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AMFEP information sheet

Contribution of enzymes to reduce emissions - Textile applications

Enzymes are used in a variety of industrial and professional applications, such as food & beverage, animal nutrition, detergents and/or textile production. They support and accelerate a number of bio-chemical reactions that drive environmental efficiency across many diverse EU sectors, in small to large companies.

The present document highlights the sustainability benefits of enzymes implementation when used in textile and garment pre-treatment and finishing processes

AMFEP c/o KELLEN
Avenue de Tervueren 188A postbox 4, 1150 Brussels
Tel +32 2 761 16 77 • VAT BE 0627.846.356

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AMFEP c/o KELLEN
Avenue de Tervueren 188A postbox 4, 1150 Brussels
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1. Enzymes are improving textile industry processes

Enzyme technologies are attractive in textile industrial applications because of their high specificity, their efficiency and their applicability (they operate for example at ambient temperature). Diverse enzymes exert diverse targeted effects on the textile processes.

In **textile pre-treatment**, enzymes are used, in desizing process, to remove starch and carboxy methyl cellulose with **amylases** and **cellulases**. In the scouring step, pectin and proteins are removed from the textiles with **pectinases** and **lipases** in vegetable fibres, with **proteases** from wool and silk and with **xylanase** from linen, jute and hemp. **Catalases** are used to degrade excess hydrogen peroxide from textile after bleaching step.

In **textile/garment finishing**, enzymes are used to finalise the ready garments before made available to consumers. **Cellulases** and **proteases** eliminate hairiness, reduce pilling, clean the surface and give an antifelting finishing in the final garment. Denim fabric is bleached with **laccases** and **cellulases** are used in biostoning, a gentler way for stonewashing denim that avoids the use of pumice stones. Cotton is bleached with **arylesterase**.

Enzymes are a special class of proteins produced either by fermentation of microorganisms or by extraction from animal or plant tissues. Enzymes are required by all living organisms, including humans, to conduct the physiological processes essential for growth and life. They act as catalysts that speed up the rate of specific chemical reactions.

All enzymes are readily biodegradable -only needed in very low concentrations to be effective. They generally exhibit no specific environmental toxicity Industrial enzymes have an excellent safety profile, with little ability to cause adverse responses in humans and in the environment and those risks are controlled. For detailed information about enzymes and their technical, food and animal feed uses, see here [About enzymes: definition, how they work and more - AMFEP]

2. Improved sustainability through the use of enzymes

The consumption of energy in form of water and electricity is relatively high in the textile industy, especially in processes like washing, de-sizing, bleaching, rinsing, dyeing, printing, coating and finishing. Using enzymes technologies allows reducing process times, spares energy and water, in addition to enhancing the quality of the final products. Enzymes are designed towards an efficient use of resources.

1.1 Reduction of water consumption

Use of enzymes can limit process steps that use large quantities of water, like rinsing steps after bleaching when catalase is used to decompose excess hydrogen peroxide. Additionally, enzymes speed up processes which lead to less water used. It is generally accepted that the resorting to enzyme technology can decrease the water usage up to 30%.

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1.2 Reduction of chemical load to environment

Enzymes are able to replace or minimise the resorting to many hazardous chemicals used in textile processing, typically hydrogen peroxide and formaldehyde for example, but other chemical such as sodium hydroxide, chlorine bleach, sodium thiosulfate. This leads to smaller environmental releases of hazardous chemicals and generation of less chemical waste. It is generally accepted that the resorting to enzyme technology can replace up to 80% of the hazardous chemicals used by this industry.

Enzymes themselves are readily biodegradable, thus with minimal impact to the environment.

1.3 Reduction of GHG emissions

Enzymes can perform in room temperature which reduces CO_2 emissions as less energy is used to increase process temperatures. Due to the catalytic function of enzymes, processes work faster which further reduces the energy used.

1.4 Improved durability of the garment

Enzymes used in textile processes are less harmful for the fibres than chemicals, which means the ready garments will look better longer and will extend their usability. This will reduce generation of textile waste.

3. Contribution to sustainability ambitions

3.1 Green Deal

Implementation of enzymes in textile manufacturing processes supports

- The reduction of carbon emissions [Climate law, Textile strategy]
- The sparing of water usage [Textile strategy]
- The reduction of use of chemicals of concern [Zero Pollution, Textile strategy[1]]
- The longer durability for garments [Circularity Action plan, Textile strategy]

3.2 Sustainable development goals

Enzymes allow textile producers to align their sustainability strategies with several of the United Nation's Sustainable Development Goals (SDGs). Implementation of enzymes in textile manufacturing processes supports

[1] https://environment.ec.europa.eu/publications/textiles-strategy_en

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- SDG3 [Goal 3. Ensure healthy lives and promote well-being for all at all ages] because enzymes in the textile industry contribute to spare hazardous chemicals [Target 3.9: By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination]
- SDG6 [Goal 6. Ensure availability and sustainable management of water and sanitation for all] because enzymes in the textile industry contribute to reduce industrial usage of water. [Target 6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally]
- SDG 12 [Goal 12. Ensure sustainable consumption and production patterns] because enzymes in the textile industry contribute to rationalise production patterns
  - towards an efficient use of natural resources and support the re-cycling of food by products [Target 12.2: By 2030, achieve the sustainable management and efficient use of natural resources]
  - to expand the lifetime of garments [Target 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse]
- SDG13 [Goal 13. Take urgent action to combat climate change and its impacts] because enzymes in the textile industry contribute to the reduction of the carbon footprint of garments. Enzymes can help the textile industry to meet its GHG reduction target

4 Enzymes are essential sustainability enablers for the textile industry

Enzymes are used for decades in the textile industry. They became essential to nowadays users for the technical performance they deliver, sparing numerous inputs (energy, water, chemicals), and adding to the quality of the finished goods.

They will become further critical for an extended number of textile producers to improve their environmental footprint, be it from a regulation push or from a consumer pull, be it in Europe or be it in other part of the world.

5 Bibliography

1. BASU, A., 2020. Sustainability in textiles and apparel industry. Asian Textile Journal, 29(4-5), pp. 31-33.
2. DE SOUZA MOREIRA, L.R., LO SCIUTO, D. and FILHO, E.X.F., 2016. An Overview of Cellulose-Degrading Enzymes and Their Applications in Textile Industry. New and Future Developments in Microbial Biotechnology and Bioengineering: Microbial Cellulase System Properties and Applications. pp. 165-175.

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3. ESPINA, G., ATALAH, J. and BLAMEY, J.M., 2021. Extremophilic Oxidoreductases for the Industry: Five Successful Examples With Promising Projections. Frontiers in Bioengineering and Biotechnology, 9.

4. JEGANNATHAN, K.R. and NIELSEN, P.H., 2013. Environmental assessment of enzyme use in industrial production-a literature review. Journal of Cleaner Production, 42, pp. 228-240.

5. LANDAGE, S.M., 2022. Biotechnological approaches in desizing of textile materials. Applications of Biotechnology for Sustainable Textile Production. pp. 47-73.

6. MADHU, A. and CHAKRABORTY, J., 2022. Sustainable Approach for Cotton Fabric Pretreatment with Immobilized Enzymes. Fibers and Polymers, 23(4), pp. 993-1007.

7. MOJSOV, K., 2018. Enzymatic scouring and bleaching of cotton terry fabrics–opportunity of the improvement on some physicochemical and mechanical properties of the fabrics. Journal of Natural Fibers, 15(5), pp. 740-751.

8. NIELSEN, P.H., KUILDERD, H., ZHOU, W. and LU, X., 2009. Enzyme biotechnology for sustainable textiles. Sustainable Textiles: Life Cycle and Environmental Impact. pp. 113-138.

9. PRAJAPATI, C.D., SMITH, E., KANE, F. and SHEN, J., 2019. Selective enzymatic modification of wool/polyester blended fabrics for surface patterning. Journal of Cleaner Production, 211, pp. 909-921.

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