IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

An Introduction To Enzymatic Desizing On Textiles Material – A Review

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Abstract: The garment and textile industries have undergone several fascinating developments over the past 20 years. Especially textile finishing plays a crucial role in imparting value addition to textiles. Preparation is important as success of all process such as dyeing and printing depend on it. Improper preparation leads to reduced performance and value in the finished product. Fabrics received as gray cloth from the loom have unwanted matter present in them. They may be natural, or stains, oils, waxes and sizes acquired during manufacture of the fabric. Elimination of these impurities is imperative before applying any other finish as they may hinder with subsequent processes. The impurities are removed by preparatory processes. This review discusses the topic of Enzymatic desizing.

Index Terms **-**Fabric, Starch, Desizing, Enzymatic desizing, Dyeing.

I. Introduction

Desizing is the process in which the sizing materials are removed from the warp yarns of the woven fabrics. Warp yarns are coated with sizing agents prior to weaving in order to reduce their frictional properties, decrease yarn breakages on the loom and improve weaving productivity by increasing weft insertion speeds. If the sizes are present, they may hinder dyeing, printing and finishing processes. Desizing must be done before other wet processes of bleaching, mercerizing, dyeing, printing or finishing are carried out. The methods and chemicals used for desizing depend on the type of sizing agent used.
Sizing products are generally natural polymers (e.g., Starch) as is or modified to improve certain of its properties with respect to the yarn to be sized (e.g., Carboxymethyl starch (CMS)) as well as synthetic polymers and co-polymers, (e.g., Polyvinyl Alcohol (PVA), Polyacrylate (PAC) etc. Any one or a mixture of two or more sizing products are used along with waxes, fats and lubricating agents.

The major desizing process are:

1. Enzymatic desizing of starches on cotton fabrics
2. Oxidative desizing
3. Acid desizing
4. Removal of water-soluble sizes
5. Bioscouring

ENZYME DESIZING

Enzyme desizing is the most widely practiced method of desizing starch. Enzymes are high molecular weight protein biocatalyst that are very specific in their action. Enzymes are named after the compound they break down, for example, Amylase breaks down amylose and amylopectin, Maltase breaks down maltose and Cellulase breaks down cellulose. For desizing starch, amylase and maltase are used. Cellulase, on the other hand, is used for finishing cotton fabrics

a. Alpha and Beta Amylase

There are two types of amylase enzymes, Alpha and Beta. Both alpha and beta amylases hydrolyse glucosidic linkages in starch; however, the point along the polymer chain at which the reaction occurs differs between the two. Alpha amylase attacks the chain at random points. The molecular weight of the starch is rapidly reduced facilitating complete removal.

Beta amylase, on the other hand, starts at a chain end removing one maltose unit at a time. The molecular weight is gradually reduced thereby taking a longer time to complete breakdown. In addition, the action of beta amylase is stopped at the 1,6 branch glucosidic linkage found in amylopectin leaving relatively high molecular fractions.

Alpha amylase is the predominate enzyme used in desizing starch. A major advantage favoring enzymes is that they not damage cellulosic fibers. On the other hand, cellulase enzyme will destroy cellulose and while it is not used in desizing, it has found a specialty application in the production of stone-washed denim look.

There are three major sources for amylase enzymes. Malt Enzymes are extracted from the fermentation of barley grain which produces a mixture of alpha and beta amylase. Pancreatic Enzymes are extracted from the pancreas of slaughtered cattle which is mainly alpha amylase and Bacterial Enzymes are prepared from the bacteria "bacillus subtilin". This too is mainly alpha amylase.

b. Effect of Temperature, pH and Electrolytes on Enzymatic Desizing

The activity of enzymes increase with temperature; however, above a critical temperature, enzymes are deactivated. The effectiveness of enzymes exhibit a maximum at certain temperatures, usually 40 -75 0 C. Bacterial enzymes are the most thermally stable and can be used up to 100 0 C under special stabilizing conditions. Certain salts increase the activity of specific enzymes. Pancreatic amylase is ineffective without the addition of salt. A combination of sodium chloride and calcium chloride increases the stability of bacterial amylase above 160 0 F. Activity of amylase enzymes are also optimum at specific at specific pH. Table 1 summarizes the optimum conditions for the various sources of enzymes.

ENZYMES IN TEXTILE PROCESSING

Enzymes have found wide application in the textile industry from fabric to garment finishing for improving efficiency of processing and enhancing aesthetic appeal. Enzymes are used in the textile industry because they:

- Act only on specific substrates.
- Can replace harsh chemicals.
- Operate under mild conditions.
- Accelerate reactions.
- Are safe and easy to control.
- Are biodegradable.

The most important advantage of an enzyme is its specific activity, which describes the enzymatic strength towards a particular substrate. Enzyme activity is a measure of substrate molecules converted into product in a unit of time, per molecules of enzyme. In most instances specific activity is expressed as mole of substrate per minute (unit of enzyme activity) per mg of enzyme protein (U/mg protein). Enzymes speedup a particular chemical reaction by lowering the activation energy for the reaction. They achieve this by forming an intermediate enzyme substrate complex, which alters the energy of the substrate such that it can be more readily converted into the product.

The enzyme itself is unaltered at the end of the reaction, thus acting as a catalyst. The enzyme changes the reaction kinetics, allowing equilibrium to be reached much more rapidly. This is because the reaction of the enzyme with the substrate provides a new reaction pathway with lower transition state energy, thereby facilitating a more rapid conversion of substrate to product.

Besides these, enzymes differ from normal chemicals in some respects. One of them is, there is a difference between the activity of an enzyme and its concentration. The same level of enzyme can show different levels of activity, ie, it can act faster or slower depending on conditions such as pH and temperature. As the enzymes are very specific in action, as each type can affect only one chemical bond, more control over final effects is easily achieved. In terms of effluent, enzymes are quite clean and affect effluent only mildly, if at all. Many common chemicals used in textile manufacturing cause toxic products to be released in the effluent. Enzymes are even clean and 'green' to manufacture as well.

Depending on substrate specificity, the commonly used enzymes during textile processing are:

- Amylases for Starch.
- Cellulases for Cellulose.
- Catalases for Hydrogen Peroxide.
- Pectinases for Pectins.
- Proteases for Proteins.

Conclusion

Sizing is necessary to ensure that yarns are adequately protected during weaving as the modern looms operate at very high speeds, causing excessively high abrasion to the yarn. Starch is the preferred sizing agent for cotton and blends. To ensure that fabric is well prepared for dyeing and further processing, all size must be removed adequately and uniformly. Failure to remove the size ingredients can result in poor absorbency, uneven dyeing, poor batch-to-batch shade reproducibility, improper printing and inadequate finishing resulting in poor fabric hand feel. Thus, enzymatic desizers are deciders of effective fabric processing.

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