A SYNOPSIS
OF
THE THESIS ENTITLED

"Enzyme and Polymer mediated Pre-treatment of cellulosic textiles to rationalize water consumption vis-à-vis Reduction in effluent loading"

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THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
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TEXTILE CHEMISTRY

Submitted by

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SYNOPSIS

In the previous century, the landscape of the world was reshaped by rapid Industrialization. The sky, land, and water became highly polluted by the chemicals used in different manufacturing processes. The urban Industrial culture damaged the traditional style of "How to walk with nature". The enlightened citizens consider this as a darker side of the changes and emphasize sustainable development. Intermediates, as well as the final product during the manufacture of dyes, are highly toxic, non-biodegradable, and entirely recalcitrant. Like plastics, some synthetic textiles have also created formidable environmental problems.

The environmentally friendly processing will include the selection of environmentally acceptable chemicals during processing, health considerations during storage, handling, and application of chemicals, and problems of their discharge in the wastewater. There is not enough awareness of these vital problems among top managers, technologists, and chemical manufacturers, despite the information explosion in the present world.

The various processes used in the textile processing industry contribute to a major portion of environmental pollution. The textile wet processing industry usually generates a large volume of effluents, which are complex in nature and variable both concerning quantity and characteristics. The wastewater from the textile industry is known to be strongly colored presenting a large number of suspended solids, pH broadly fluctuating, high temperature, besides high chemical oxygen demand (COD). Colour is also a psychologically very important factor in water pollution. The discharge of highly colored waste is not only aesthetically displeasing, but it also interferes with the transmission of light and upsets the biological processes which may then cause the direct destruction of aquatic life present in the receiving stream. Various attempts are made to reduce the pollution load.

Under this background the proposed research & plan of work will concentrate on the following areas:

- Establishing a suitable process formulation for the environmentally friendly pretreatment processes for cellulosic textiles like low GSM cotton and Viscose. To formulate solutions for the desizing & scouring process with polymers, enzymes, soda, etc. The formulation will be standardized and optimized in terms of its performance at the end of individual steps of pretreatment of cellulosic textiles.
- Testing of pretreated textiles in terms of change in their properties.
- Analysis of water consumption in the preparatory processing of cellulosic textiles.

- Quantitative and qualitative analysis of water is required in a series of preparatory processes in terms of COD, BOD, and TDS.

The thesis entitled "Enzyme and Polymer mediated Pre-treatment of cellulosic textiles to rationalize water consumption vis-à-vis Reduction in effluent loading" comprises six chapters.

1. **Chapter 1 General introduction and Review of literature**

Chapter 1 reviews, the literature available in the related area.

2. **Chapter 2 Classification of fibers and characteristics of cellulosic fiber**

In cellulosic, two types of fiber are present. One is natural and the other is semi-synthetic. For this research study, take cotton fabric pretreatment from natural fiber and Viscose rayon fabric from the semisynthetic side. Both Cotton and Viscose rayon are widely used fibers for making garments.

3. **Chapter 3 Different types of products used in the pretreatment of wet processing of Cotton and Viscose rayon with its chemical composition details**

For wet processing of Cotton and Viscose rayon different products are used from desizing to finishing but this research focuses on the pretreatment part of Cotton and Viscose rayon fabric. Generally, pretreatment of Cotton and Viscose rayon is done in a batch-wise and continuous process. This research, more highlights batch-wise process where it is more in decentralized sector work.

4. **Chapter 4 Materials and methods**

4.1. Eco-friendly products formulated for pretreatment of Cotton and Viscose

- Polymeric Wetting agent/ cleaning agent (PWA)
- Desizing agent (DA): Formulated product with Amylase Enzyme

Chapter 4.1 deals with the synthesis and stabilization of Products. The stability of products in dispersion was monitored through the analysis of the absorbance spectra at different stages during the process of synthesis. The stability of the products dispersed in an aqueous medium was investigated after different time intervals. Also, these product particles were studied for their stability. The size and size distribution of the particles

were examined by a particle size analyzer. The morphology of the particles synthesized was examined by particle size analyzer studies.

4.2. Different types of Grey fabric used

- Viscose Woven fabric: Dry singed fabric; Construction – 30 X 30 / 68 X 68; GSM – 103.06; GLM – 174.68; Width – 169.5cm;
- Viscose knitted fabric Combed fabric; Count – 34s; GSM – 240
- Cotton woven fabric: Dry singed; Combed fabric; Count – 30s; GSM – 85
- Cotton knitted fabric: Carded Fabric; Count – 36s; GSM – 180

4.3. Machine for lab trial

Use padding mangle, Laundr-o-meter, Weighing balance, Stenter/ironing

4.4. Machine for bulk trial

After achieving lab trials on different fabrics, bulk trials were done in different industries. Take soft flow trials for viscose woven, viscose knitted, and cotton knitted fabrics. Take bulk trial in jigger machine for cotton woven fabric.

5. Chapter 5 Results and discussion

Chapter 5 deals with results and analysis of changes in physicomechanical properties. The physicomechanical properties of variously treated samples were evaluated through various techniques, namely, stiffness, tensile properties, drop test, Sinking time, etc. All these were co-related with the chemical constitution of the pretreated samples. A new blend of enzyme and polymeric material was developed, characterized, and applied to Cotton and Viscose fabrics. Their effect on various properties of fabrics has been evaluated and analyzed in chapter 5.

5.1. Testing of products

Desizing aid and Scouring aid (wetting agent) are tested in terms of colour and physical appearance, Solid content by oven method, Viscosity, Solubility/ Dispersibility in tap water and soft water, and Enzyme activity, AHS test at 60 and 80°C temperatures, pH of the product, etc.

5.2. Stepwise processing data of cotton pretreatment and viscose rayon pretreatment in the current process vs. modified process.

- Steps involved in the pretreatment of Cotton woven in conventional vs modified process
- Steps involved in the pretreatment of Viscose rayon woven in conventional vs modified process

- Steps involved in the pretreatment of Cotton knitted in conventional vs modified process
- Steps involved in the pretreatment of Viscose knitted in conventional vs modified process
- Explaining results of current pretreatment vs modified process of cotton and viscose rayon
- Comparison of both processes in terms of change in process

5.3 Chemical characteristics of IR grey fabric, conventional process fabric, and modified processed fabric. Also, characterizations of the product have been determined by various methods such as The absorbance Particle size and size distribution of the particle were analyzed using particle size analyzer instrumental method, The results obtained in each case studied to ensure the products to archive special properties has been analyzed in chapter 5.

5.4 Change in functional properties

5.4.1 Feel of fabric after pretreatment

5.4.2 Aesthetically i.e., colour characteristics (with dyeing)

Wet processing is not completed if the dyeing behavior of pretreated Cotton & Viscose rayon is not studied. Therefore, pretreated textiles samples obtained from various processes were dyed with Reactive class of dyestuff. The dyes selected were of different classes depending on the type of fiber. The dyeing behavior of various dyestuffs was assessed and correlated with their respective chemical constituents. The *K/S* values of different dyed samples were compared with the modified pretreated sample. Further, various fastness properties of dyed samples were evaluated.

5.5 Evaluation of Effluent load in both processes with conventional vs. modified process

5.5.1 Water consumption in the modified pretreatment process against the conventional pretreatment process

5.5.2 Analysis of effluent load in terms of SS, DS, TDS, BOD, COD, and pH, in both processes. The wet processing industries of textiles are often criticized due to the stringent effluent problem.

5.6 Industrial Trial

5.7 Economy involved

5.7.1 Related to process

5.7.2 Related to chemical

6 Lastly, conclusions were summarized in **chapter 6**.

7 Paper published & presented

- Kushal Desai and Bharat Patel; Pre-treatment of cotton and viscose rayon to minimise water consumption and effluent loading; **Journal of Textile and clothing science**; Vol 4; No. 2 (2021); pp. 07-16.
- Kushal Desai and Bharat Patel; Ecofriendly preparatory processing of cotton Textiles; **Asian Dyer**; Aug-Sep 2021; pp.26-33.
- Presented paper on "Pre-treatment of Cotton and viscose rayon to minimise water consumption and effluent loading" at **International Web Conference** on Advances in Textile Engineering and Apparel Technology (ICATEAT 2020) 23rd Aug, 2020.
- Presented paper on "Eco-friendly pre-treatment of viscose and low GSM cotton to reduction in energy and effluent loading" at **National conference** on Sustainable growth in Textiles (SGT 2020) 12-14th Aug, 2020.

References

1] Sivaramakrishnan, C.N., 2012. Environmental Concerns In Textile Processing. J. of Textile Asso.73 (2), 105-106.

2] Patel, K.J., Patel, B.H., Patel, A.I., 2004. Eco- friendly Wet processing of Cotton. Asian Textile J. 13(8), 89-93. https://www.researchgate.net/publication/278727052_Eco-friendly_wet_processing_of_cotton.

3] Menezes, E., 2009. Eco-friendly Chemicals, Enzymes and Dyes, New Cloth Market. https://www.fibre2fashion.com/industry-article/4059/eco-friendly-chemicals-enzymes-and-dyes.

4] Jadhav, A., 2007. Eco-friendly substitution in textile, fibre2fashion. https://www.fibre2fashion.com/industry-article/2524/eco-friendly-substitution.

5] Intertek services, Eco-Textiles broacher, http://www.intertake.com/consumergoods (accessed 13 March 2013).

6] Arya, D., Kolhi, P., 2009. Environmental Impact of Textile Wet Processing, fibre2fashion. https://www.fibre2fashion.com/industry-article/4287/environmental-impact-of-textile.

7] Koushik, C., Josico, A., Chemical processing of textiles. Chapter-9. pp. 364-380.

8] Dalal, A., 1993. Environment and Safety Aspects in Indian Dyestuff Industry. https://www.researchgate.net/publication/295127266_Environment_and_safety_aspects_in_Indian_dyestuffs_industry.

9] Kanimozhi, M., 2011. Textile Effluent Treatment- An Eco-friendly Approach, fibre2fashion. https://www.fibre2fashion.com/industry-article/5513/textile-effluent-treatment-an-ecofriendly-approach.

10] Gujarat Pollution Control Board; Effluent Standard. https://gpcb.gujarat.gov.in/ (accessed 10 Jan 2008).

11] Subramanian, S., Phalgumani, G.R., 1995. Processing of Eco-friendly Textiles: International Norms, A Bilateral Symposium on Eco-Friendly Textile processing, IIT Delhi, Nov 6-7.

12] Cegarra, J., 1996. The state of the art in textile biotechnology, J. of Society of Dyers and Colourists. 112, 326-329. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1478-4408.1996.tb01767.x.

13] Chinta, S., Wasif, A., Doshi, B., 1993. Role of Speciality Chemicals and Auxiliaries in Textile Wet Processing-A Review, Textile Dyer and Printer, (7) 25-34. https://www.researchgate.net/publication/294128531_Role_of_speciality_chemicals_and_auxiliaries_in_textile_wet_processing_-_a_review_II.

14] Clariant Ltd, Eco-friendly products. https://www.clariant.com. (accessed 10 June 2013).

15] Chelating agent. https://en.wikipedia.org/wiki/Chelation. (accessed 10 Feb 2013).

16] Thiagarajan, P., Selvakumar, N., 2008. Cotton, Pectinlytic enzymes and enzymatic scouring of cotton, Colourage. 9, 51-57. https://www.researchgate.net/publication/288790761_Cotton_pectinlytic_enzymes_and_enzymatic_scouring_of_cotton.

17] Li, Y., Hardin, I., 1997. Enzymatic scouring of cotton: Effects on Structure and Properties, Textile Chemist and Colorist. 29 (8), 71-76. https://www.semanticscholar.org/paper/ENZYMATIC-SCOURING-OF-COTTON-%3A-EFFECTS-ON-STRUCTURE-Li-Hardin/c9c90901ccaeef5bfb7598423dd28a0dd951d601.

18] Shah, S., 2013. Chemistry and application of cellulase in textile wet processing, Research Journal of Engineering Sciences. 2278, 9472. http://www.isca.in/IJES/Archive/v2/i7/From_Editorial_Desk.pdf.

19] Sekar, N., 1999. Bleaching of cellulosic materials, Colourage. 3, 25-28.

20] Shukla, S., 2006. Developments in textile auxiliary chemicals, Colourage Annual. 175-180. https://www.researchgate.net/publication/294216939_Developments_in_textile_auxiliary_chemicals.

21] Chavan, R., Chattopadhyay, D., Sharma, J., 2000. Peracetic acid – An ecofrindly bleaching agent, Colourage. 1, 15-20. https://www.researchgate.net/publication/285797556_Peracetic_acid_-_an_eco-friendly_bleaching_agent

22] Amorim, M., Gasques, D., Andreaus, J., Scharf, M., 2002. The application of Catalase for the elimination of H2O2, Annals of the Brazilion academy of Sciences. 741 (3), 433-436. https://www.ncbi.nlm.nih.gov/pubmed/12378311.