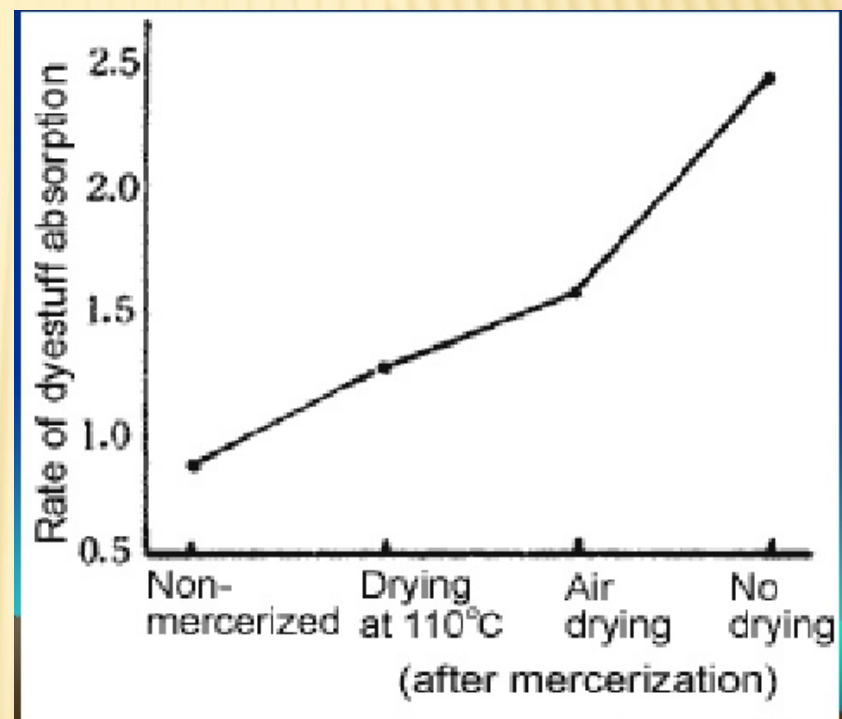
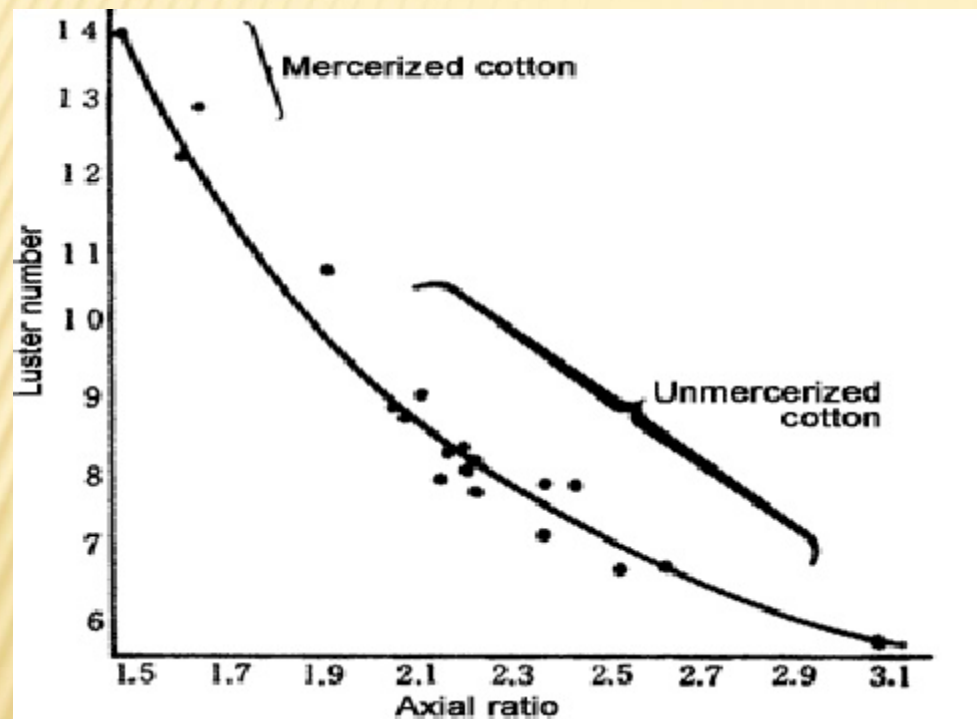


Swelling in mercerization results compactness in structure and hence further shrinkage is limited and this improves dimensional stability of fabrics.

HAND MODIFICATION IN RELATION TO INCREASE IN DENSITY & CHANGE IN CROSSECTION







STAGES OF MERCERIZATION

Mercerization can be carried out at different stages:

- **Grey mercerization** [*Addition of wetting agents*]
 - **After desizing**
 - **After scouring** [*Sufficient washing off of caustic liquor*]
 - **After bleaching**
-
- ❖ Mercerization before bleaching can be disadvantage due to *contamination of caustic recovery* --- *Problem in caustic recovery*
 - ❖ Mercerization after bleaching can also be a disadvantage - *Tendency of yellowness*

Why yarn mercerization?

- ✦ **To produce lustrous and strong sewing thread**
- ✦ **To produce yarns for constructions that are difficult to mercerize**
- ✦ **To produce yarns for special construction effects**
- ✦ **For complete mercerization for luster and strength**
- ✦ **To produce yarn dyed fabrics**
- ✦ **To produce knit goods**

Yarns are mercerized in hank form or as a continuous run of yarn

MODIFICATIONS ON CONVENTIONAL MERCERIZATION

CAUSTICIZATION

- ✦ *When mercerization is carried out at lower concentration of caustic soda (10 – 18%) it is called CAUSTICIZATION.*
- ✦ Highly hydrated NaOH penetrates into the cellulose structure causing high degree of swelling and ***enhancement of dyeability.***

HOT MERCERIZATION

➤ In conventional cold mercerization ***fast swelling*** results increase in outer edge density; inhibits further penetration of alkali into the inner core.

✓ When mercerization is carried at higher temperature above RT it is known as hot mercerization:

LUSTROUS

FAST & UNIFORM ALKALI PENETRATION

Impregnation at 100°C – Controlled hot stretching – Cooling – Washing

Faster caustic soda penetration(speedier swelling) & high swelling uniformity (no ring mercerizing)

Highly concentrated caustic soda solution in mercerization

➤ *Caustic recovery plant*

TEST FOR MERCERIZATION

Barium /Barytes Number:

Based on the fabric's ability to absorb barium hydroxide:

$$\text{Ba No.} = \frac{\text{Amt. Absorbed by mercerised}}{\text{Amt. Absorbed by unmercerised}} \times 100$$

Unmercerized fabric - 100 to 105.

Completely mercerized fabric - 150.

Commercially treated fabrics - 115 to 130.

COMBINED PREPARATORY PROCESSES

(DESIZING-SCOURING) + BLEACHING

DESIZING + (SCOURING-BLEACHING)

DESIZING + (SCOURING-BLEACHING)

DESIZING-SCOURING-BLEACHING

**COST REDUCTION IN
PRETREATMENT**