## *INDEX*

Sr.	Particulars  List of Figures  List of Tables		Page	
No.			No.	
			viii xi	
1	INTRO	ODUCTION	1	
2	LITEI	RATURE REVIEW	3	
2.1	Textile fibers		4	
	2.1.1	Classification of Textile fibers	6	
	2.1.2	Importance on cellulosic fibers	7	
	2.1.3	Cotton	10	
		2.1.3.1 Brief description of cotton fibre production	10	
		2.1.3.2 Cotton characteristics	11	
		2.1.3.3 Natural and added impurities present in Cotton fabric	15	
	2.1.4	Viscose rayon	17	
		2.1.4.1 Production of viscose rayon fibre	17	
		2.1.4.2 Properties of viscose rayon	20	
		2.1.4.3 Added impurities present in Viscose rayon	21	
2.2	Eco-friendliness Concept		22	
2.3	The environmental impact of textile wet processes		22	
	2.3.1	The effect of wastewater on the ecosystem	22	
	2.3.2	Negative effects of toxic substances on human health	24	
	2.3.3	A comparison of the GPCB, MPCB and CPCB's effluent requirements	26	
	2.3.4	Comparison of eco-parameters on textiles for various eco-labels	27	
2.4	Advancements in eco-friendly cotton and viscose rayon wet processing		27	
2.4	techniques		27	
	2.4.1	Singeing	28	
	2.4.2	Desizing	28	
		2.4.2.1 Pollution-reduction strategies for desizing	28	
		2.4.2.2 Product used in cotton and rayon desizing	30	

2.4.3	Process of scouring	31
	2.4.3.1 Methods to reduce pollutants in cotton scouring	32
	2.4.3.2 Use of products in cotton scouring	34
2.4.4	Process of bleaching	35
	2.4.4.1 Methods for reducing pollutants during cotton bleaching	35
	2.4.4.2 Products used in Cotton Bleaching	38
2.4.5	Process of mercerizing	39
	2.4.5.1 Methods for reducing pollutants during cotton mercerization	40
	2.4.5.2 Product usage in cotton mercerizing	40
2.4.6	Process of dyeing	41
	2.4.6.1 Ways to reduce dyeing pollution	41
	2.4.6.2 Environmentally friendly methods for various dye application	42
	2.4.6.2.1 Vat dyeing	42
	2.4.6.2.2 Sulphur dyeing	43
	2.4.6.2.3 Direct dyeing	43
	2.4.6.2.4 Reactive dyeing	44
	2.4.6.2.5 Natural dyeing	48
2.4.7	Printing process	51
	2.4.7.1 Printing pollution reduction strategies	52
2.4.8	Process of finishing	54
	2.4.8.1 Ways to reduce pollution in finishing	54
	2.4.8.2 Environmentally appropriate methods for various finishing	54
	2.4.8.2.1 Durable press finishes	54
	2.4.8.2.2 Antibacterial finish	56
	2.4.8.2.3 Finish Softness / Stiffness	56
	2.4.8.2.4 Finish that is flame-resistant	58
	2.4.8.2.5 Finish bio-polishing	59
	2.4.8.2.6 Water, oil, and stain-repellent coating	60
2.4.9	General Eco-Friendly Methods for Cotton Pre-Treatment	61
	2.4.9.1 Desizing, scouring, bleaching and mercerizing cotton fabrics in one step	61
	2.4.9.2 Two-step processes	61
	2.4.9.3 Textile mercerization, souring and bleaching electrochemically	61

2.5	Brief of Enzyme		
	2.5.1	What is Enzyme?	61
	2.5.2	Need of Enzyme Technology	62
	2.5.3	History of Enzyme	63
	2.5.4	Sources of Enzyme	63
	2.5.5	Classification of Enzymes	64
	2.5.6	Mechanism	65
	2.5.7	Factors Influencing Enzymatic Activity	67
	2.5.8	Enzyme as a Catalyst	68
	2.5.9	Properties of Enzyme	68
	2.5.10	Benefits of Enzymes	69
	2.5.11	Enzymes in Textile Processing	69
2.6	Brief of Polymer		71
	2.6.1	Polymer and polymerization	71
	2.6.2	Characteristics of Polymers	71
	2.6.3	Classification of Polymers	72
	2.6.4	Preparation, properties and applications of some textile chemical polymers	75
		2.6.4.1 Silicone	75
		2.6.4.2 Polyester resin	76
		2.6.4.3 PET-PEG Co-polymer	76
2.7	The Stu	dy's Objective	77
3	MATE	ERIALS AND METHODS	79
3.1	Phase-I	I: Eco-friendly pretreatment interventions for cotton and viscose rayon	79
	3.1.1	Materials required to formulate Enzymatic desizing agent (EDA) & Polymeric wetting agent (PWA)	79
	3.1.2	Machines used for formulation	79
		3.1.2.1 Weighing Balance	80
		3.1.2.2 Motor for homogenized mixing	80
		3.1.2.3 Electric heating mantle	81
	3.1.3	Experimental formulation method to formulate products EDA and PWA	81
		3.1.3.1 Enzymatic desizing agent (EDA): Formulated product with Amylase Enzyme	81
		3.1.3.2 Polymeric Wetting agent/ cleaning agent (PWA)	83

	3.1.4	Testing procedure of EDA and PWA	84
		3.1.4.1 Physical appearance of the products	84
		3.1.4.2 Checking pH of the products	84
		3.1.4.3 Viscosity of the products	84
		3.1.4.4 Specific gravity of the products	85
		3.1.4.5 Solid content of the products	86
		3.1.4.6 Dispersibility of products in Hard and Soft water	86
		3.1.4.7 Foaming test of the products	86
		3.1.4.8 Stability of the products tested by AHS test	87
		3.1.4.9 Particle size distribution and Zeta potential	87
		3.1.4.10 Amylase activity in EDA	89
	Phase -		
3.2	Phase – II: Lab scale Pre-treatment of Cotton and Viscose rayon by modified process		92
	3.2.1	Different types of grey fabric used	92
	3.2.2	Different types of chemicals used	92
	3.2.3	Machines used for lab trial pretreatment process	92
	3.2.4	Lab scale application method for pre-treatment of Cotton and Viscose rayon by modified process	93
		3.2.4.1 Steps involved in the pre-treatment of Cotton woven in modified	93
		process	93
		3.2.4.2 Steps involved in the pre-treatment of Viscose rayon woven in modified process	97
		3.2.4.3 Steps involved in the pre-treatment of Cotton knitted in modified process	99
3.3	Phase – III: Industrial scale application method for Pre-treatment of Cotton and Viscose rayon by current process vs. modified process		101
	3.3.1	Different types of grey fabric used	102
	3.3.2	Different types of chemicals used	102
	3.3.3	Machines used for bulk trial	102
		3.3.3.1 Soft flow machine	102
		3.3.3.2 Jigger machine	104
	3.3.4	Bulk scale application method for pre-treatment of Cotton and Viscose rayon by current process vs. modified process	105
		3.3.4.1 Steps involved in the pre-treatment of Cotton woven in current vs modified process	105
		3.3.4.2 Steps involved in the pre-treatment of Viscose rayon woven in current vs modified process	108

		3.3.4.3 Steps involved in the pre-treatment of Cotton knitted in current vs modified process	110
	3.3.5	Testing method of pre-treated fabric	112
		3.3.5.1 Check weight loss of fabric	112
		3.3.5.2 Tegawa rating	113
		3.3.5.3 Measurement of Absorbency	113
		3.3.5.4 Sinking time	114
		3.3.5.5 Whiteness and Yellowness index	115
		3.3.5.6 Core pH of fabric	115
		3.3.5.7 Dyeing of pretreated fabric and its Colour strength	116
		3.3.5.8 Tensile strength Measurement	118
		3.3.5.9 Tear strength Measurement	119
		3.3.5.10 Feel of pre-treated fabric by subjective evaluation	120
	3.3.6	Testing method for effluent solution, discharged from pre-treatment department	121
		3.3.6.1 Determination of pretreated effluent TDS	121
		3.3.6.2 Determination of pretreated effluent BOD	122
		3.3.6.3 Determination of pretreated effluent COD	123
		3.3.6.4 Determination of pretreated effluent pH	124
4	RESU	LTS AND DISCUSSION	125
4.1	Test results of formulated products		125
	4.1.1	Physical appearance of the products	125
	4.1.2	pH of the products	126
	4.1.3	Viscosity of the products	126
	4.1.4	Specific gravity of the products	126
	4.1.5	Solid content of the products	126
	4.1.6	Dispersibility of products in Hard and Soft water	126
	4.1.7	Foaming behavior of the products	127
	4.1.8	Stability of the products tested by AHS test	128
	4.1.9	Particle size distribution and Zeta potential	130
	4.1.10	Amylase activity in EDA	133
4.2		s of optimized parameters for the pretreatment of cotton woven, viscose and cotton knitted fabric	133
	4.2.1	Analysis of optimized parameters for desizing process of cotton woven	133

	Reprints of Review and Research publications; paper presentation certificates		
	Scope for further study  References  Abbreviations		166 173
			165
5	CONCLUSIONS		161
4.7	Cost-saving comparison		159
	4.6.3	Economics comparison of Cotton knitted pretreatment	159
	4.6.2	Economics comparison of Viscose woven pretreatment	158
	4.6.1	Economics comparison of Cotton woven pretreatment	157
4.6	7.6 The economics of the current method against the modified procedure.		157
	4.5.3	Comparison of pretreatment for cotton knitted fabrics	154
	4.5.2	Comparison of pretreatment for Viscose woven fabrics	151
	4.5.1	Comparison of pretreatment for cotton woven fabrics	148
4.5	Comparison of the existing process's chemical, water, steam and time consumption with the modified process		148
4.4	Result and Discussion of effluent testing of current v/s modified pre-treatment process		
	4.3.10	Feel of the pretreated fabrics	146
	4.3.9	Tear strength of fabrics	145
	4.3.8	Tensile strength of fabrics	143
	4.3.7	Dyeing of pretreated fabrics and their colour strength	142
	4.3.6	Core pH of fabrics	141
	4.3.5	Whiteness and Yellowness Index	141
	4.3.4	Sinking time	141
	4.3.3	Absorbency of fabrics	140
	4.3.2	Tegawa rating	139
7.5	4.3.1	Weight loss of fabrics	139
4.3	Result of	process of cotton knitted fabric and Discussion of pretreated fabric testing methods	139
	4.2.4	Analysis of optimized parameters on combined scouring & bleaching	137
	4.2.3	Analysis of optimized parameters for desizing process of Viscose woven	136
	4.2.2	Analysis of optimized parameters on combined scouring & bleaching process of cotton woven fabric	134