Desiging

Define - Desiging

(Size forms a stiff, hard and smooth coating on warp yarns to enable them to withstand the cyclic tensions during weaving and reduce breakage)

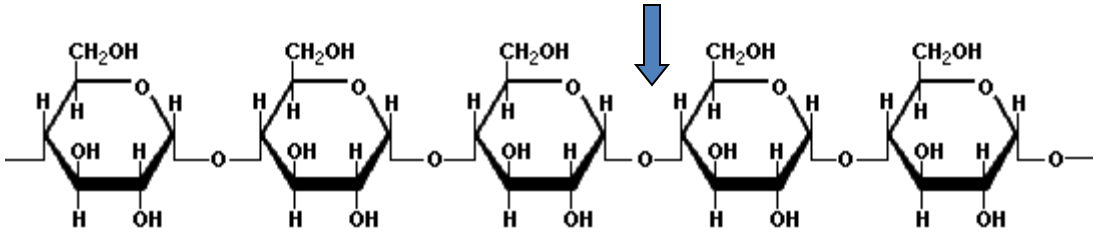
Desizing is the process of removal of size material applied on warp threads of a fabric to facilitate the process of weaving.

Sizing Agents

1. Starch sizes
2. Modified starches
3. Cellulose derivatives
4. CMC (carboxymethyl cellulose)
5. Sizes based on polyvinyl alcohol (PVA)
6. Polyacrylates (PAC)
7. Galactomannans (GM)
8. Polyester sizes (PES)
9. Vinyl, acrylic and styrene homo- and copolymers
10. Waxes and fats
11. Paraffins, silicones, softeners, fungicides and others

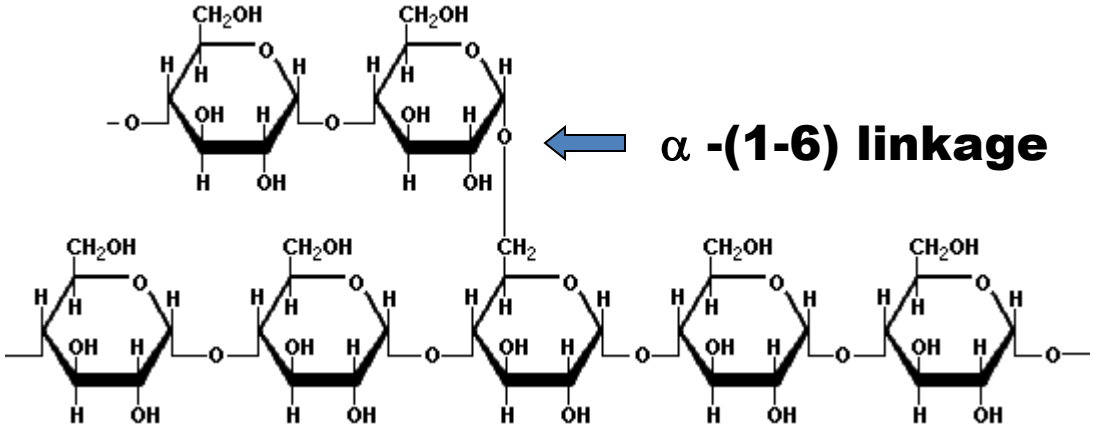
Starch

α -(1-4) linkage



Representative partial structure of amylose

(20-30%)



Representative partial structure of amylopectin

(70-80%)

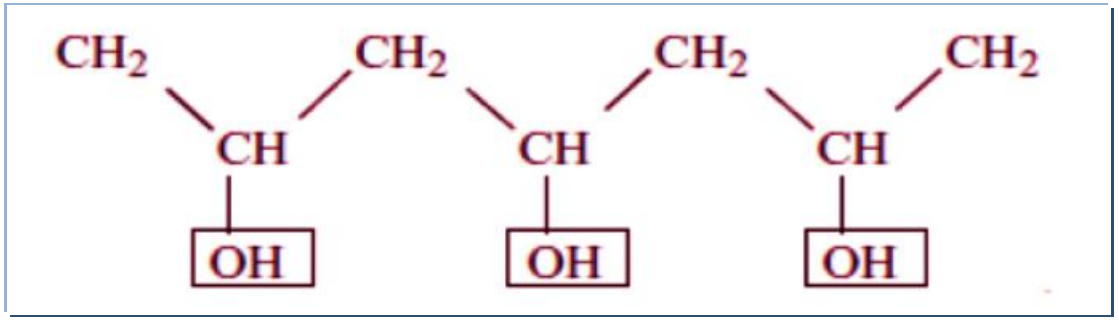
Structural difference: Amylose and Amylopectin

Properties	Amylose	Amylopectin
Structure	linear	Branched
	α-1,4 glucoside	α-1,4 glucoside
		α-1,6 glucoside
Molecular weight	10,000 to 50,000	50,000 to 10,00,000
Iodine reaction	blue	Violet
Film-forming properties	elastic	not very elastic
Enzymatic degradation	complete	partial (60%)
Structure	crystalline	amorphous

Sizes based on Synthetic Polymers

Polyvinylics:

(PVA)

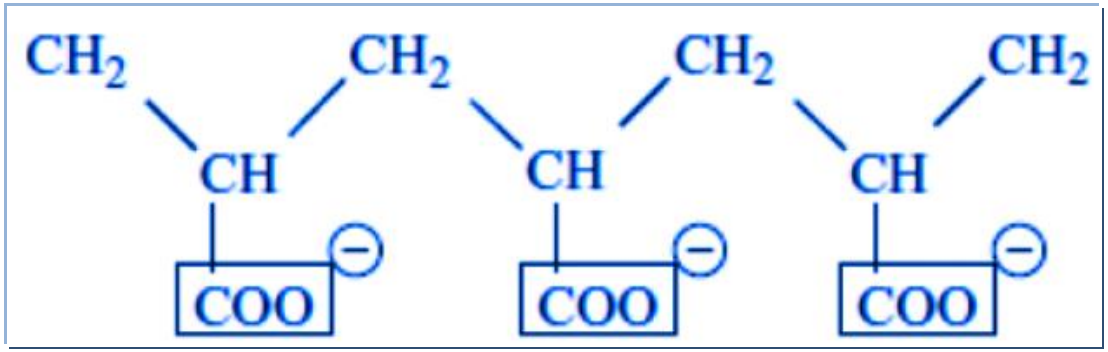


Polyacrylates:

(Polyacrylate)

Water Jet Weaving (preferable):

$COONH_4$ (form)



Desizing – Mechanism

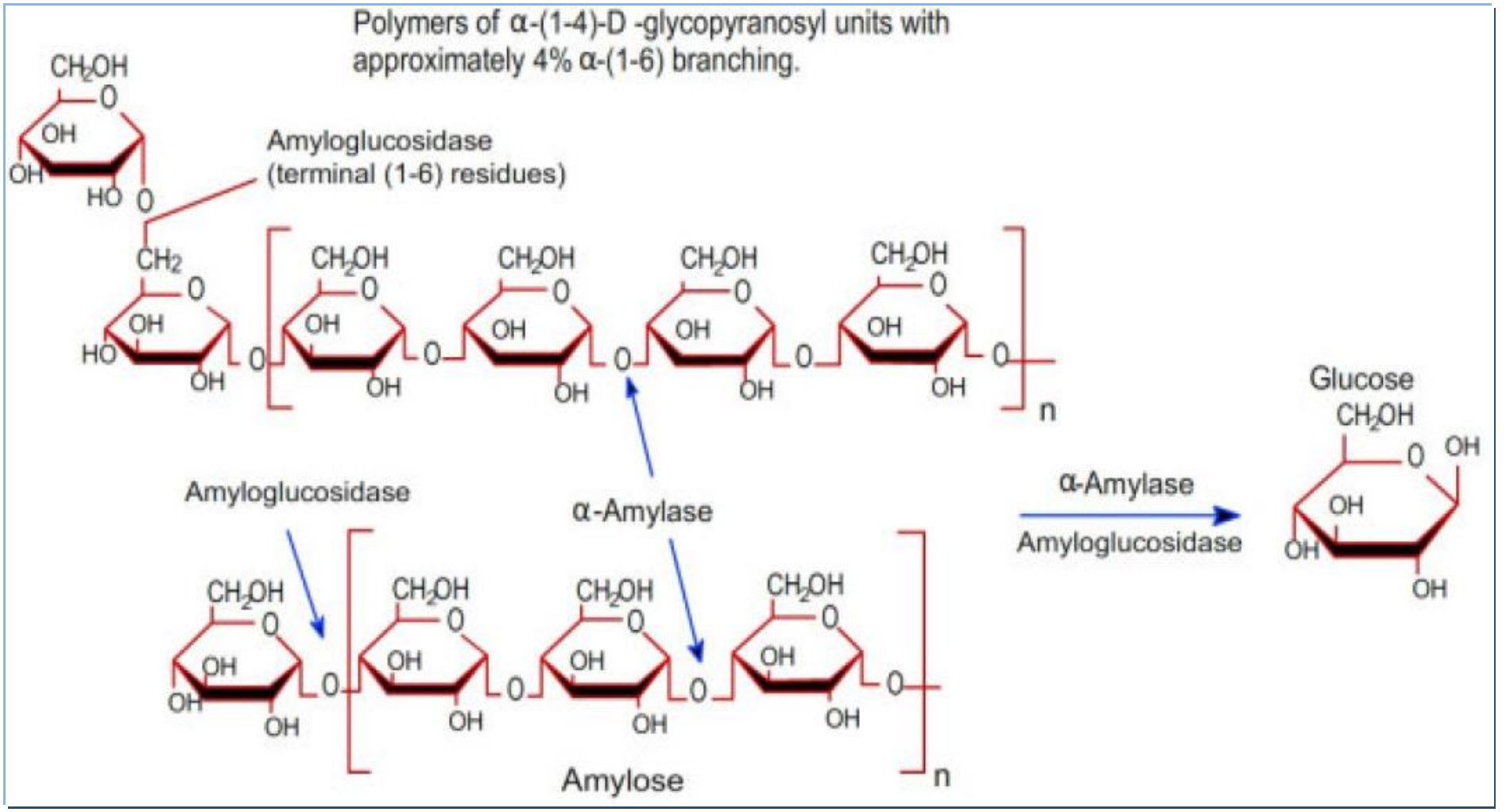
- **HYDROLYTIC DESIZING**
- **OXIDATIVE DESIZING**

Hydrolytic Desizing

When the '**1-4 linkage**' is attacked and broken by hydrolysis, the desizing is called hydrolytic desizing.

Initial starch degradation product is insoluble dextrin, which on further hydrolysis is converted to soluble dextrin and finally glucose.

HYDROLYTIC DESIZING



Hydrolytic Desizing Methods

ROT STEEPING

- Steeping in water at 30 - 40^0C, starch swells
- Swollen starch is attacked by enzymes secreted by microorganisms in environment
- Hydrolyzed starch is removed by normal washing
- Low capital investment
- Slow, low reproducibility, risk of cellulose being attacked

Rot steeping has become obsolete because of poor process control and slowness of the process.

ACID DESIZING

- The 1-4 linkage can be broken by acid hydrolysis also
- Mineral acids are used

- H_2SO_4/ HCl (5 – 10 gpl) is needed at 40 ^{0}C for 3-4 hrs. (> 40 ^{0}C & 10 gpl acid concentration, degradation of cotton cellulose itself may occur)

- The fabric is padded with acid solution and stored (batched)

ACID DESIZING……..

Action of acid will result in gradual degradation of starch. But not all starch is degraded to the extent where it all becomes water soluble.

Hence the action of acid will result in fabric having a range of starch molecular weights. Some with high water solubility, some with medium and some with poor or no solubility.

Hence desizing should always be followed with hot water washing to remove maximum amount of starch

Precaution: Local drying during storage should not be allowed to take place at any cost. It may result in high concentrations of acid at localized places which can cause cellulose degradation.

ENZYMATIC DESIZING: Enzyme means yeast (Greek word)

The term was coined in 1876 by German biochemist Willey Kuhne

- Organic biocatalyst, highly specific in reaction catalyzed and choice of reactants/substrate and hence safe to the substrate
- Physically colloidal in nature & High molecular weight proteins (3D)
- Work under specific conditions of temp. & pH (better process control is needed)
- Lose activity gradually with time
- Generally, act under mild conditions
- Have to be cultivated and nurtured like crops (from fungi)
- Genetic engineering allows enzymes to be designed for specific processes

Enzyme Sources for Desizing

Vegetable, Bacterial, Animal
(Diastase, Amylase, Rapidase, etc.)

Developments:

(1900) Malt Diastafor, by Diamalt Co. of Munich, Germany for commercial Desizing (vegetable)

(1912) Enzymes from slaughter-house waste (animal)

(1919) From bacterial sources (bacterial)

Amylase

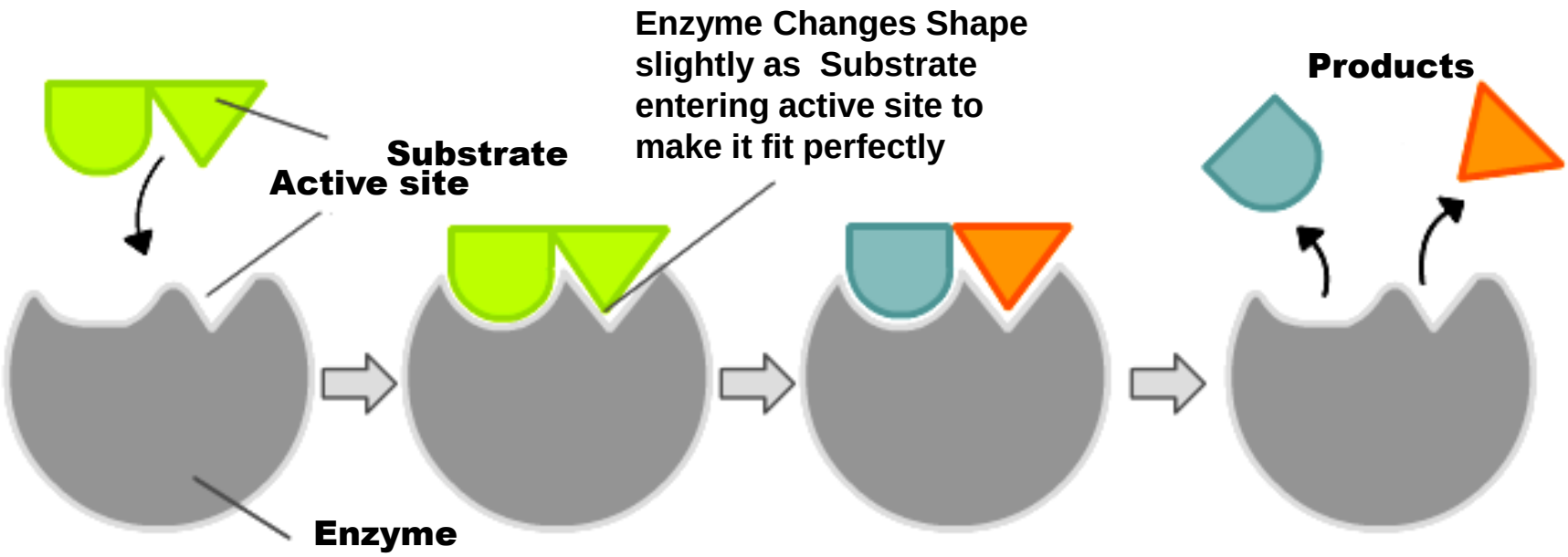
The enzymes are classified according to the manner in which the glycosidic bond is attacked:

- **α- Amylase** attacks the chain at random yielding dextrins, oligosaccharides and monosaccharides.

- **β -Amylase** attacks the chain end & produces maltose

- **Glucoamylase** cleaves the alpha-1, 4 and alpha 1,6 glycosidic linkages of amylose and amylopectin to yield glucose

MECHANISM OF ENZYME ACTION



Enzyme + Substrate entering active site

Enzyme/Substrate Complex

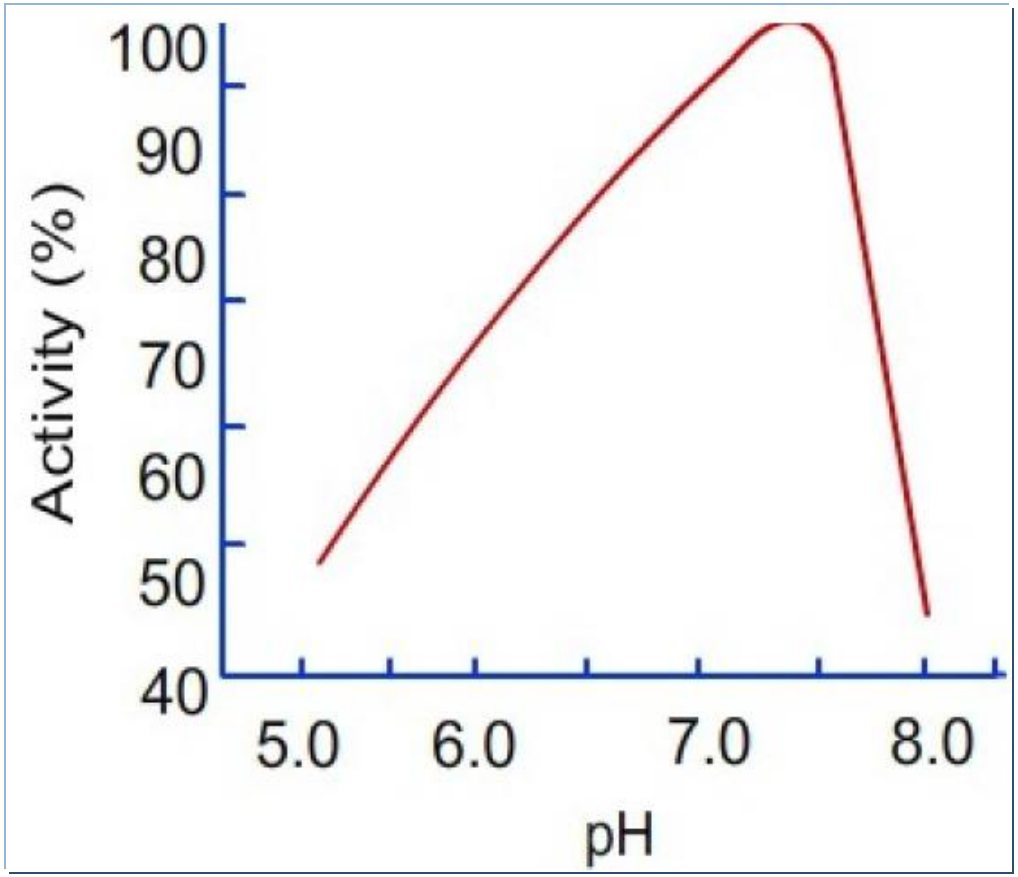
Enzyme/Product Complex

Enzyme +Products leaving active site

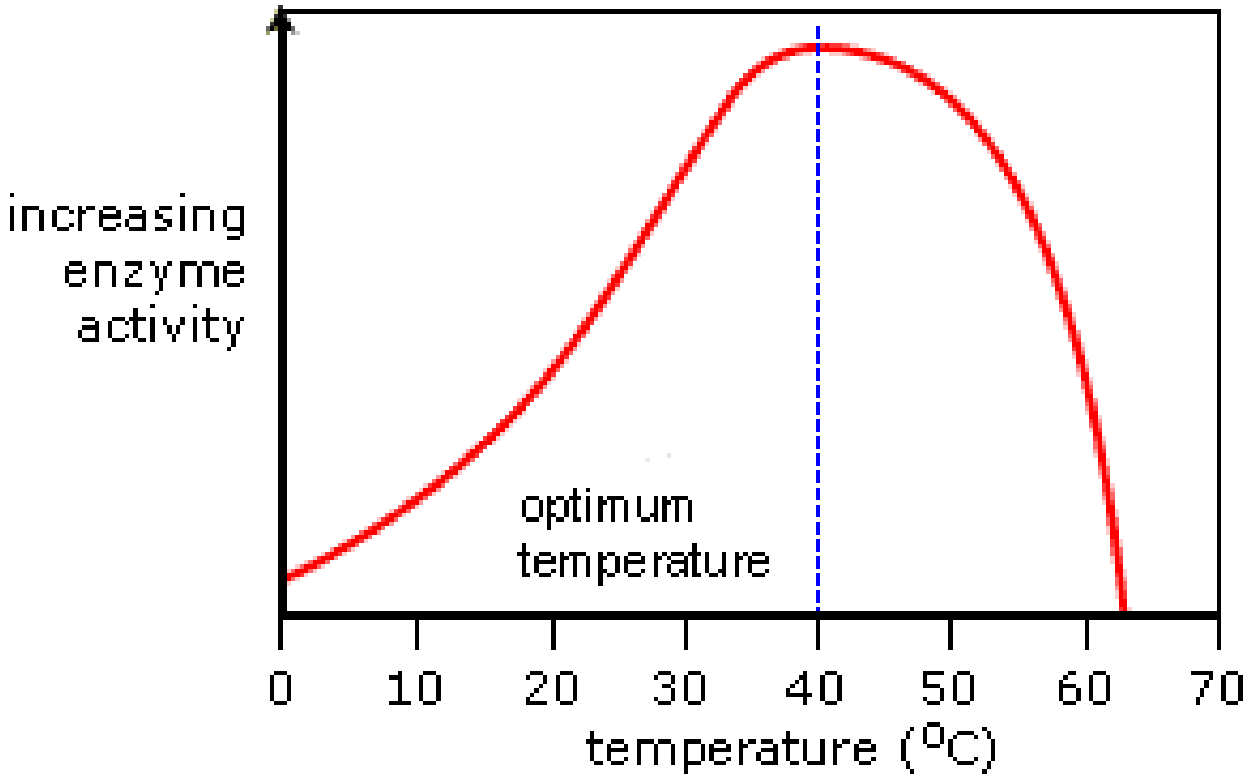
Enzymatic Desizing Parameters

Since enzymes act optimally at specific conditions of temperature and pH, it is important to maintain narrow range of conditions for best results.

Effect of pH on enzyme activity



Effect of temperature on enzyme activity



Stability of various amylases

- Sodium & Potassium chloride (0.2-1%) improve the activity of pancreatic enzyme

- Ca^{++} improves the thermal stability of malt amylase

- However, heavy metal ions like copper, iron, etc. inhibit their activity

Water Quality ?

Use of Surfactant

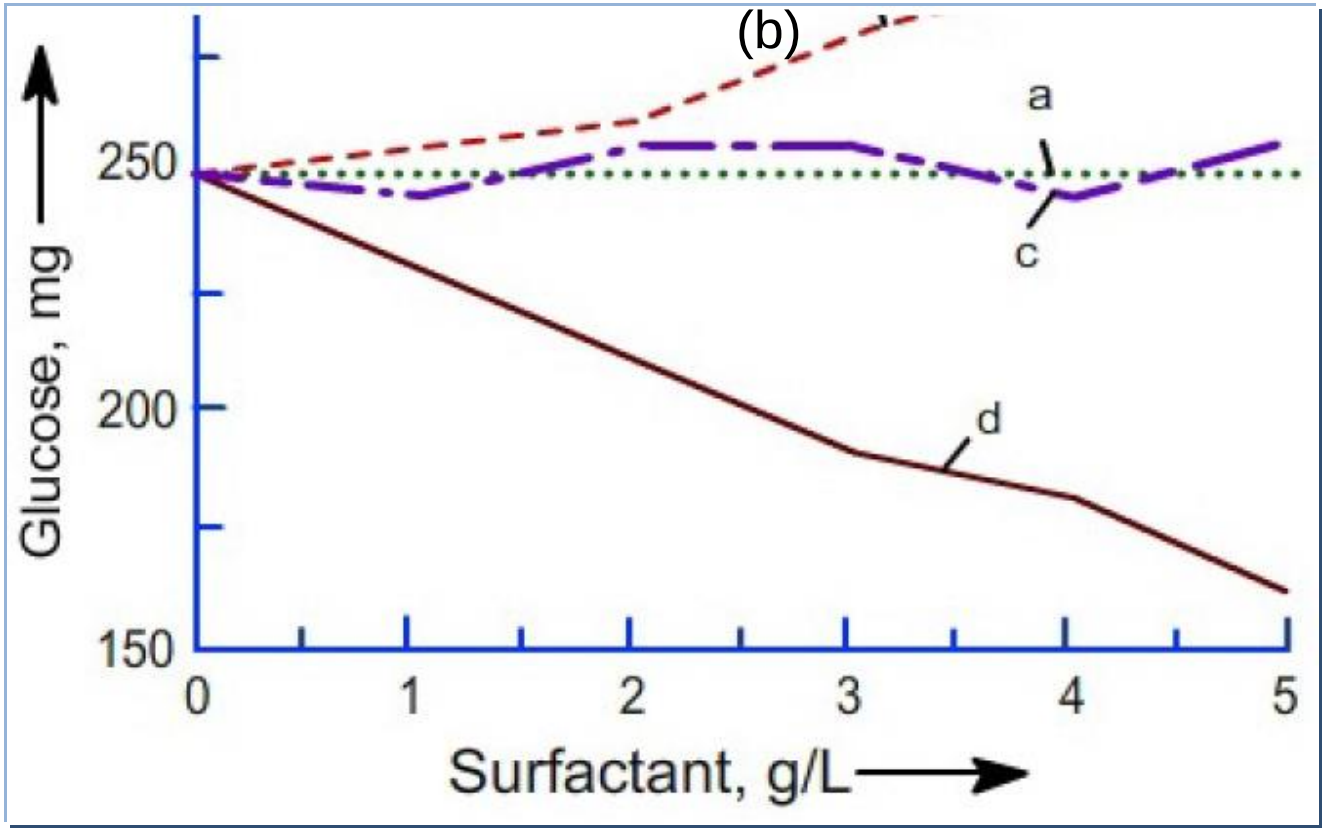
Grey cotton has poor absorbency

(Surfactants can be used to improve the wetting of fabric and dispersion of hydrophobic impurities)

- In general, anionic surfactants inhibit enzyme action

- Non-ionic surfactants are generally preferred

Effect of surfactant type of starch degradation into glucose



a) No surfactant
b) Octaphenyl ethoxylate
c) Mixture of nonionic and anionic surfactants
d) Ester of sodium sulfosuccinic acid

The optimum process conditions for various enzymes

The table given below compares the best process conditions for these enzymes

PROCESS	CONCENTRATION (gpl)	TIME (hr.)	TEMPERATURE (^{o}C)
Rot Steeping	-	10-16	30-40
H_2SO_4	5-10	3-4	40
Malt Diastase	3-20	4.5-5.5	50-60
Pancreative Diastase	1-3	6.8-7.5	50-60
Bacterial Diastase	0.5-1	6.5-7.5	60-70

High temperature enzymatic desizing

Novozymes, an enzyme producing organization, introduced an alkaline amylase with a broad activity spectrum, capable of application over the pH range 5 – 10 and from 20 - 85° C. This has enabled combined desizing and bio-scouring to achieve commercial acceptance in a number of textile mills.

Enzyme product	Temp. (°C)	pH
Aquazym® PS	85-115	5.5-6.5
Aquazym® SD	20-85	5.5-6.5

Oxidative desizing

In oxidative desizing, the size is removed by **oxidative degradation**

Oxidative desizing

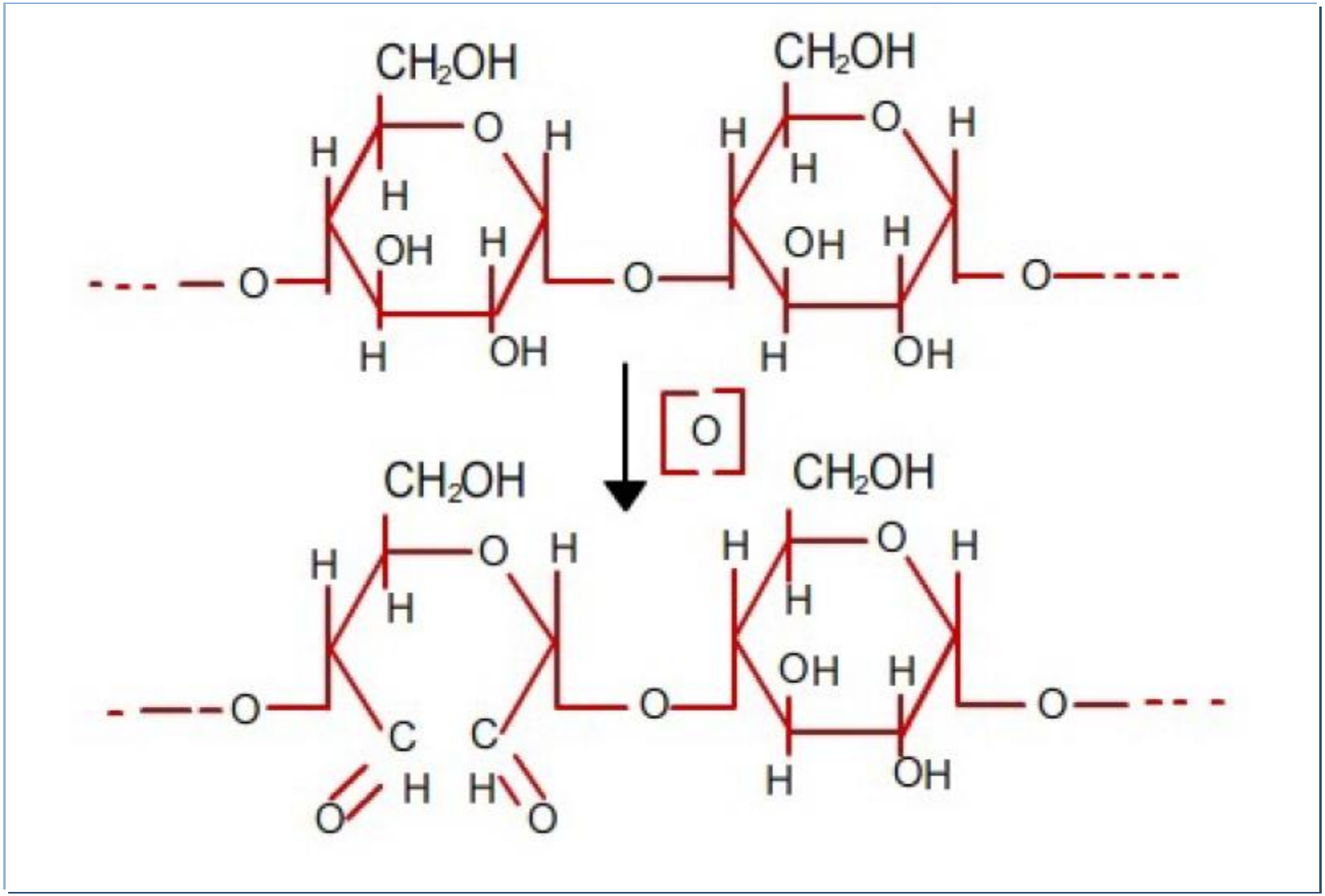
Hydrolytic desizing is successful in case of natural starch but it does not remove sizes based on synthetic polymers.

- It is particularly useful when the size is based either on a synthetic polymer like high MW. PVA (poly vinyl alcohol) or is a mixture of synthetic and natural polymers.

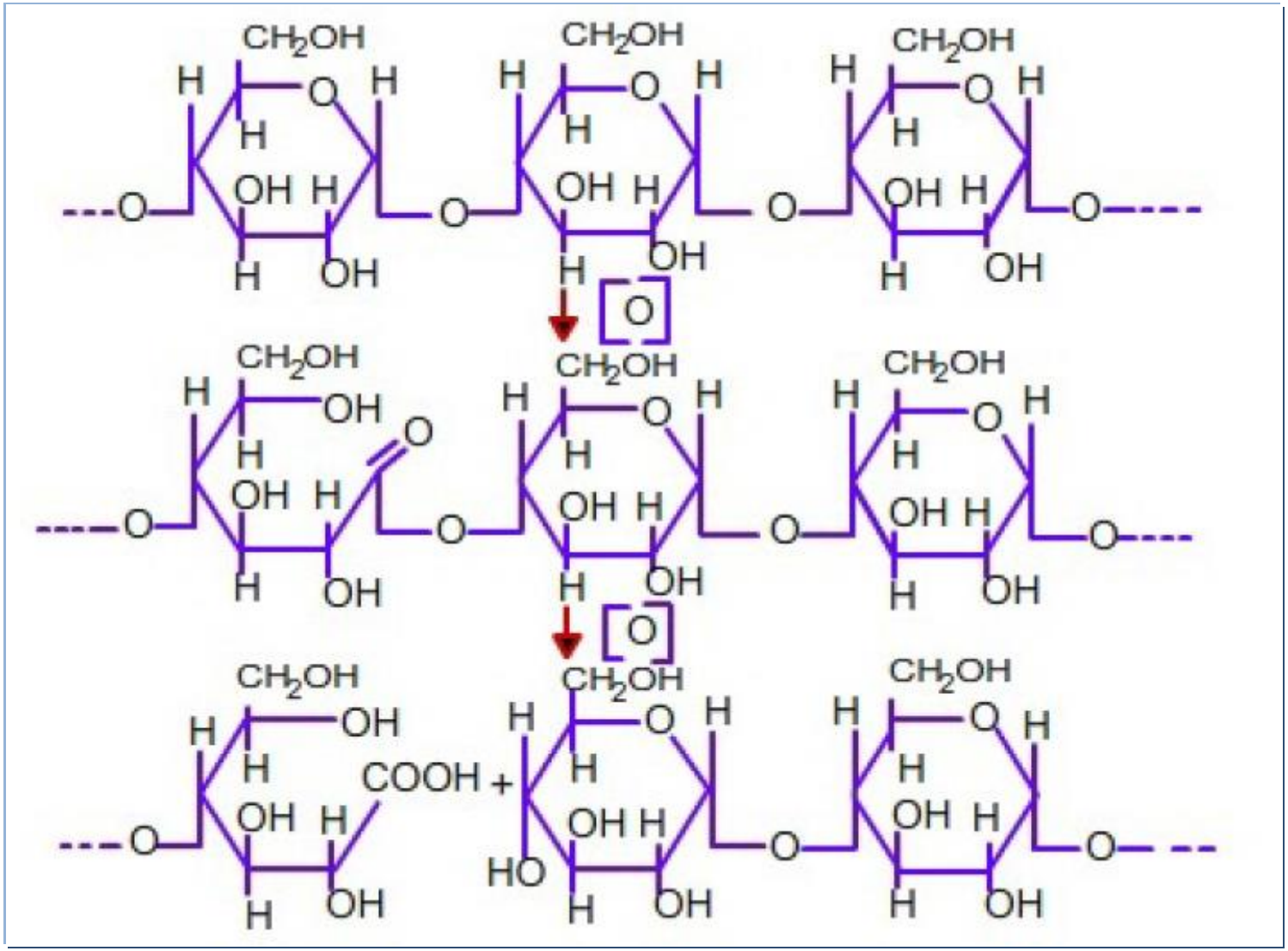
Oxidative agents used in oxidative desizing:

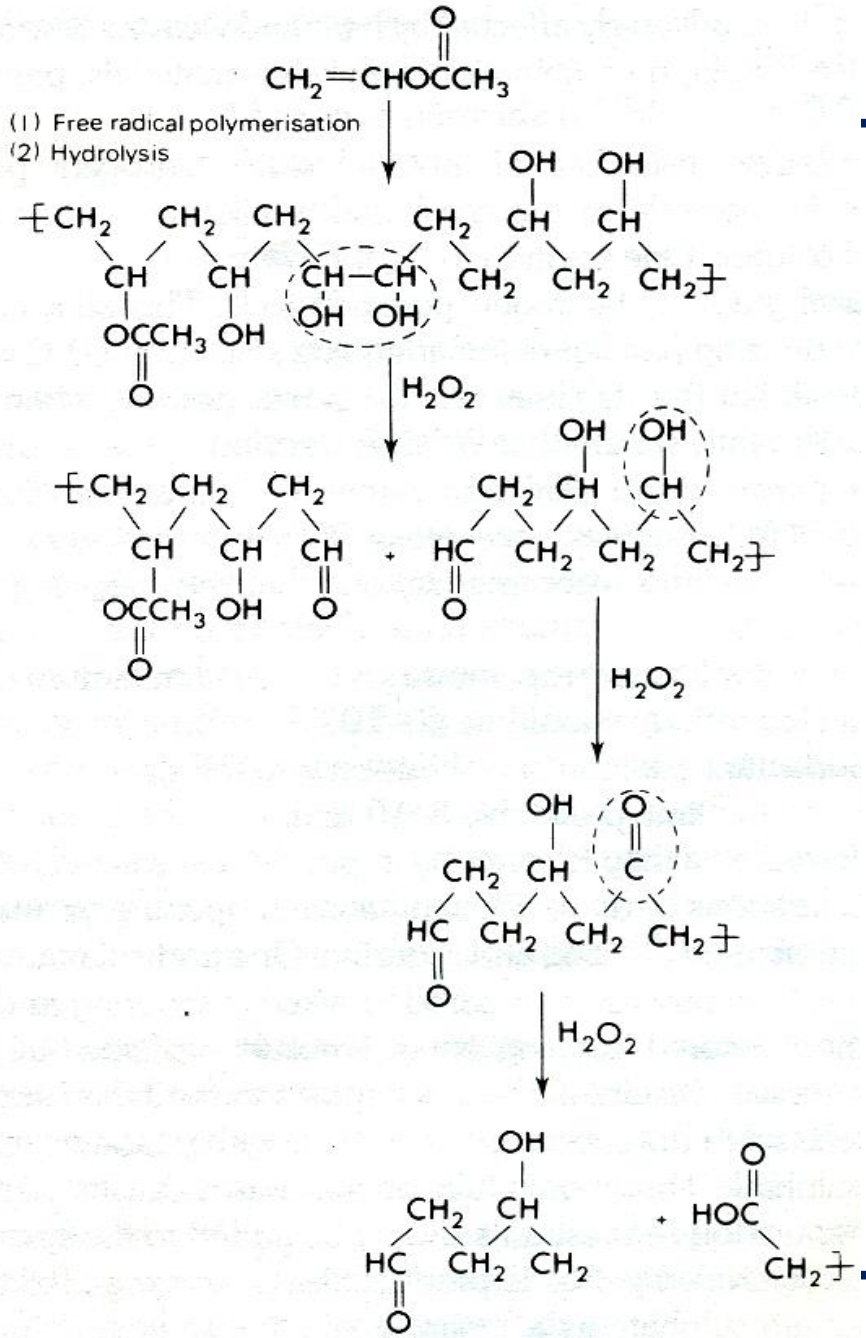
- Sodium chlorite ($NaClO_2$)
- Sodium bromite ($NaBrO_2$)
- Hydrogen peroxide (H_2O_2)
- Sodium and Potassium persulphate ($Na_2S_2O_8$, $K_2S_2O_8$)
- Peroxy monosulphuric acid (H_2SO_5)

(a) Oxidation of starch – ring opening



(b) Oxidation of starch – chain scission





Mechanism of oxidation of Poly vinyal Alcohol with Hydrogen Peroxide during Desizing Process

Sodium chlorite ($NaClO_2$)

With sodium chlorite, the desizing is carried out under alkaline conditions.

Sodium bromite ($NaBrO_2$)

- Sodium bromite is a powerful oxidant for starch
- Breaks glucose ring by breaking C_2-C_3 link and produces a dialdehyde. The dialdehyde dissolves in alkaline solution. hence desizing is followed by an alkaline wash
- Acts best at pH 10
- Works at room temperature for short durations and is highly efficient
- However, 50% of the bromite reacts with impurities and increases pollution problem of the effluent

Sodium and potassium persulphate ($Na_2S_2O_8$, $K_2S_2O_8$)

With persulphates, desizing is carried out in alkaline medium.

Peroxy monosulphuric acid (H_2SO_5) / Hydrogen peroxide (H_2O_2)

Peroxy compounds are sensitive to presence of heavy metal ions, a sequestering agent is usually employed.

Hydrogen peroxide may be used in a similar way. Conditions are generally kept mild (pH-6-8) and washing is done in alkaline conditions.

Desizing Conditions

Methods	Chemical	Temp. (°C)	Time	pH
Rot	None	30 (RT)	16 -24 hrs.	7.0
Acid	HCl (0.5 -1.0 %)	30 - 60	2 -8 hrs.	1.0 -2.0
Enzyme	0.5 -1.0%	60 - 70	1 -2 hrs.	6.0 -7.0
Oxidative (Persulphate)	0.3 -0.5%	100	10 min	14.0

Assessment of desizing efficiency

TEGEWA violet scale (industrially)

The TEGEWA Association (established in 1951 in Wiesbaden) comprises of manufacturers of the following:

Textile, paper, leather & fur auxiliaries, colourants, surfactants, complexing agents, antimicrobial agents, polymeric flocculants, cosmetic raw materials, pharmaceutical excipients and allied products

The name being an amalgam of these key activities:

“TExtilhilfsmittel” (textile auxiliaries)
“**GErbstoffe” (**tanning agents**)**
“WAschrohstoffe” (detergent raw materials**)**

Reagent preparation

Put potassium iodide [10 g of KI (100%)] in 100 ml of water; then add 0.6358 g of iodine (100%).

Stir well until iodine is completely dissolved in the KI solution. After this, add 800 ml of ethanol.

Then by adding water the volume should be raised to 1000 ml.

Testing Method

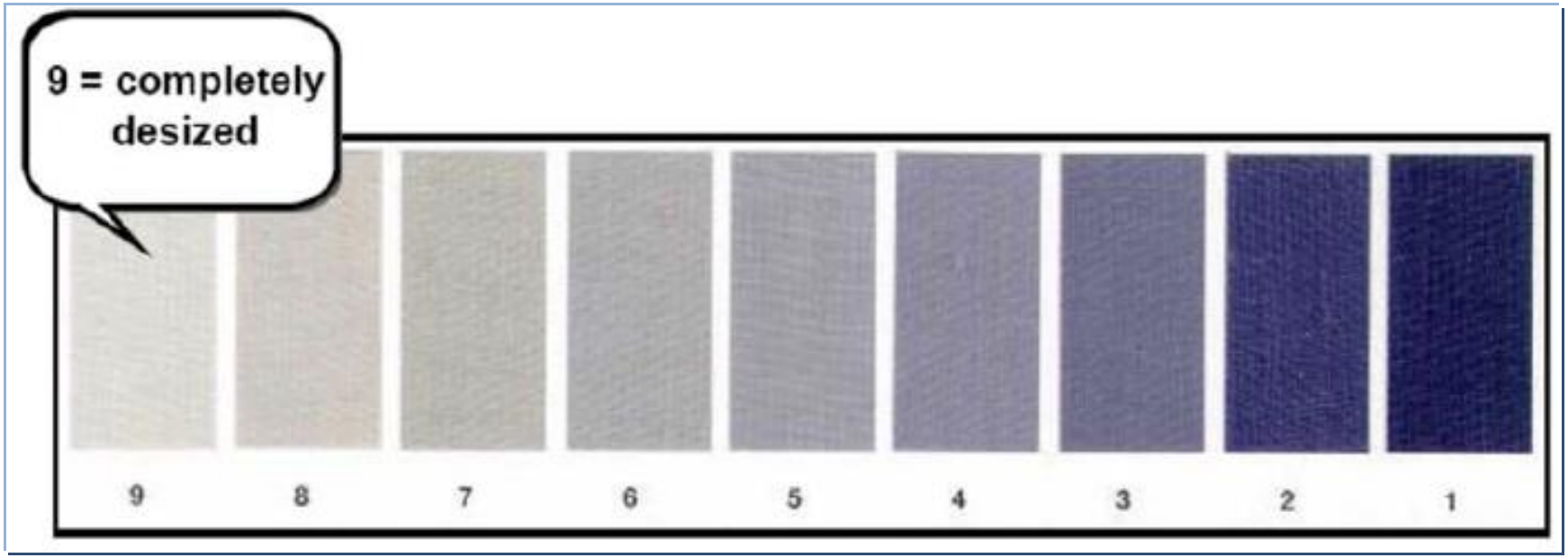
Put one or two drops of the above solution on a fabric. Rub it gently and then assess the colour change as per the TEGEWA scale. Before testing, the fabric should be cold and there should not be any residual alkalinity in it

Assessment: TEGEWA violet scale (1-9)

No Colour Change = No starch is present

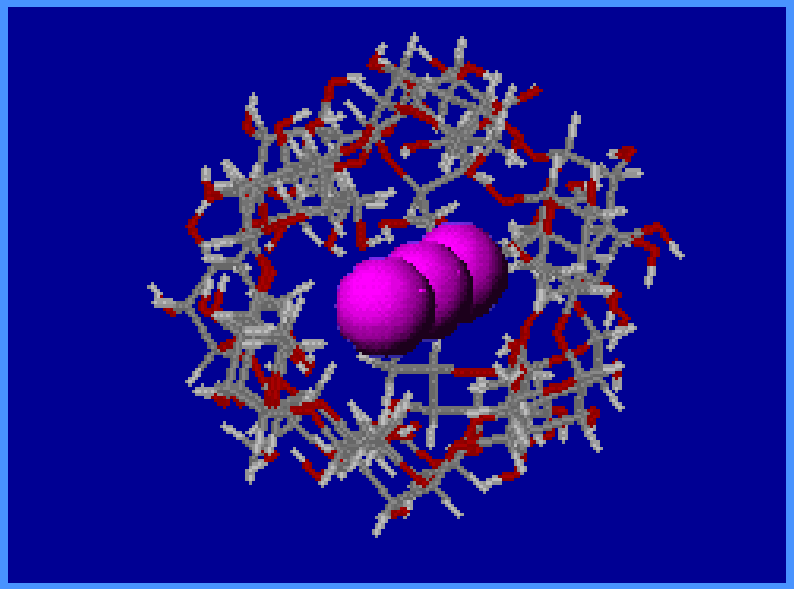
Pale blue to bluish violet = Presence of starch size or a blend of starch+ synthetic size

Brown = Presence of modified starch or a blend of modified starch/PVA size



Starch - Iodine Complex

$$I_2 + I^- \longrightarrow I_3^-$$



Iodine slides into starch coil
to give a blue-black color

C. Ophardt, c. 2003

Starch Test:

Add Iodine-KI reagent to a solution of starch or to starch. A blue-black colour results if starch is present. If starch amylose is not present, then the color will stay orange or yellow. Starch amylopectin does not give the colour, nor does cellulose, nor do disaccharides such as sucrose in sugar.