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Increasing The Strength Of Polyester And Cotton Yarn Using A Chemical Compound (Universal Potentiator)

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Abstract
Globally, the textile industry is one of the most important sectors globally, both economically and in everyday life. The textile industry is experiencing increased demand with a major focus on sustainability. Increasing the strength of cotton and polyester yarns to obtain high-quality materials and products is a dynamic need. We developed a chemical compound named Universal Potentiator. The cotton and polyester yarns are soaked in aqueous (distilled water) form of potentiator and found 42% and 16% increased strength respectively in polyester and cotton. In cotton yarn 27-58% CV and 4% hairiness reduced. This study highlights the use of Universal Potentiator in enhancing yarn strength in an economical and easy way and will gain a significant focus in literature.

Keywords*: polyester, cotton, yarn, universal potentiator, soaking, strength, increased, economical, easy*

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I. Introduction

The textile industry has seen significant advancements in the past and has a promising future. Over decades, the industry has undergone multiple transformations. However, the industry faces a range of economic, environmental, and social problems viz., skilled manpower, rising cost of production, environmental pollution, unsustainable resource consumption, waste generation, inadequate working conditions and the need for scientific and technological evolution **(Minakshi, 2022; Rosangela et al., 2022; Rosa et al., 2022; Sugeng et al., 2022; Lebo et al., 2023)**. These challenges require attention and action for sustainable development. This study is aimed to increase the strength of textile fiber yarns using a newly developed sustainable approach.

Basically the strength of the fiber yarn plays a vital role in apparel production and of paramount importance to obtain high-quality products. Followed by cotton, polyester fibers are commonly used by the textile industry **(Zhuo-Er et al., 2023; Hu et al., 2019)**. We have developed Universal Potentiator (UP) salt and experimented it in cotton and polyester yarn. The UP was found to have multiple positive effects on the yarn and are described in this paper.

II. Material

We developed Universal Potentiator (UP) (granted patent no.320979) containing a mixture of inorganic salts (Na, K, N, CO3, Cl) with molar mass 118.44 g/mole **(Umakanthan, 2017)**. UP exerts electrostatic interaction, pH buffering and catalytic action.

III. Method

The cotton and polyester yarns are soaked separately in Universal Potentiator solution for 5 minutes. The percentage of solution was 0.5, 0.75, 1.0, 1.5, 1.75, 2.0, 2.5 and 3% w/w proportion to yarn weight. The soaked yarn were dried in sunlight and tested for various parameters.

IV. Result

Table 1: Effect of Universal Potentiator in Polyester (Intorama company) stable length-38mm (cut length) diner-1.0

Sl.no	Salt used	Materials used (stable length-38mm (cut length) diner-1.0 and Weight- 1.34 gm)	Percentage of Universal Potentiator added	Strength (CSP)	Increased percentage
1	Control	Polyesters	--	87	

2	Universal Potentiator	"	0.25	86	
		"	0.5	96	
		"	0.75	108	24%

Table 2: Effect of Universal Potentiator in yarn count-50 (Polyester yarn used)

Sl.no	Universal Potentiator Percent	Yarn weight in gm	Salt (in mg)	Strength (CSP)	Percentage increased
1	Control	5.21	--	62	
2	0.75	5.16	39	60	-3%
3	1	5.33	53	72	16%
4	1.5	5.22	778	78	26%
5	2	5.22	104	88	42%
6	2.5	5.04	126	78	26%
7	3	5.26	157	68	10%

Table 3: Effect of Universal Potentiator in Yarn count-50

Sl.no	Universal Potentiator Percent	Strength (CSP)
1	(Control - only yarn)	98
2	Yarn soaked in dis. Water	86
3	0.25%	90
4	0.5%	100
5	1%	72
6	1.5%	84
7	2%	96

Table 4: Effect of Universal Potentiator compared to distilled water

Cops No.	1 (Control – sample soaked in Dis. Water)	2 (Control)	3 (0.5% UP)	4 (0.75% UP)	5 (1% UP)	6 (1.5% UP)	7 (1.75% UP)	8 (2% UP)
Count	30.25	29.63	30.43	29.47	29.76	29.17	29.28	29.36
CV%	1.02	2.13	0.33	0.92	0.56	0.57	1.55	0.62
Strength	92.18	98.22	88.9	95.39	96.78	90.68	98.78	97.00
CV%	5.58	5.29	9.72	5.68	4.14	5.82	2.19	5.19
CSP	2788	2910	2705	2811	2880	2645	2892	2848
HAIRINESS	4.15	4.28	4.74	4.79	4.75	4.8	4.11	4.02

V. Discussion

Textile yarn strength is a major concern in the textile industry. Various methods have been explored to enhance yarn strength, such as using chemical adhesives like polyvinyl butyral (PVB) to improve bonding between fibers **(Xu et al., 2021)**. Additionally, the development of upland cotton cultivars with superior fiber quality has been a focus for breeders **(Jonn et al., 2009)**. Coating cotton yarn with poly(vinyl alcohol) (PVA) and crosslinking via UV-C radiation has shown promise in increasing yarn tensile strength **(Ana et al., 2021)**. Furthermore, the use of cellulose nanomaterials, such as cellulose nanofibrils (CNF) and cellulose nanocrystals (CNC), has been explored to improve the mechanical properties of yarns and tapes produced from natural fibers **(Shokoofeh et al., 2018)**. There are some other methods studied for enhancing the strength of polyester and cotton yarns but these have their own limitations.

In polyester (i) changing the total draw ratio increase the tenacity and young's molecules **(Young et al., 2012)**; (ii) addition of novel chain extenders **(Jianzhong et al., 2012)**; (iii) use of high strength powder coating **(Zhang, 2016)**; (iv) stretching, heating, cooling, false twist processing, network nozzle processing and oil applying **(Hu et al., 2019)** have increased the tensile strength. Polyester has lower elongation due to its synthetic nature made from petroleum-based chemicals **(Wu, 2017)**. Even in the manmade fibre – polyester – the application of the Universal Potentiator has demonstrated a remarkable increase in the material's tensile strength, thus paving the way for new advancements in polyester technology.

The strength of cotton yarn is increased by (i) blending the cotton with high performance polyethylene **(Kimmel et al., 2006)**; (ii) load bearing and transverse yarn, yarn crimp percentage, etc **(Swapna, 2015)**; (iii) coating the cotton yarn with polyvinyl alcohol and cross-lining with irradiation **(Ana et al., 2021)**; (iv) reduction of micronaire method **(Umida et al., 2021)**; (v) blending cotton with polyester fiber **(Osman et al., 2022)**

Textile yarn hairiness is yet another important quality parameter that affects the quality of yarn. Various factors, such as raw materials, technology, and equipment, influence yarn hairiness **(Tran et al., 2023)**.

Researchers have explored different methods to reduce hairiness in ring spun yarns, including the use of rotary compact groove cylinders (CGC) to minimize the spinning triangle **(Hao et al., 2023)**. Another study focused on reducing hairiness by controlling fiber torsion using dynamic- and static-friction rollers, which resulted in improved yarn properties **(Zi et al., 2023)**. Fabric surface hairiness also plays a crucial role in fabric processing and garment quality **(Zhigang et al., 2021)**. Overall, these studies highlight the importance of controlling and reducing yarn hairiness in the textile industry.

Comparing the existing methods, the Universal Potentiator soaking method has its own unique advantages. Concurrently this method enhanced the cotton yarn strength and reduction of 27-58% co-efficient of variation and 4% hairiness. Universal Potentiator treatment has given better quality yarns with reduced variability of yarn strength, less imperfection and hairiness, and thus exhibited improved quality.

The result obtained using universal potentiator is in line with the other studies in which salt treatments have been found to increase the strength of yarns. **Abdan et al., 2017**, investigated the effect of alkali treatment on kenaf fiber and found that the tensile and modulus properties of the treated fibers improved significantly, especially at the optimum concentration of 6% sodium hydroxide (NaOH). **Stanley et al., 1965**, studied the alkali treatment of dialdehyde cotton yarns and fabrics and observed pronounced improvements in breaking strengths after the treatment. **Sakai, 1965**, examined the effects of various salt solutions on wool fibers and found that increasing the concentration of the salt solution resulted in better shrink-proof properties and larger tensile strength of the treated yarns.

Therefore, it can be concluded that salt treatments, particularly with Universal Potentiator, have a positive effect on the strength of yarns. Elaborate favourable study is ongoing using Universal Potentiator solution in various sub-sector of textile industry.

VI. Conclusion

An inorganic mixture of salts in the form of Universal Potentiator has been developed to investigate its effect on the quality improvement of textile yarn. Experimental results indicated that polyester and cotton yarn soaked in Universal Potentiator has reduced co-efficient of variation and hairiness with increased yarn strength.

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