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Eco-Friendly Textile Processes

Synthesis Lectures on Chemical Engineering and Biochemical Engineering

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Preface

The textile industry, one of the oldest and most dynamic sectors, has shaped economies, cultures, and societies for centuries. From its roots in natural fibers to today's global, technology-driven enterprise, textiles remain central to trade and livelihoods. However, this progress comes at a cost, as the industry is highly resource intensive, consuming vast amounts of water and energy while generating pollution and waste.

This book, *Eco-Friendly Textile Processing*, addresses these challenges and explores pathways for sustainable transformation. It highlights the industry's environmental footprint and presents advances in energy and water efficient technologies, green chemistry solutions, and innovative smart fabrics. Together, the chapters offer a comprehensive view of how textiles can evolve from a resource heavy model to one that is cleaner, circular, and resilient.

Chapter 1 sets the context by introducing the global significance of the textile industry, its complex value chain, and the pressing sustainability challenges such as water pollution, energy demand, air emissions, and waste generation. It also highlights pathways such as Green Supply Chain Management, certifications, and Corporate Social Responsibility initiatives that frame the broader sustainability discourse.

Chapter 2 focuses on drying technologies, one of the most energy intensive operations in textile processing. It explores eco-friendly alternatives including heat recovery systems, renewable heating sources, infrared drying, microwave-assisted techniques, and hybrid systems that demonstrate significant potential for reducing energy consumption and emissions.

Chapter 3 examines eco-friendly chemical treatment methods, particularly in wet processing. It highlights how green chemistry, enzyme-based processes, supercritical CO₂ dyeing, plasma treatment, and bio-based finishing agents can reduce chemical loads and effluent toxicity while maintaining or improving fabric quality and performance.

Chapter 4 looks ahead to emerging trends, showcasing the potential of smart textiles and advanced materials that combine functionality with sustainability. From biopolymers

and nanomaterials to responsive fabrics and digital integration, this chapter envisions a future where innovation and environmental responsibility go hand in hand.

Together, these chapters provide a structured exploration of sustainable textile processing. It is hoped that this book will serve as a resource for researchers, industry practitioners, policymakers, and students committed to fostering a textile sector that not only sustains economies but also safeguards the environment for future generations.

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Contents

1	Textile Industry and Sustainability Context	1
1.1	Introduction to the Textile Industry	2
1.2	Textile Processing Chain	3
1.2.1	Raw Materials	4
1.2.2	Dry Processing	5
1.2.3	Wet Processing	5
1.3	Environmental and Sustainability Challenges	8
1.3.1	Water Pollution from Textile Effluents	8
1.3.2	Heat and Energy Requirements	9
1.3.3	Air Pollution and Greenhouse Gas Emissions	10
1.3.4	Solid Waste and Microplastic Generation	11
1.4	Pathways to Sustainability in Textiles	11
1.5	Concluding Remarks	13
	References	13
2	Sustainable Heat Management and Drying in Textile Processing	17
2.1	Introduction	18
2.1.1	Fundamentals of Heat and Mass Transfer in Textile Porous Media	19
2.1.2	Influence of Fabric Structure on Heat and Moisture Transport	21
2.1.3	Mechanism of Drying	23
2.2	Convection Drying of Textiles	24
2.2.1	Heat Recovery	24
2.2.2	Moisture Sensors and Process Control	25
2.2.3	Hybrid Systems	26
2.3	Conduction Drying of Textiles	26
2.3.1	High-Efficiency Steam Management	27

2.3.2	Use of Renewable Heating Sources	27
2.4	Radiation Drying of Textiles	27
2.4.1	Infrared with Renewable Power	28
2.4.2	Microwave-Assisted Drying	28
2.4.3	Hybrid Radiation-Convection Systems	29
2.5	Concluding Remarks	30
	References	31
3	Eco-Friendly Chemical Treatment Methods	35
3.1	Introduction	36
3.2	Chemical Treatment Principles: Functionalization and Finishing	38
3.2.1	Functionalization—Building New Performance into Fibers/ Fabrics	38
3.2.2	Finishing—Tuning Comfort, Handle, and Serviceability	41
3.3	Eco-Friendly Dyeing and Printing Techniques	42
3.3.1	Natural Dyes with Bio-mordants	43
3.3.2	Cold Pad-Batch Reactive Dyeing	43
3.3.3	Heritage Printing Methods: Dabu Printing	44
3.4	Sustainable Finishing Treatments for Textiles	44
3.4.1	Enzyme-Based Finishing	44
3.4.2	Plasma Treatments	45
3.4.3	Advanced Oxidation Processes Using UV and Ozone	46
3.4.4	Nanotechnology-Based Green Finishes	47
3.5	Plasma and Nanotechnology Applications	47
3.5.1	Applications of Plasma Technology	47
3.5.2	Applications of Nanotechnology	49
3.6	Conclusion	50
	References	51
4	Future Directions and Emerging Trends in Eco-Friendly Textiles	57
4.1	Introduction	58
4.2	Classification of Smart and Responsive Textiles	59
4.3	Material Innovations in Eco-Friendly Smart Textiles	60
4.3.1	Natural Fibers and Biopolymers	60
4.3.2	Nanomaterials	61
4.3.3	Phase-Change Materials (PCMs)	62
4.3.4	Conductive Polymers	64
4.4	Mechanisms of Responsiveness	64
4.5	Fabrication Techniques for Smart and Eco-Friendly Textiles	66
4.5.1	Coating and Finishing	66
4.5.2	Electrospinning	66
4.5.3	Weaving and Knitting with Conductive Yarns	67