

TECHNOLOGY OF ACID WASH ON WOVEN DENIM APPAREL WITH DAMP PUMICE STONE

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Abstract: Now-a-days the woven denim apparel has achieved the highest level of popularity. The denim trend is accepted by anyone from fashion concern to unconcern personality. Faded denim is one of the most well-liked fashions to today's youth. The aim of this work was to study the technology of acid wash with damp pumice stone on woven denim apparel (jeans) of 100% cotton indigo dyed, 3/1 twill weave. The effect of acid wash on jeans also investigated. The jeans were processed with damp pumice stone (400%) (owm) at room temperature for 15 min without additional water. Phosphoric acid (1ml/l) and potassium permanganate (4gm/l) were used for soaking the pumice stone at room temperature for 10 min by shuffling. It has been explored that acid wash treatment is very effective for woven denim apparel to create an irregular fading effect. The properties of denim that were inspected contained breaking strength, stiffness, GSM, dimensional changes (shrinkage / growth %) count, EPI & PPI and color change. Obtained results were compared and found that breaking strength, stiffness, GSM, dimensional stability, colour depths are decreased. But count, EPI & PPI is increased for acid wash treatment on woven denim apparel.

Keywords: Denim apparel, Acid wash, Pumice stone, Tensile strength.

1. Introduction

Apparel washing is the combination of several chemical treatments in sequence. The names of washing method rely on the chemical types used in respective washing. In apparel washing particularly for denim apparel manifold types of chemicals are exercised to meet the quick change of current demands of customer. The common washing methods are enzyme wash, bleach wash, acid wash, normal wash, stone wash etc [1, 2]. Acid wash on denim jeans is becoming very popular due to its significant contrasts and attractive appearance in colour. It is a chemical wash process which stripped the top layer of colour and makes a white surface while the colour remained in the lower layer of the denim, giving it a faded look. It can be carried on indigo and sulphur dyed base fabric [3]. In acid washing basic chemicals

are potassium permanganate (KMnO_4) and phosphoric acid (H_3PO_4) or Ortho-phosphoric acid which are used for soaking the pumice stone [4]. The soaked pumice stone are applied to modify the appearance of denim apparel. Denim wear has gained popularity all over the world. As a result jeans wear is one of the most prominent apparel items in the world [5]. But without washing denim apparel is uncomfortable to wear, because denim is produced using very coarser yarns in both warp and weft [6]. The manufacturing process of denim is little bit different than any other fabric. It is a special process in which only the surface of the warp yarn is dyed; the core stays white. They are hard wearing, high density fabrics with a high mass per unit area [7]. So washing practice becomes a crucial issue for the denim apparel (jeans) to make it softer, more supple, smooth and comfortable to wear performance [8]. Among the various types of washing we have chosen the acid wash because only few works have been done on it. In our work we used the damp pumice stone instead of pre-soaked completely dry pumice stone to explore a time saving method of acid wash. We also investigated the effects of acid wash on denim properties by comparing the properties of treated and untreated jeans.

2. Materials and Methods

2.1 Materials

100% cotton indigo dyed denim apparel (jeans) was used for this experiment. The denim fabric was collected from Bangladesh University of Textiles (BUTEX, Dhaka, Bangladesh). The jeans were made in Apparel Manufacturing Lab of BUTEX. The yarn count of denim was 11/10 (warp/weft), the EPI (Ends per inch) & PPI (Picks per inch) 72 & 47 respectively & GSM was 303. The apparels were desized using Desizing agent NE (Amylase enzyme, Bangladesh) & Super-excel (enzymatic detergent, Bangladesh) with the standard recipe [4]. Then the desized apparels were treated with damp pumice stone. The pumice stones were soaked with potassium permanganate & phosphoric acid (Ortho-phosphoric acid, H_3PO_4 , India). The fresh pumice stones (Turkey) of medium size (3-5cm) were used for soaking. Then the washed jeans were neutralized with sodium meta-bisulphite (Meta, $\text{Na}_2 \text{S}_2\text{O}_3$, India). For softening (Basu-soft, BASF, Germany) and Acetic acid (India) was used for this experiment.

2.2 Methods

2.2.1 Desizing treatment

Denim apparels (jeans) were desized using detergent and desizing agent. The liquor ratio containing Desizing agent Ne (2gm/l) and super-excel (1gm/l) and material to liquor ratio of

1:13. The process was accomplished in an industrial horizontal sample washing machine (NgaiShing, Model-NS-2205, Hong Kong) at 60°C for 20 min. Desizing treatment was carried out to remove the sizing material from the yarn dyed denim. After that a hot wash was conducted at 70°C for 20 min following a cold wash for 3 min.

2.2.2 Hydro- extracting and drying processes

Desized apparels were squeezed in Hydro-extractor m/c (Zanussi, Roaches International LTD, England) at 200 RPM for 4 min to remove excess water from the apparels. Then the samples were dried at 65°C for 25 min in a sample steam drier (OPTI-DRY, Roaches, International LTD, England) following 5 min cold dry in the same machine.

2.2.3 Soaking of pumice stone

The fresh pumice stones were soaked at room temperature for 10 min by shuffling using potassium permanganate (4gm/l, KMnO_4) and phosphoric acid (1ml/l, H_3PO_4) containing the liquor ratio 1:2. Pumice stones are naturally perforated; hence pick up the solution very quickly [9].

2.2.4 Damp pumice stone treatment

After the desired soaking of pumice stone, the completely dried desized apparels were treated with them (damp pumice stone) at room temperature for 15 min at the same sample washing machine at 30 RPM without additional water followed by the standard washing procedure [4]. After the treatment the pumice stone were unloaded from the machine.

2.2.5 Neutralization and softening treatment

The acid washed apparels were conducted by a neutralization process, a detergent wash and a softening process respectively. The neutralization process was carried out by sodium metabisulphite (4gm/l) at room temperature for 5 min, detergent wash by super-excel (2gm/l) at 50°C for 10 min to remove the breaking stone dust and adhering chemicals and Softening was carried out by Basu-soft softener (1gm/l).

2.2.6 Hydro-extracting and drying process

The acid washed apparels were squeezed and dried in the same hydro-extractor machine and drier respectively following the same time, temperature and RPM. Then the treated apparels were assessed to find out the changes of properties of denim apparel due to acid wash treatment.

3. Testing and analysis:

The treated apparels were conditioned to moisture equilibrium directed in ASTM D 1776.

Stiffness was measured from the bending length of fabric by Shirley stiffness tester according to BS 3356 [10]. GSM was calculated from the differences in denim fabric weight between before and after washed treated denim according to ASTM D 3776 [11]. Breaking length was calculated by using the grab test principle according to ASTM D 5034[12]. The change in colour depth was assessed with a gray scale for assessing change in colour. The dimensional changes were calculated by assessing the difference in fabric length between before and after washed denim apparel.

4. Result and Discussion

From the experiment a time saving method of acid wash for denim apparels was investigated. Pre-treated denim apparel was subjected to the potassium permanganate ($KMnO_4$) and phosphoric acid (H_3PO_4) combined with damp pumice stone. This technique makes it different from any other washing. It also found from the experiment that some properties are affected positively and others are negatively by the acid wash treatment. The properties of denim apparel were evaluated by various testing procedure and findings are summarized below in a tabular form.

Table: Effect of Acid wash on the properties of woven denim apparel

Properties of denim fabric		Before wash	After wash
Stiffness (cm)	warp	3.46 (0%)	2.9 (-16%)
	weft	2.1 (0%)	1.9 (-9.5%)
GSM (gm/ m ²)		303(0%)	291 (-4%)
Breaking strength (lbf)	warp	337(0%)	278(-17.5%)
	weft	225(0%)	191 (-15%)
Color shade (grey scale)		5	4
Dimensional changes (shrinkage or growth %)	Length wise	0%	-2.5%
	Width wise	0%	+ 1.25%
Count (Ne)	warp	11	12
	weft	10	11
EPI (Ends/inch)&PPI(picks/inch)		72×47	73×47

From the above table the effect of acid wash on the properties of denim apparel can be identified by analyzing the before and after wash properties. In the experiment we have used

400% pumices stone on the weight of material. As a result the rubbing action of stone negatively affects the breaking strength of denim both in the warp and weft yarn. The strength loss% is more in the warp way because the stone attacks the warp yarn more as it is 3/1 warp faced twill denim. The measuring of stiffness was calculated from bending length. It is evident from experiment that reduction of stiffness % is more significant in the warp way than the weft as the size material of warp yarn was removed in the desizing treatment. As a result the warp yarn became softer. Due to finishing process the dimensional instability was temporarily set in the fabric [13]. After subsequent washing process the garments become fully relaxed. This causes a decrease in GSM of fabric slightly. As the potassium permanganate is color discharging oxidant the acid wash caused a color fading of denim garment with a frosty look due to irregular rubbing action of pumice stone. If the denim and stone are longer spun together the lighter color of the fabric with better contrasts would result [14]. The cotton fabric is tightly weaved and the tension is more in the warp direction. This tension increases at the time of subsequent finishing process [13]. This tightly weaved fabric become relaxed after the several times of washing process. This causes a reduction in fabric length. As the sample was 100% cotton indigo dyed denim apparel the count measuring unit was English count Ne. Due to washing the yarns become softer. As a result the count slightly increases both in the warp and weft way. It was also evident from the experiment that acid wash is less significant in the EPI & PPI of the denim apparel.

5. Conclusion

A time saving method of acid wash has been explored from this work. The implication of acid wash on the properties of denim apparel also inspected. Properties were influenced by the chemical action combined with rubbing action of the pumice stone and accelerated with the action of rotating cylinder of washing machine. It has been investigated from the study that stiffness, GSM, fabric weight, breaking strength is reduced due to acid wash whereas EPI,PPI and count slightly increased. It has been further noted that acid wash gives a frosty or freezing look on denim apparel. It is concluded that this technology can be applied in the sample washing of woven denim apparel as a time saving method.

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