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Response to Ambient Atmosphere on Pre and Post Autoclaved P/C Yarn Cones

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ABSTRACT

Autoclave steamer has recently been inducted in spinning industry to stabilize required level of moisture in the yarn package. This study explores the effect of the auto-clave steaming on various yarn characteristics of 24^s and 30^s PC yarn. Three different ratios of polyester/cotton were selected. The yarn cones were treated in autoclave steamer under three different temperature levels (60^{O}C, 70^{O}C and 80^{O}C) for six different time durations ranging from 20 to 45 minutes. The results revealed that maximum time duration and temperature recorded maximum strength and count strength product value due to the moisture take up of yarn after autoclave treatment.

Key Words: Yarn; Spinning

INTRODUCTION

Conditioning of all natural fibre yarns, blends, synthetic and micro fibre yarns improve the strength, elasticity resistance to stretching, breaking elongation effects better dye affinity etc. and reduces yarn fly, snarling, electrostatic charge generation and dusts. Thus the aim of conditioning is to provide an economical device for supplying the necessary moisture in a short time, in order to achieve a lasting improvement in quality. Unsuitable conditioned yarn not only affects the quality but production is also effected directly.

Conventional techniques like conditioning rooms become obsolete for economic reasons (high residual time of upto 24 hours). However in autoclave steamer typical conditioning cycle time is of around 40 minutes, which is 16 times shorter than conventional conditioning. Conditioning of yarn cones at autoclave revealed significant improvements in the blended yarns, which has a direct effect upon quality of end products. The assigned research project was planned to investigate the effect of autoclave steamer upon the PC blended yarn quality. Kleinhansl (1995) perceived that steaming system improves yarn quality and increases the weight of yarn. Similarly Carter (2001) observed that in line yarn steamer achieves impressive advantages of maintaining maximum strength. Also Saville (1999) explored that some fibres, such as wool and viscose lose strength when they absorb water and some such as cotton increase in strength.

MATERIALS AND METHODS

The present research work was initiated in the Department of Fibre Technology, University of Agriculture, Faisalabad and conducted at “Reliance Cotton Spinning Mills Ltd., Ferozewattwan (Distt. Sheikhpura) during the year 2003. The study explores the effect of the auto-clave steaming on various yarn characteristics of (24^s) C1 and (30^s) C2 PC yarn. Three different ratios viz (0:100) B0, (25:75) B1 and (50:50) B2 of polyester/cotton were selected. The yarn cones were placed in autoclave steamer at three different temperatures (60^{O}C) T1, (70^{O}C) T2 and (80^{O}C) T3 for six different time durations (D1 to D6) ranging from 20 minutes to 45 minutes

Yarn characteristics. The yarn count, strength and CLSP values were estimated according to the method of ASTM Committee (1997) and British Standards (1985).

Analysis of data. The data was analyzed statistically by applying analysis of variance technique, while DMR test was applied for individual comparison as suggested by Steel and Torrie (1984) using M-Stat micro computer package devised by Freed (1992).

RESULTS AND DISCUSSION

Yarn count. The comparison among control (untreated) and control versus other treatments presented in table I shows that the controlled values of blends (B_0, B_1, B_2) under C_1 (24^s) recorded 24.22^s, 24.17^s, 24.19^s and for C_2 (30^s) as 30.16^s, 30.20^s, 30.17^s, respectively. This reveals a significant difference within controlled mean values for both counts (C_1, C_2). It is obvious from the results that the actual yarn number of all blends under both counts (C_1, C_2) slightly differs from the nominal count. The diversification in the results may have induced by various variants as Rehman (1990) investigated that actual value of yarn count spun from cotton or any other fibres generally differ from nominal value.

The comparison of controlled values versus other treatments (Table I) clarifies that when various blends (B_0, B_1, B_2) under C_1 (24^s) were autoclaved for temperature T_1 (60^{o}C) at different steaming time levels, the maximum value is achieved under D_1 (20 min) as 24.18^s, 24.15^s, 24.18^s and minimum values as 24.05^s, 24.05^s, 24.10^s for D_6 (45 min), respectively. Identical trend in count decrease is also observed under treatment T_2 (70°C) at various time durations (D). Over all coarser values of yarn count of all blends (B_0, B_1, B_2) for 24^s are recorded at highest treatment parameters i.e. T_3D_6 as 23.78^s, 23.82^s, 23.94^s, respectively; which reveals significant difference from control specimen. It is inferred from the above results that percentage decrease (after treatment) in count value of blends (B_0, B_1, B_2) under C_1 are as 1.85, 1.46, and 1.04%, respectively.

Similar results are achieved for all blends under C_2 (30^s) with maximum and minimum values as 30.12^s, 30.18^s, 30.16^s and 29.63^s, 29.79^s, 29.88^s percent respectively after conditioning in autoclave under variant combinations of temperature (T) and time (D). At highest setting ($T_3D_{6)}$, the percentage decrease under (B_0, B_1, B_2) for C_2 is recorded as 1.78, 1.37, 0.97%. From the above results, it is clear that the yarn becomes coarser as temperature and time level (D) is increased and B_0 (Pure cotton) under both counts becomes

Table I. Individual comparison of all treatments with their control values

			$C_1 = 24^s$			$C_2 = 30^s$	
		B_0	**B_1**	**B_2**	**B_0**	**B_1**	**B_2**
Temperatures	**Control values/ Time Durations**	24.22a	24.17a-d	24.19ab	30.16A-D	30.20A	30.17ABC
	D_1	24.18abc	24.15a-d	24.18abc	30.12A-F	30.18AB	30.16A-D
	D_2	24.13a-e	24.14a-d	24.16a-d	30.09A-G	30.17A-D	30.15A-E
	D_3	24.07b-j	24.11a-f	24.14a-d	30.07A-H	30.13A-F	30.12A-F
T_1 (60C°)	D_4	24.06c-j	24.09b-h	24.15a-d	30.03A-J	30.10A-G	30.13A-G
	D_5	24.05c-j	24.07b-j	24.12a-f	29.99A-L	30.08A-J	30.09A-G
	D_6	24.05c-j	24.05c-j	24.10a-g	29.97A-M	30.06A-I	30.07A-H
	D_1	24.00p-k	24.01e-k	24.08b-i	29.93B-O	30.01A-L	30.04A-K
	D_2	23.97g-l	23.98g-l	24.07b-j	29.88F-Q	29.98A-N	30.02A-L
	D_3	23.95i-m	23.97g-l	24.05c-j	29.85H-Q	29.96A-N	30.00A-M
T_2 (70C°)	D_4	23.94j-n	23.94j-m	24.04b-j	29.82I-Q	29.98D-P	29.98A-N
	D_5	23.88k-p	23.91k-o	24.01e-k	29.75L-Q	29.88F-Q	29.96A-O
	D_6	23.86l-p	23.90k-p	24.00f-k	29.75L-Q	29.87G-Q	29.94A-O
	D_1	23.84m-p	23.87l-p	23.98g-l	29.71M-Q	29.83H-Q	29.92B-O
	D_2	23.84m-p	23.87l-p	23.95I-m	29.70N-Q	29.82H-Q	29.91C-P
T_3 (80C°)	D_3	23.81op	23.85l-p	23.96h-m	29.68OPQ	29.81H-Q	29.91C-P
	D_4	23.80op	23.84m-p	23.95I-m	29.65PQ	29.80I-Q	29.89C-Q
	D_5	23.79op	23.82nop	23.94j-n	29.63Q	29.78J-Q	29.88F-Q
	D_6	23.78p	23.82nop	23.94j-n	29.63Q	29.79I-Q	29.88F-Q

Note: - Small and capital alphabets are used separately for 24^s and 30^s counts respectively
Any two means not sharing a letter in common differ significantly at 0.05 level of probability.

Table II. Individual comparison of all treatments with their control values

			$C_1 = 24^s$			$C_2 = 30^s$	
		B_0	**B_1**	**B_2**	**B_0**	**B_1**	**B_2**
Temperatures	**Control values/ Time Durations**	78.82v	91.49n	105.4g	62.04X	71.00O	81.72G
	D_1	79.21v	91.82mn	105.7fg	62.26WX	71.15NO	81.85G
	D_2	79.51uv	92.06mn	105.9efg	62.54VWX	71.30NO	81.97FG
	D_3	79.82tuv	92.36lmn	106.2d-g	62.80U-X	71.54MNO	82.21EFG
T_1 (60C°)	D_4	80.03tuv	92.41lmn	106.3d-g	62.95U-X	71.65MNO	82.26EFG
	D_5	80.55s-v	92.78k-n	106.5c-g	63.30T-W	71.79L-O	82.55D-G
	D_6	80.76r-v	92.96k-n	106.7c-g	63.51T-W	72.10L-O	82.65C-G
	D_1	81.38q-u	93.39j-n	107.1b-g	63.76S-V	72.43K-N	83.00B-F
	D_2	81.72p-t	93.74I-m	107.4a-g	64.05R-U	72.70J-M	83.25A-E
	D_3	82.13o-s	93.82I-n	107.6a-f	64.42Q-P	72.78I-M	83.40A-D
T_2 (70C°)	D_4	82.55o-s	94.22h-l	108.0a-e	64.70P-T	73.10H-L	83.68A-D
	D_5	82.72o-r	94.68h-k	108.2a-d	65.02P-S	73.45H-K	84.85ABC
	D_6	83.31opq	94.74h-k	108.3a-d	65.14PQR	73.40H-K	83.95AB
	D_1	83.19opq	95.10hij	108.6abc	65.47PQ	73.75H-K	84.15AB
	D_2	83.25opq	95.16hij	109.0ab	65.50PQ	73.84HIJ	84.31AB
T_3 (80C°)	D_3	83.62op	95.23hij	108.9ab	65.71PQ	73.88HIJ	84.40AB
	D_4	83.85op	95.59hi	109.1ab	65.82P	74.00HI	84.47AB
	D_5	84.03o	95.89hi	109.2ab	65.89P	74.18GI	84.54AB
	D_6	84.21o	96.03h	109.3a	66.00P	74.30H	84.60A

Note: - Small and capital alphabets are used separately for 24^s and 30^s counts respectively
Any two means not sharing a letter in common differ significantly at 0.05 level of probability.

more coarser when compared with B_1 (25/75), B_2 (50/50). Because pure cotton yarn is hygroscopic in nature, it absorbs more moisture and ultimately its weight increases more which leads towards coarser count. The variations in results of yarn number (after steaming) for both counts C_1 (24^s) and C_2 (30^s) is attributed to multiple reasons as Kleinhansl (1995) perceived that steaming system improves yarn quality and increases the weight of yarn, steaming and humidification also increases the moisture content of cotton yarn.

Yarn lea strength. The statistical comparison of treatment means with respective control value and among controls pertaining to lea strength presented in table II, indicates that control value of yarn strength for pure cotton and blends for C_1 (24^s) recorded 78.82, 91.49 and 105.4 pounds and 62.04, 71.00 and 81.72 pounds, respectively for C_2 (30^s). Within controls, the mean values for both counts showed significant differences. The above table reveals that yarn lea strength goes on improving under both counts with the addition of polyester in pure cotton. Infect polyester fibre is far stronger than cotton and its components share in blend register quantitative strength increment. A more supporting statement was advanced by Shahbaz and Nawaz (1998) they concluded that blends with higher percentage of polyester fibre shows more strength as compared to yarn with lower percentage of polyester. Prior investigation by Magi (1978) explored that the strength of cotton yarn was improved if blended with polyester. However, strength of yarn could be predicted from stress-strain, behaviour of the spun yarn.

However ironically this is factual evidence that blended yarn has breaking strength lower than those expected from the summation of the proportionate constituent fibre components strength.

Table II clarifies that when 24^s blends (B_0, B_1, B_2) are conditioned at T_1 (60°C) under various time levels (D), the highest value for all blends is observed at D_6 showing yarn strength values as 80.76, 92.96 and 106.7 pounds, respectively which differ non-significantly from their control values. Similarly the maximum and minimum values of blends for C_1 at T_2 (70°C) are noted as 83.31, 94.74 and 108.3 pounds, and 81.38, 93.39 and 107.1 pounds, respectively. Identical trend for all blends under C_1 is found at various combinations of T_3 (80°C) with steaming duration (D) the best values of yarn lea strength of blends of for C_1 are recorded at maximum temperature and time (T_3D_6) as 84.21, 96.03 and 109.3 pounds, respectively. From the above results, it is obvious that at T_3D_6 the yarn lea strength of B_0, B_1, B_2 is increased to extent of 6.83, 4.96 and 3.70%, respectively from control value. It is very well clear from the above observations that gain in yarn is lea strength of 100% cotton yarn is more than that its of blended yarns, simply because cotton is hygroscopic in nature whereas synthetics are not.

Likewise after autoclave treatments of all blends (B_0, B_1, B_2) of C_2 (30^s) under variant combinations of temperature (T) and time levels (D), the overall maximum and minimum values are noticed as 66, 74.30 and 84.60 pounds and 62.26, 71.15 and 81.85 pounds, respectively. The trend of increase in yarn lea strength of all blends under C_2 (30^s) with the rise of temperature and time level is similar identical to that for C_1 (24^s). The percentage increase of all blends for C_2 (30^s) at T_3D_6 is observed as 6.38, 4.64 and 3.52%, respectively.

The above results indicates that lea strength of all blends (B_0, B_1, B_2) for both counts (C_1, C_2) increases as temperature and steaming duration rises up and percentage

Table III. Individual comparison of all treatments with their control values

		$C_1 = 24^s$			$C_2 = 30^s$		
		B_0	**B_1**	**B_2**	**B_0**	**B_1**	**B_2**
Temperatures	**Control values/ Time Durations**	1909v	2211n	2550g	1871S	2144K	2465D
	D_1	1915uv	2217mn	2555fg	1875RS	2147JK	2468D
	D_2	1919uv	2222mn	2559efg	1882RS	2151JK	2471CD
	D_3	1921uv	2227lmn	2563d-g	1888QRS	2156J-K	2476CD
T_1 (60C°)	D_4	1926tuv	2226lmn	2567d-g	1890P-S	2157IJK	2478CD
	D_5	1937s-v	2233k-n	2579c-g	1898O-S	2162H-K	2484BCD
	D_6	1942stu	2235k-n	2572c-g	1903O-S	2166G-K	2485A-D
	D_1	1953rst	2242j-n	2578b-g	1908N-S	2170F-K	2493A-D
	D_2	1959qrs	2248i-m	2584a-f	1914M-R	2179E-K	2499A-D
	D_3	1967p-s	2249i-m	2588a-e	1923L-Q	2180E-K	2502A-D
T_2 (70C°)	D_4	1976o-r	2256h-l	2595a-d	1929L-Q	2191E-J	2508ABC
	D_5	1975o-r	2264h-k	2599abc	1934L-P	2194E-I	2512AB
	D_6	1988opq	2264h-k	2600abc	1938L-O	2191E-I	2513AB
	D_1	1983o-r	2270hij	2605ab	1945LMN	2200E-I	2517AB
	D_2	1985o-r	2271hij	2609ab	1945LMN	2202E-H	2522AB
T_3 (80C°)	D_3	1991opq	2271hij	2609ab	1950LM	2202E-H	2524AB
	D_4	1996opq	2279hi	2613a	1952LM	2205EFG	2525AB
	D_5	1999op	2284h	2615a	1952LM	2209EF	2526A
	D_6	2003o	2287h	2616a	1956L	2213E	2528A

Note: - Small and capital alphabets are used separately for 24^s and 30^s counts respectively

Any two means not sharing a letter in common differ significantly at 0.05 level of probability.

gain in strength for B_0 (pure cotton) at maximum treatment parameters is the maximum when compared with blends B_1 (25/75) and B_2 (50/50), only because of the reason that cotton is hygroscopic in nature where as and polyester is hydrophobic. These results are at par with the previous research observations Anonymous (2002) who mentioned that cotton is hygroscopic fibre. The properties of the cotton fibres such as dimensions, strength, elastic recovery and electrical resistance etc., are affected by the amount of water vapour it absorbs from the surrounding atmosphere.

Review of the above cited facts elucidate 3.52-6.83 percent gain in yarn strength due to autoclave treatment, which is more pronounced at maximum time and temperature level (T_3D_6). Evidence further proves that strength attainment is more for pure cotton, which gradually descend as the proportion of polyester is escalated, simply because of the fact that cotton is hygroscopic in nature while polyester is not.

Count lea strength product value. This is authentic confirmation that blended yarns have breaking strength lower than those anticipated from the computing of converse integral fibre components strength.

It is also quite apparent from the results shown in Table III that after conditioning in autoclave, the CLSP values for blends (B_0, B_1, B_2) under both counts (C_1, C_2) increase gradually with the rise of temperature from T_1 (60^{o}C) to T_3 (80^{o}C) as well as steaming time minimum value for D_1 (20 min.) to maximum D_6 (45 min.). However the best values for blends (B_0, B_1, B_2) under both counts (C_1, C_2) are recorded at elevated treatment parameter (T_3D_6) as 2003, 2287, 2616 and 1956, 2213, 2528 hanks, respectively which reveals a significant difference from their control output. The percen gain in CLSP at best combination (T_3D_6) for blends (B_0, B_1, B_2) under C_1 (24^s) was 4.92, 3.43 and 2.58 and for C_2 (30^s) by 4.54, 3.21 and 2.55%, respectively. Which clearly shows that after autoclave treatments, CLSP of B_0 (pure cotton) is increased more than that of blended yarn. The increase in CLSP of both counts (C_1, C_2) with temperature and time duration is due to the fact that at higher temperatures, the moisture take up of B_0 (pure cotton) is greater than its blends B_1 (25/75), B_2 (50/50) which ultimately effects the yarn strength parameters. The above results gets support from the researches of Saville (1999) who explored that some fibres, such as wool and viscose lose strength when they absorb water and some such as cotton increase in strength.

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