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Study on Properties Analysis of Knitwear After Acid Wash

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Keywords

Acid Wash, Potassium Permanganate, Thermocol Ball, Physical Properties, Knitted Garments

This article deals with the investigation on the effect of the acid washing (with thermocol balls and potassium permanganate) on different properties of three knitted garments (Single Jersey 100% Cotton T-shirt, Single Jersey 95% Cotton 5% Spandex T-Shirt and 1×1 Rib100% Cotton T- Shirt). Typical washing procedures and techniques were followed and then physical properties were analyzed under standard condition. It is observed that fabric weight, CPI, WPI, spirality and shrinkage increase while bursting strength, stitch length absorbency decrease after washing treatment. P^H of all the samples is under controlled and lies between 7 – 8. There is no change in pilling, colorfastness to wash, water and dry rubbing while a little bit decrease in wet rubbing.

Introduction

Now a days, faded textile products have become very popular among the young customers all over the world [1]. For this reason, textile manufacturers are trying to develop numerous techniques to improve the visual out look of the sewn garments [2-5]. Different denim washing techniques have been developed and used on different materials to create a large variety of designs for trendy denim garments and jeans [6-11]. Nowadays along with denim washing knit garments such as T-shirt, Polo shirt, and trouser, are also washed by using different techniques such as enzymes wash, softener wash, Silicone wash, tie dye wash, pigment wash, caustic wash, etc. are used to create or enhance the physical and mechanical property changes [12-13].

Acid washing in knitted garments is a new technique which is done by potassium permanganate and pumice stone or other substitutes [13-14].

Potassium permanganate is an inorganic chemical compound with the chemical formula $KMnO_4$ [15]. It is a strong oxidizing agent and used to make color fading effect on sewn garments [16 - 18]. Sometimes it is used at the point of hand sand area or without hand sand area. As it is a great oxidizing agent, after applying, it is necessary to neutralize the garments by any good neutralizing agent [19].

Thermocol is a commercial name. In 1951 the researchers of a German company named BASF successfully restructured chemical bonding of polystyrene (a synthetic petroleum product) molecules and developed a substance named stretch polystyrene. This substance was named Thermocol, which nowadays is manufactured through a simple process. Thermoplastic granules are expanded through application of steam and air. Expanded granules become much larger in size but remain very light, formable, & rigid [20-23].

Small thermocol balls (0.75-1 cm diameter) are being used as a substitute of pumice stone in garments finishing process [24-25].

Elias et al. (2015) studied the effect of change in concentration of $KMnO_4$ and processing time on physico-mechanical properties of denim jeans during acid washing. It was found that the tensile strength, seam strength, stiffness and fabric weight were decreased after application of potassium permanganate with increasing processing time during washing treatment while yarn count (Ne), EPI, PPI and dimensional change were increased [26-28].

Solaiman et al. (2015) investigated the effect of three types of washing (enzyme, softener, Silicone) on Physical and Mechanical Properties on five Single Jersey T-shirt. The results showed that when enzyme wash is applied on the knit

garments, it improved all the tested properties of knit garments, and it also reduced the hairy fibers from the fabric surface. Similar results were found in case of Silicone and softener wash as well [29].

However, the effect of acid wash with thermocol balls and potassium permanganate on physico mechanical properties on knitted garments was not studied in the past research. In this present study, three knitted garments (Single Jersey 100% Cotton T-shirt, Single Jersey 95% Cotton 5% T-Shirt and 1×1 Rib100% Cotton T- Shirt) were washed with H_3PO_4, $KMnO_4$ along with thermocol balls and various properties were analyzed according to standard methods.

Materials and Methods

Garments Samples

Following three types of reactive dyed knitted garments were used for this research:-Single Jersey (S/J) T-Shirt (100% cotton), Single Jersey (S/J) T-Shirt (95% Cotton 5% Spandex), 3. 1×1 Rib T- Shirt (100% Cotton)

Chemicals

Phosphoric acid (H_3PO_4, Yalong, China) and potassium permanganate ($KMnO_4$, GC, China), Jet (an anionic detergent, Bangladesh)

Washing Machine

Brand Name-Ngai Shing Development Limited, M/C capacity-20kg, RPM -30-33rpm, Origin-Hong Kong

Acid Washing

At first make a solution with 5% phosphoric acid and 15g/L potassium permanganate. Thermocol balls (0.1% owg) are taken into the washing machine. Sprinkle the solution into the machine and Run the machine for 5 min for ensuring all the balls get wetted completely. Load the garments into the machine and washing process carried out for 15 min at normal temperature. After unloading the garments from the machine, cold wash is done by automatic washing machine (Front loading) with detergent 1gm/L (For 10 min at 30° C temperature. Then Neutralization with 3gm/L Sodium metabisulfite for 5 min at 45°C. Then Hydro extracting and drying the garments by tumble dryer for 15 min at 70°C temperature for getting washed garments.

Testing and Analysis

Fabric weight was measured according to ASTM D 3776 method [30] and according to BS EN 14970-2006, stitch length was measured [31]. According to AATCC 8 standard both the dry and wet rub tests were done [32]. For absorbency testing, AATCC 79 method was followed [33]. CPI and WPI of the fabric was calculated by counting the number of the Coarses and wales contents in 1 inch of the fabric. IS 1963 method was used for this measurement [34]. According to ASTM D 2259, shrinkage of these sample garments were tested [35]. Bursting strength of samples was measured by an automatic bursting strength tester. Samples are gradually set on the diaphragm, the automatic bursting strength tester, measures time, distortion, pressure & the flow rate to burst the fabric. It was done according to ASTM D3786 [36]. AATCC 81-2006 method was used for measuring P^H of the fabric [37]. Spirality (Dimensional change) was measured according to AATCC Test Method 187-2013 [38]. Pilling test of Single Jersey and Rib fabric was done according to ISO 12945-1:2001 [39]. Color fastness to washing and water were determined respectively according to ISO 105-C10 and ISO 105-E01 [40-41].

Results and Discussions

In this article, the change of physical and mechanical properties due to the washing treatment has been investigated. The overall results are shown in Table 1. From this table, it is seen that the weight of the fabric increases for each garments. This

increase is high in case of 1×1 Rib garments (13.76%). Actually when the knitted garments are faced with frictional action due to the thermocol balls and rotating cylinder of the washing machine, a trace of solution of $KMnO_4$ and H_3PO_4 also get penetrated into the fiber structure causing change in internal tension in the constituted molecules. The garments then tended to revert its more dimensions that results in the contraction of the yarns. This effect causes the reduction of the stitch length also increase stitch density for higher value of CPI and WPI. Thus weight of the garments, spirality and shrinkage increase after washing.

Table 1. *Effect of Acid Wash on Physical Properties of different Cotton Knitted Garments.*

Properties		Single Jersey 100% Cotton T-shirt		Single Jersey 95% Cotton 5% Spandex T-Shirt		1×1 Rib100% Cotton T- Shirt	
		Before Wash	After Wash	Before Wash	After Wash	Before Wash	After Wash
Fabric Weight (GSM)		140	142	159	169	138	157
Bursting Strength (KPa)		354.5	332.1	367.5	349.3	369.4	363
Coarse Per Inch (CPI)		50	52	60	62	44	48
Wale Per Inch (WPI)		34	35	40	42	44	46
P^H		7.5	7	8	7.5	8	7
Colorfastness to Rubbing	Dry	4.5	4.5	4.5	4.5	4.5	4.5
	Wet	4.5	4	4.5	4	4.5	4
Spirality (%)		2	3	1	2	1	2
Water Absorbency (Sec)		33	44	39	40	43	60
Colorfastness to Washing		4.5	4.5	4.5	4.5	4.5	4.5
Colorfastness to Water		4.5	4.5	4.5	4.5	4.5	4.5
Stitch Length (mm)		2.9	2.5	2.95	2.20	2.75	2.30
Shrinkage (%)	Lengthwise	1	2	2	3	4	6.66
	Widthwise	1	2	2	2.8	1	1.5
Pilling Resistance	Warp	4.5	4.5	4.5	4.5	4.5	4.5
	Weft	4.5	4.5	4.5	4.5	4.5	4.5

It is also found that the acid washing treatment of the knitted garments causes significant decrease in tensile strength (bursting strength). Maximum strength loss (6.31%) occurred in case of 100% cotton single jersey T shirt. At first thermocol balls with solution breaks the chemical bond of the primary wall of the cellulose molecules and after that it attacked slightly on secondary wall. The result of this reaction is that the primary wall of the cotton fiber is loosened and broken down quicker with the mechanical forces of washing machine and rough surface of thermocol balls. As a result, internal bonding force among the molecules of the cellulose gets reduced which causes lower tensile strength. No significant change was occurred in fabric P^H as mild concentration of acid was used.

It is also found from the table that color fastness properties against washing, water and dry rubbing were unchanged while wet rubbing property is deteriorated a bit. After washing, absorbency reduced as the treatment changes the interfacial tension of the fiber molecules. The washed garments showed better pilling resistance.

Conclusion

Acid washing treatment with thermocol balls has greater effect on the properties of knitted garments. Though the weight of the increased but bursting strength decreased after washing. The concentration of potassium permanganate, phosphoric acid and thermocol balls should be optimized during this processing. ■

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