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SADRŽAJ

U FINANSIRANJU ČASOPISA UČESTVOVALO MINISTARSTVO PROSVETE, NAUKE I TEHNOLOŠKOG RAZVOJA REPUBLIKE SRBIJE

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REČ UREDNIKA

U istoriji okupljanja stručnjaka tekstilaca važno je napomenuti organizacije, Društvo diplomiranih tekstilnih tehničara, osnovano u Novom Sadu 1935. godine, pa potom i u Beogradu i Leskovcu. Već 1937. godine, pokrenut je prvi stručni list „Diplomirani tehničar" u kome se kao autori pojavljuju tekstilni tehničari sa svojim stručnim člancima o tekstilnoj proizvodnji, organizaciji i tehnologiji u tekstilnim fabrikama. Pomenućemo neke od tekstilnih tehničara: Iliju Mihajlovića, Oskara Kelnera, Milorada Grozdanovića. Ta malena grupa tekstilnih tehničara je radila u tekstilnoj industriji naše zemlje sve do 1941. godine. Za vreme Drugog svetskog rata, od 6. aprila 1941. godine pa sve do 1945. godine, prestaje aktivnost svih društava tekstilaca koji su se rasuli po zarobljeničkim logorima, delovali kao revolucionari, a neku su se povukli iz svake javne delatnosti.

Društvo hemičara i tehnologa Srbije, a u njihovom sklopu i sekcija tekstilaca, formirana je 1949. godine. Prvi predsednik Sekcije tekstilaca u sklopu Društva hemičara i tehnologa Srbije bio je Oskar Kelner. Povećanje broja članova, kao i specifilni zadaci tekstilnih tehničara i inženjera polako su tekstilce odvajali od Društva hemičara, pa je 30 jula 1953. godine u Beogradu održana osnivačka skupština Društva inženjera i tehničara tekstilaca Srbije. Izabrana je prva uprava i određeni su zadaci čitavom članstvu, koji je je u tom momentu brojilo 580 aktivnih članova. Upravu su činili: predsednik Ilija Mihajlović, potpredsednik Dušan Đukić, sekretar Branko Vešović, zatim Natalija Pavlović, Milorad Grozdanović i Kosta Vinokić. I tako je počelo. Sledili su brojni naučni skupovi, savetovanja, kongresi inženjera i tehničara tekstilaca, saradnja sa ostalim društvima i savezima, izdavanje stručnog lista „Bilten" do 1953. godine, a od tada do današnjih dana, naučno stručni časopis „Tekstilna industrija", koji će u godini koja je pred nama proslaviti svoj mali jubilej i 65 godina neprekidnog publikovanja.

Za prvog glavnog urednika časopisa izabran je Dušan Đukić, a tehničkog urednika Branko Vešović, koji od 1958. godine postaje i glavni i odgovorni urednik časopisa. Tehnički urednik postaje prvi put lice sa stalnim radnim odnosom, novinar Milutin Vujović, koji je u časopisu bio samo te godine. Od 1959. godine, za glavnog urednika se bira Sulejman Čičić, jedan od osnivača časopisa, koji takođe na toj dužnosti ostaje samo godinu dana. Mesto glavnog i odgovornog urednika časopisa Tekstilna industrija od početka 1960. godine zauzima mr Branko Ilić, koji je položaj glavnog urednika zadržao sve do kraja 2009. godine, kada ga preuzima dr Gordana Čolović, a od početka 2017. godine glavni i odgovorni urednik postaje Prof. dr Snežana Urošević.

Povodom obeležavanja 150 godina Saveza inženjera i tehničara Srbije, zatim povodom 65 godina postojanja Saveza inženjera i tehničara tekstilaca Srbije i 65 godina neprekidnog izlaženja naučno-stručnog časopisa „Tekstilna industrija", Savez tekstilaca će organizovati u toku 2018. godine Konferenciju sa međunarodnim učešćem. Konferencija pod nazivom „Savremeni trendovi i inovacije u tekstilnoj industriji" biće održana u Beogradu na kojoj će naučni radnici, ali i stručnjaci iz prakse, iz preduzeća tekstilnog sektora iz Srbije i zemalja u okruženju, prezentovati svoje naučne i stručne radove. U danima jubileja 150. godišnjice Saveza inženjera i tehničara Srbije, ponosni smo na proteklo vreme entuzijazma ogromnog broja naših inženjera i tehničara tekstilaca, koji su svojim zalaganjem na poslu afirmisali i naš Savez, stvarajući čvrste temelje za njegovo postojanje i dalji koristan rad.

Glavni i odgovoni urednik
Prof. dr Snežana Urošević

ADVANTAGES OF ENZYME IN TEXTILE TECHNOLOGY

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Abstract: *Enzymes are high molecular weight protein biocatalysts that are very specific in their action. They have emerged to become the fastest developing segment of several industry fields. Across its different phases of theprocesses, the wet processing of textile consumes a lot of chemicals, water and energy. The textile field uses amylases, catalase, and laccase enzymes which remove the starch, degrade the excess hydrogen peroxide, the bleach and degrading lignin. The textile hemical processing with enzymes is getting global recognition rapidly, mainly due to their and eco-friendly and non-toxic characteristics, as environmental considerations is of major importance to the textile manufacturers lately. Additional advantage of the procedures including enzymes is the drastically lower requirement of chemicals energy and water thus reducing costs. So it has advantages as well in terms of ecology as in economy.*

Keywords: enzymes, application, textile industry, ecological characteristics.

PREDNOSTI ENZIMA U TEKSTILNOJ TEHNOLOGIJI

Apstrakt: *Enzimi su proteinski biokatalizatori velike molekularne mase koji su veoma specifični u svom delovanju. Upotreba enzima u tekstilnoj industriji je jedan od najbrže rastućih oblasti u industrijskoj enzimologiji. U različitim fazama tekstilnih procesa, tekstilna mokra obrada je proces u kome se troši mnogo energije, vode, i hemikalija. Enzimi koji se koriste u tekstilnoj oblasti su amilaze, katalaza, i lakaza koji se koriste za uklanjanje skroba, razgradnju viška vodonik-peroksida, beljenje tekstila i razgradnju lignina. Upotreba enzima u hemijskoj obradi tekstila brzo dobija globalno priznanje zbog svojih netoksičnih i ekoloških karakteristika kao bitnih uslova za proizvođače tekstila za smanjenje zagađenja u tekstilnoj proizvodnji. Opisani enzimski postupci su praćeni značajnim smanjenjem potrošnje energije, vode, hemikalija, vremena i samim tim troškova. Ovi postupci imaju brojne prednosti kako u pogledu ekologije, tako i u pogledu ekonomičnosti.*

Ključne reči: *enzimi, primena, tekstilna industrija, ekološke karakteristike.*

1. INTRODUCTION

Enzymes were discovered in the nineteenth century around 1833. Ever since their discovery they have been used in several industry branches. In their essence, enzymes are globular proteins, and like the other proteins, they contain long linear chains of amino acids which are folded to produce a 3D product. Every individual amino acid sequence creates a unique structure, with properties specific to it. Enzymes are very effective and specific biocatalysts. The main sources of enzymes are collected from several primary sources, such as plants, microbes and animal tissue. There are quite a few micro-organisms including *Aspergillus* and *Trichoderma* fungi, *Streptomyces,* and *Bacillus* bacteria which produce a large variety of enzymes [1, 2]. Enzymes are rapidly becoming very important, especially in the spheres of sustainable technology and green chemistry.

With pollution becoming a major concern in the last severeal decades, goverments have been impos-

ing strict regulations attempting to control the pollution causes. As a result from this, there is a greater demand for chemical processes which do not pollute the environment, or at the very least pollute the environment with a lower intensity. In particular, the textile industry and its chemical processing sector, has had a great chare in the environtment's pollution process. This is where enzymes come into play, serving as eco-friendly alternatives for several chemical processes. Use of enzymes in textile started as long as a century ago.

Enzymes can be used to prepare cotton under very mild conditions. The environmental impact is reduced since there is less chemicals in the waste and lower volume of water. This biopreparation process uses less effluent load and water, thus making the new technology a sound economically viable alternative. As an alternative to hot sodium hydroxide, enzymes are used to remove the imperfections and damaging parts of the fibre, while not affecting the cotton fibre itself.

Enzyme usage has been a tradition in textile manufacturing, specifically in the modern industries, which have regognized that enzymes are more convenient, efficient and bio-friendly, unlike their harmful chemical counterparts. The wide usage of Starch as a size agent has been accepted, as the material is readily available, is cheap, and it is based on natural and raw materials. Starch and its derivatives make up for 75% of the worldwide usage of sizing agents [3]. Use of amylase for removing of starch sizes is among the oldest applications of enzymes [4, 5]. In different cotton pre-treatment and finishing processes are used cellulases, hemicelulases, pectinases, lipases and catalases [5, 6]. Enzymes are used to treat other natural fibers as well. They are used in catalytic concentrations with low temperatures, where pH-values are near to neutral. Enzymes' high substrate selectivity ensures a gentle treatment of the goods affected. Alzo, enzymes are biologically degradable, so can be handled without any risks [7, 8].

All of the these advantages of the enzymes, combined with their specificities and catalytic activities, and the possibility of creating an genetically engineered enzyme with the desired properties, suggest that there can be a potential application of the process in the effluents treatment

2. ENZYMES AND CLASSIFICATION

Enzymes are biocatalysts, and can speed up a chemical process they participate in, which would otherwise be slower, without them being consumed in the process itself. As soon as the reaction finishes, the enzyme is released and can be used to start another reaction. Howevee, most enzymes are used just once and discarded upon the process completion.

The enzymes, are active at mild temperature. After an enzyme reaches a certain temperature, it is denaturated. They have a specific pH which maximizes their activity. Extreme pH values create electrostatic interactions within the enzyme it self, which leads to the enzyme becoming inactive. Other important factors that influence the effect of enzymatic processes are the concentration of enzyme, the time of treatment, additives like surfactants and chelators and mechanical stress [9]. For each type of reaction in a cell there is a different enzyme and they are classified into six broad categories namely hydrolytic, oxidising and reducing, synthesising, transferring, lytic and isomerising. The essential characteristic of enzymes is catalytic function. Consequently, the original attempt to classify enzymes was done according to function.

3. PROPERTIES OF ENZYMES IN TEXTILE

Because of their specific action, efficiency, mild conditions they operate in, and their biodegradability, enzymes are well suited for a whole range of industrial applications. They work on renewable raw materials only. Fruit, cereal, milk, fats, cotton, leather and wood are some candidates for enzyme conversion in their respective industry.

4. ROLE OF ENZYMES IN TEXTILE PROCESSING

Enzymes are large protein molecules made up of long-chain amino acids which are produced by living cells in plants, animals and microorganisms. Enzymes are products of living organisms which catalyze biochemical reactions. They are grouped as:

- Oxidoreductases – Oxidation, reduction reaction.
- Transferases – Transfer of functional groups.
- Hydrolases – Hydrolysis reaction
- Lyases – Addition to double bond or its reverse
- Isomerases – Isomerization
- Ligases – Formation of bonds with ATP cleavages.

Hydrolases type of the enzyme is mostly used in textiles.

The fabric should be free from natural and added impurities before it goes coloration. Some chemicals such as soda ash, caustic soda, hydrochloric acid, hydrogen peroxide, detergent and auxiliaries which are sometimes used in the process process are found to be polluting the environment. Enzymes application comes with many benefits when being compared compared to the non-enzymatic processes. They can be used in catalytic concentrations with low temperatures and at pH-values near to neutral. The enzymes which are used in textile industry and their effects are shown in *Table 1*.

ditional natural-fiber scouring processes and replacing them with enzyme-based solutions. There are many enzymes that can act to remove natural impurities such as polymeric substances from cotton or other natural fibers. Alkaline pectinases loosens the fiber structure by removing pectins between cellulose fibrils and makes the the wash-off of waxy impurities easier, is the key enzyme for a bioscouring process.

Other enzymes have been tested as well, such as cellulases, hemicellulases, proteases and lipases, but currently, bioscouring enzymes based on pectinases are the only ones being used.

Table 1.- *Enzymes used in textile processing and their effects*

Enzyme	Effect
Amylase	Starch desizing
Catalase	In situ peroxide decomposition without any rinse in bleach bath
Protease	Scouring of animal fibres, degumming of silk and modification of wool properties
Pectinase	Scouring of vegetable as well as bast fibres e.g. cotton, jute
Lipase	Elimination of fat and waxes
Laccase	Discoloration of coloured effluent chromophore; Bio-bleaching of lignin containing and pigments fibres like kenaf and jute; Bio-bleaching of indigo in denim for various effects
Cellulase	Break down cellulosic chains to remove protruding fibres by degrading &create wash-down effect by surface etching on denims etc.
Cellulases and Hemicellulases	Biostoning of jeans Desizing of CMC Stylish effect on cellulose fibres
Pectinase	Breaks down pectins in scouring
Proteases	Scouring of animal fibres, degumming of silk and modification of wool properties
Lipases	Elimination of natural triglycerides (in scouring) or present in desizing (tallow compounds)

The enzymatic desizing of cotton with α-amylases is state-of-the-art since many decades [10]. The amylopectin is bioconverted to 50% into glucose and maltose whereas the amylose is bioconverted to 100% into glucose by the α-amylase. Amylases bring about complete removal of the size without any harmful effects on the fabric. In different cotton pre-treatment and finishing processes are used cellulases, hemicellulases, pectinases, lipases and catalases.

Cellulase enzymes were introduced after several decades of using amylase as a standard for desizing processes. Today, there are efforts within the textile industry which are focusing on eliminating the tra-

In the pre-treatment these substances are removed with alkaline treatment at high temperatures after the enzymatic desizing of raw cotton fabrics with α-amylases. This process consumes a lot of energy, water and alkali and can damage the cellulosic material.

5. CONCLUSIONS

Innovative applications of various enzymes are increasing and spreading rapidly into all areas of textile processing. The companies which produce enzymes always strive to improve the products and adjust them to more flexible application of enzymes, along with a wider-spread usage.

As is the case with all chemicals, enzymes too, have their advantages, as well as disadvantages. They show specific action without undesirable effects on other components and normally operate under mild temperature and pressure conditions, but at the same time are sensitive to temperature, pH, humidity and contaminants. They often shorten the process cycle reducing time, water consumption and wastewater generation. The main obstacle in using enzymes is their high cost.

In textile processing like desizing, scouring and bleaching the enzymes can be successfully used. Using enzymatic processes reduces water consumption, power energy, pollution, time, and increases quality of textile products

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