WHAT IS AN ENZYME

Enzymes are bio-catalysts that are synthesized by living cells, have protein structure and biological activity. Reactions occurring in all organic cells depend on enzymes.

Enzymes are produced by living organisms and can remain active for a long time under appropriate conditions after the cells lose their vitality, but they are not alive. Although it is not easy to practically extract the enzymes from microorganisms, it is possible to obtain them using high technology.

Enzymes have 3 basic properties

1. Enzymes are composed of proteins.

2. The catalytic activity of enzymes depends on the specific structure of the protein.

3. Enzymes are not passive catalysts, but active molecules that act by forming intermediate complexes with their substrates

We have previously defined enzymes as catalysts of biological origin, with a protein structure. Enzymes differ from other catalysts in three important ways.

1. Enzymes work extremely fast

Enzymes carry out reactions much faster than other catalysts. Some enzymes are known to affect millions of molecules in a minute.

2. Enzymes catalyze reactions specifically

Each enzyme selectively catalyzes only a specific reaction. Whereas most catalysts catalyze a wide variety of chemical reactions, enzymes usually catalyze only one type of reaction specifically. In some cases this selection is astonishing.

When an enzyme affects a chemical compound made of hundreds of different atoms, it selects a specific region of the molecule and removes or adds one or two atoms or a functional group without disturbing the main structure of the molecule. Even if another chemical compound is very similar to the substrate structure and some of the groups are slightly different, the same enzyme can distinguish between the two substances.

3.Enzymes accomplish biochemical reactions with less energy and at lower temperatures

A chemical reaction that requires very high temperatures and energy expenditure under normal laboratory conditions can be achieved with less energy and body temperature thanks to enzymes. Enzymes reduce the activation energy of reactions more effectively than inorganic catalysts. Thus, they enable reactions to proceed at lower temperatures and with less energy.

The ability of enzymes to utilize their activities at maximum levels depends on two important parameters. Although temperature and pH vary according to the biological properties of the enzymes, maximum activity is achieved if the optimum values are complied with in practice.

ENZYME PRODUCTION

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The production of enzymes by fermentation can be divided into two as deep fermentation method and surface fermentation method. The deep fermentation method was mainly used in the years following World War II and completed its development in the seventies and eighties and reached its current form. Surface fermentation in solid media has been practiced in Far Eastern countries for hundreds of years in the production of some traditional foods.

Today, various enzymes are produced from bacteria, yeasts and molds by deep fermentation. This method is generally preferred by western enzyme producers. Solid fermentation is mainly used by Far Eastern enzyme producers to produce enzymes from molds.

Enzyme production by fermentation, assuming a suitable producer microorganism is present

- ✓ Vaccine fermentation
- ✓ Solid-liquid separation
- ✓ Concentration-purification
- ✓ Standardization stages.

In the textile sector, enzymes are used for the following purposes

- ✓Enzymatic desizing
- ✓Enzymatic antipilling
- ✓Enzymatic antiperoxide

WHAT IS HASHIL

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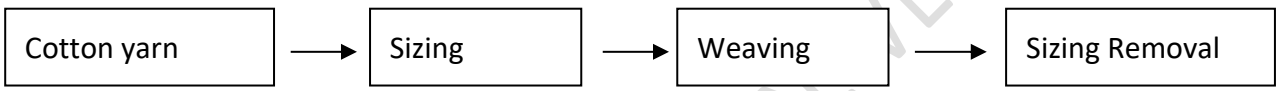
During the weaving of fabrics, the warp yarns are subjected to the back and forth of the shuttle and other mechanical stresses. Therefore, cotton yarns are sizing before weaving to give them the strength, smoothness and lubricity necessary for the weaving process.

The materials used for sizing (sizing agents, sizing) are generally natural or artificial macromolecular fluid substances that can form a film on the fiber and have a certain adhesion and adhesion ability to the fibers.



Sizing agents are categorized in two groups as natural and artificial.

A. Sizing agents from natural sources:

1. Starch and derivatives (Natural starch, partially degraded and chemically modified starch derivatives)
2. Cellulose derivatives (carboxymethylcellulose, methylcellulose, oxyethylcellulose, etc.)
3. Egg white sizing agents (glue, gelatin)

B. Artificial sizing agents:

1. Styrene-maleic acid copolymer
2. Polyvinylalcohols
3. Polyacrylates

HASHIL REMOVAL

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Cotton fiber contains 8-12% foreign matter in its raw state depending on its source. In cotton woven fabrics, around 10-15% foreign matter comes from sizing materials.

Before the processes of boiling and bleaching, the first wet process in cotton weaving bleaching is the removal of the sizing agent.

Desizing is done for the following purposes.

1. Since sizing agents have hydrophobic properties, they reduce the absorption and wetting ability of the textile material. This adversely affects the efficiency and effectiveness of the processes and the smoothness of the result obtained.
2. The hard and drape-preventing behavior of the sizing is an undesirable feature. For these reasons, the sizing on the woven fabric must be removed.

According to the structure of the materials used as sizing agents, desizing conditions vary. The solubility of sizing agents in water is different from each other. Synthetic sizing agents (such as polyvinyl alcohol, polyacrylate...) and cellulose derivatives such as carboxymethylcellulose are soluble in water. Therefore, they are easy to remove from the woven fabric. Starch is a water-insoluble sizing agent.

Sizing methods

- Boiling method
- Acidic and basic washing method
- Enzymatic desizing method

REMOVAL OF STARCH SIZING

Water insoluble starch sizing is not as easy to remove from fabric as synthetic sizing agents. The essence of removing starch sizing is based on first breaking down the starch molecules to make them water soluble and then washing away these water soluble breakdown products.

If starch and synthetic sizing agents are used in combination, starch is first made water soluble and then desizing is carried out with a suitable washing agent during the washing process.

Starch macromolecules can be broken down according to various methods. Treating the fabric with strong chemicals such as acids, bases or oxidizing agents are some of these methods. However, the difficulty in these methods is to provide working conditions that will not damage cellulose macromolecules, which is a polysaccharide consisting of glucose building blocks, while breaking down starch macromolecules.

In recent years, starch degrading enzymes (amylases) have been preferred for starch desizing due to their high efficiency and specific effects.

ENZYMATIC DESIZING

The most reliable method for starch desizing is enzymatic desizing. The effective enzyme in breaking down starch sizing is amylase enzyme. Amylases are of two types: alpha and beta amylase. Alpha amylases convert starch molecules in the sizing bath into dextrin molecules. Beta amylases convert starch to maltose.

HOW ENZYMES REMOVE ICHASHI

The active end of the amylase enzyme used in desizing has a structure that is compatible with the starch molecule, i.e. its substrate is starch. Thanks to this structure, first the starch molecule and the active end of the enzyme combine to form a complex and then this part of the starch is hydrolyzed. During this process, the selectivity of the enzyme comes into play and it only breaks down the starch and does not damage the fabric. After the fabrics are immersed in the enzyme flota, the desizing process starts. The process continues with the swelling and disintegration of the starch and the dissolution of the sizing degradation products.

After the starch is completely broken down, the sizing agent becomes water soluble and can be washed off the fabric. Washing can be done in ower-flow, jigger or other washing equipment depending on the structure of the fabric. The important factors for the washing operation are the flotte ratio, flotte flow rate, fresh water supply and especially the temperature and composition of the washing liquor.

DESIZING PROCESS WITH ENZYMES

The process of desizing with enzymes is divided into 3 parts.

1)**EMPRENING STAGE:** Absorption of the enzyme solution (sizing bath) by the fabric.

2)**INCUBATION STAGE:** The breakdown of the sizing by the enzyme.

3)**WASHING STAGE:** Removal of shredded products from the fabric.

IMPREGNATION STAGE

In order to remove the sizing completely, some factors need to be considered in this process. If high temperatures are not to be used, it may be advisable to pre-wash the fabric with a nonionic wetting agent at 800C or higher. Hot pre-washing is useful for fabrics that are difficult to wet or contain acidic or antimicrobial substances that can damage the enzyme.

The temperature, pHS and Ca+2 ion content of the desizing bath should be kept within the recommended limits to ensure enzyme stability. The control of these parameters is very important. Because outside the specified temperature and pH values, the enzyme may become inoperable. It should be noted that enzymes can only be used in combination with nonionic chemicals.

INCUBATION PHASE

Upon contact of the enzymeS solution with the sizing, the starch dissolves in water and starts to degrade into dextrin. Although long incubation time requires low enzyme concentration, short incubation time requires high enzyme concentration and high incubation temperature.

The desizing process continues until the disintegrated sizing products are removed from the fabric. The best way to remove the dissolved sizing from the fabric is to wash with the highest possible degree of detergent. The addition of NaOH is recommended for heavy fabrics.

CONSIDERATIONS IN THE ENZYME DESIZING PROCESS

- Enzymes are significantly affected by environmental conditions. They can become inactive after certain pH and temperatures.
- Metal ions, surfactants, oxidizing and conservative materials can affect the activity of enzymes.
- Anionic surfactants negatively affect the activity of enzymes. Therefore, nonionic materials should be used as wetting agents.
- Be very careful in the selection of wetting agents and dispersing agents because some of them are enzyme poisons. Also, it should be checked whether the desizing filtrate affects the enzyme effect or not.
- Water quality is important when working with enzymes. The Ca+2 ion in the water positively affects the enzyme by stabilizing it.

CHARACTERISTICS THAT MAKE ENZYMATIC DESIZING PROCESS SUPERIOR TO OTHER METHODS

- Enzymes act specifically during the desizing process, breaking down only the starch, without any damage to the cellulosic fibers.
- It does not harm the environment like other chemical materials, the waste water from the process is cleaner than the waste water obtained by other methods.
- Enzymes are biodegradable easily and rapidly.
- The 21st century is set to be the biotechnological century. All industries will use environmentally friendly living materials of living nature.

CONTROL OF DESIZING PROCESS

The KI/I2 test is used to determine whether the desizing process is complete. This is a quick and easy test. After thoroughly rinsing the desizing fabric, it is wetted with a few drops of 0.005 N iodine solution.

Light yellow color: Starch sizing has been completely removed

Blue color : Indicates that some of the starch remains on the fabric.

Preparation of iodine test solution:

Dissolve 18 grams of potassium iodide and 13 grams of iodine in one liter of water. 5 ml of this stock solution. It is taken and completed to 100 ml. and the test solution is prepared.

The stock and test solution should be stored in dark bottles and the iodine strength should be checked on starch sizing fabric before each use.

WHAT IS ANTI-PILLIING

Biological polishing finish, (antipilling) is an enzymatic wet treatment for cotton and viscose fabrics, which serves to destroy the fiber ends coming out of the fabric, thus giving shine and a pleasant feeling of use.

Hair balls consisting of small strands protruding from the surface of the fiber are called “pills” in textile language. These pills can be a serious quality problem as they give the fabric an unattractive, knotted appearance.

HOW ENZYMES MAKE FABRIC FLUFF EXPENSES

The enzymes used for biological polishing are cellulase enzymes, usually of the acidic and neutral types. Cellulase enzymes work on the principle of hydrolyzing the cellulose fragments present at the top level. These enzymes provide a special modification of the yarn surface. Especially the small protrusions and small fibers on the surface of the cotton fiber are weakened by the effect of the enzyme and can easily break away from the fiber. The effects of the enzymes are specific, they do not damage the fabric while removing fiber ends. In fact, hydrolysis only weakens the fiber ends that come out of the fabric structure, whereas the friction of the fabric against itself and the metal tears the fiber away from the body of the fabric.

BENEFITS OF ANTI-POLYMERIZATION TREATMENT WITH ENZYMES

Fabric after antipilling;

- ✓ It tends to grow less hair,
- ✓ It becomes softer and smoother,
- ✓ It has superior color brightness.

POINTS TO CONSIDER IN ANTI-POLYLYNG WORK WITH ENZYMES

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- The pH and temperature at which the enzyme works must be adjusted very carefully.

- Friction is needed to ensure that the fibers weakened by the enzyme are separated from the fabric surface. Washing should be done in machines such as jet and ower-flow where the goods are mechanically exposed to friction.

- It is very important that the enzyme is diactivated after the end of the process. The non-diactivated enzyme continues the process and may affect the subsequent stages. It causes dusting especially during the drying process in towels.

- The adequacy of the antipilling process can be determined by weight loss. 3-5% weight loss is a good result means that the enzyme can be applied to woven fabrics as well as knitted fabrics.

- Cellulase enzyme can be applied to woven as well as knitted fabrics. Cotton fabric, polyester-cotton blend fabrics, linen and ramie fabrics and other cellulose fiber fabrics. Cannot be used on synthetic fabrics.

CATALASE ENZYME

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Natural fabrics such as cotton are bleached with hydrogen peroxide before dyeing. Bleaching is done with highly reactive chemicals and any peroxide residue can affect the subsequent dyeing process. Therefore, peroxide residues need to be removed.

Neutralizing the bleaching bath with reducing reagents is a traditional method, but the dose must be strictly controlled. Enzymes have emerged as a more suitable alternative because they are faster and cheaper to use. Even a small dose of antiperoxide (catalase) enzymes is capable of breaking down hydrogen peroxide into water and oxygen.

The hydrogen peroxide remaining after bleaching is degraded by enzyme diactivation as follows.

Catalase

$$2H_2O_2 \longrightarrow O + 2H_2O$$

If thiosulfate is used instead of the enzyme, the situation is as follows.

$$2H_2O_2 + Na_2S_2O_3 \longrightarrow 2NaHSO_4 + 3H_2O$$

If the amount of tiosulfate is used less;

$$5H_2O_2 + Na_2S_2O_3 \longrightarrow 2NaHSO_4 + 3H_2O + H_2O_2$$

(oxidizes dye groups) If the amount of

thiosulfate is used in excess;

$$4H_2O_2 + 2Na_2S_2O_3 \longrightarrow 2NaHSO_4 + 3H_2O + 2Na_2S_2O_3$$

(Oxidizes dye groups)

Reactions occur and the groups released oxidize the dye groups.

ADVANTAGES OF USING AN ANTIPEROXIDANT ENZYME

The advantages that emerge when comparing hydrogen peroxide removal with conventional methods and the use of enzymes can be listed as follows.

1. Catalase enzymes are specific for hydrogen peroxide and are used before the dyeing process. Because dyes are sensitive to hydrogen peroxide and other chemicals used for its diactivation. Catalase enzymes do not react with dye groups. Therefore, color differences due to hydrogen peroxide and reducing agents are prevented.

2. No harm to the environment as residual hydrogen peroxide breaks down into water and oxygen

3. The enzyme is biodegradable.

4. Preparation time for dyeing is reduced, saving time and energy. Amount of water required for rinses. Saves at least as much water and wastewater as a bath.

5. Traditional hydrogen peroxide binders have carcinogenic effects. Therefore, it is healthier to use enzymes.

DETERMINATION OF THE AMOUNT OF PEROXIDE IN THE BATH AFTER ANTIPEROXIDANT TREATMENT

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Hydrogen peroxide test papers can be used to determine whether hydrogen peroxide is still present in the bath after treatment with enzyme or peroxide can be determined by potassium permanganate volumetric method.

METHOD : Take 2 or 10 ml. of the hydrogen peroxide bleaching solution, add it to a flask, add dilute acid and immediately titrate with 0.1 N KMnO4 until pink.

CALCULATION : 1 ml. 0.1 N KMnO4 0.0017 gr. When H2O2 is 100% equivalent, X ml. bleaching flotte sample 0.0017 gr. x A gr. H2O2 will contain 100%.

$$\% \quad \frac{0.0017 \times A \times 1000}{X} = \text{gr/lt } H_2O_2 \quad 100$$

Calculation for 35% H2O2: 4.86 x

$$\frac{A}{X} = \text{gr/lt } H_2O_2$$

Calculation for 50% H2O2:

$$\frac{4.28 \times A}{X} = \text{gr/lt } H_2O_2$$

H2O2 DEACTIVATION PROCESS WITH ANTIPEROXIDANT CATALASE ENZYMES

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> Catalase enzymes have the highest activity at pH : 6-9 and at maximum process temperatures of 700C.

> Catalase enzymes can work in harmony with commonly used surfactants and H2O2 stabilizers.

The diactivation process with catalase enzymes can be carried out as follows;

1. The bleaching bath is drained.

2. A rinse is carried out to remove unwanted impurities from the bleaching process that will affect the dyeing process.

3. Fresh water is added to the bath in accordance with the dyeing liquor.

4. The pH value of this fresh water will be around 8-8.5 and the temperature will be around 40-450C. After checking, if there are differences, necessary corrections should be made.

5. After the catalase enzyme is added, the diactivation process starts.

6. After 10-15 minutes, the amount of hydrogen peroxide is checked. If there is still hydrogen peroxide, the process is continued for another 5-10 minutes.

7. Dyeing is started in the same bath. If the fabric to be dyed is very dirty or if there are impurities that will affect the dye, it is recommended to empty the bath and take a new dye bath.

A CASE STUDY WITH CATALASE ENZYMES

PROCESS SEQUENCE;

1) CASAR OPERATION
2) HOT WASH
3) BATH WITH CATALASE ENZYME