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The Effect of Vacuum Steaming Parameters on the Physical Properties of Chenille Yarns

Abstract
In this study, the effects of vacuum steaming process parameters on the physical properties of chenille yarns and fabrics were studied. For this purpose chenille yarns were produced with viscose and acrylic pile and core yarns in different yarns counts. The chenille yarns were subjected to vacuum steaming at varying process parameters, for example the steaming temperature (60, 80 and 110 °C) and steaming period (20, 40 and 60 minutes). According to the results of statistical analyses performed using experimental values obtained before and after vacuum steaming, physical parameters, like yarn count, twist, tenacity, elongation and work-of-break values were affected by the vacuum steaming process. An increase in fabric abrasion resistance was observed when the vacuum steamed chenille yarns were used as filling in the woven fabric construction. Process parameters are significant regarding change in yarn count and twist, but are insignificant regarding change in work-of-break values. Temperature is not a significant factor during any change in the tenacity of viscose chenille yarn, but is a significant factor in any change in the elongation values of acrylic chenille yarns.

Key words: *chenille yarn, vacuum steaming, temperature, abrasion resistance, tenacity.*

Introduction

Fancy yarns differ from the normal construction of single and folded yarns by way of the deliberately produced irregularities in its construction. These irregularities relate to an increased input of one or more of its components, or to the inclusion of periodic effects [1]. This irregularity is incorporated with the intention of producing an enhanced aesthetic effect. Fancy yarns can be manufactured by such techniques as twisting threads together, which are different in the material, colour, softness, thickness, length, amount and direction of twist; and by forming curls, snarls, lumps, knops, as well as thick and thin places at intervals in the yarn [2 - 4].

Chenille is a type of fancy yarn which has a soft, fuzzy, lofty surface- an effect achieved by a core of two yarns (core yarn) plied together and firmly holding short tufts of soft-twisted yarn (pile yarn) between the twist along the core's length. The result is a yarn with a velvet- like or pile surface (Figure 1) [5, 6]. Generally, core yarns are highly twisted, fine and strong, whereas pile yarns are soft-twisted spun or filament yarns. Chenille yarns can be created on modified ring-spinning frames.

Despite the fact that chenille yarns are used to produce special fabrics with high added value, a literature survey showed that there is limited research on the physical properties of such yarns and fabrics. Recently, several researchers attempted to determine the effect of yarn structure (pile length, twist level, pile material type) and laundering parameters on the dimensional, physical and abrasion characteristics of chenille yarns and fabrics produced with these yarns [5, 8 - 12].

Nevertheless, there is no research on investigating the dimensional and physical behaviour of chenille yarns after different vacuum steaming conditions.

With the aid of steaming, yarns are conditioned or heat-set with saturated steam under vacuum. The purposes of vacuum steaming are to relax yarns, to prevent them from snarling, to enable them to be worked efficiently in the processes described below, to improve quality in weaving and knitting plants by reducing yarn tension, softening yarns, moisturising them homogenously, eliminating the electrostatic effect, reducing fly, to make it possible for bobbins to shrink homogenously and to fix yarn twist [13, 14].

This study aims to fill this gap by contributing to both the examination of the most significant parameters governing vacuum steaming and to the investigation of the interrelationships and specific influences of vacuum steaming parameters on the physical and mechanical properties (twist level, yarn count, tenacity, elongation and work-of-break) of chenille yarns and the abrasion properties of woven fabrics from chenille yarns. In doing so, the vacuum steaming parameters that affect chenille yarn properties were defined and an experimental study program was designed.

Experimental

The experiments involved chenille yarn samples manufactured from viscose and acrylic pile, and core yarns of the same yarn count. 190 tex count viscose chenille yarns were produced using two 30 tex count viscose lock yarns and one 30 tex count viscose pile yarn. 250 tex count acrylic chenille yarns were produced using two 30 tex count acrylic (staple acrylic fibre) lock yarns and one 30 tex count acrylic pile yarn of 1.0 mm length with a yarn twist of 810 turns/m - in the S twist direction. The chenille yarns were produced on a HZR-10 model Huzur chenille yarn machine

Afterwards, the chenille yarn samples were subjected to vacuum steaming under 40 kPa pressure using Violet-A model Tekst yarn conditioning and a steaming machine, which has an indirect vacuum steaming system. Saturated steam was used in the machine during the process, which at low temperature is effectively water ready to condense immediately on contact with yarn since it maximum satu-

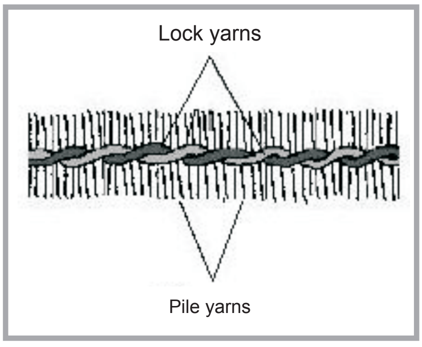

***Figure 1.** Chenille yarn [7].*

ration is achieved with water. Also, it has the highest energy density, which allows the quick heating of yarn. The Chenille yarn samples were subjected to vacuum steaming at temperatures of 60, 80 and 110 °C, and the steaming periods were 20, 40 and 60 minutes. Table 1 shows the steaming cycles characterised by pressure, temperature and period.

Yarn Coding:
The coding of the yarns according to vacuum steaming conditions is given by:
abc: a) - chenille yarn material; b) - steaming temperature; c) - steaming period
for a:
V stands for viscose, A for acrylic
for b:
1 stands for 60 °C, 2 for 80 °C, 3 for 110 °C
for c:
1 stands for 20 minutes, 2 for 40 minutes, 3 for 60 minutes.

For example, A23 means that: the pile and core yarn material of the chenille yarn is acrylic; the chenille yarn is subjected to vacuum steaming at 80 °C and the period of vacuum steaming is 60 minutes.

Fabrics from vacuum steamed and unsteamed chenille yarns were subsequently woven on a HTVJ model (rigid rapier) Dornier weaving machine, using the chenille yarns as filling in the fabric construction. For all the fabrics the weave was twill 1/2 (S), the warp yarn was 16.7 tex polyester (the twist amount was 400 turns/m in the Z twist direction), the warp direction density was 66 ends/cm and that of the weft direction was 10 picks/cm.

Vacuum steamed chenille yarns were constantly compared with the unsteamed reference yarns, on the basis of the difference in yarn count in tex, twist level in turns/meter, tenacity in cN/tex, elongation at break in %), work-of-break in N·cm and fabric mass loss in per cent values.

Yarn count and yarn twist measurements of the chenille yarns were performed according to Standards ISO 2060 and ISO 2061, respectively. The chenille yarns were also subjected to tensile tests on a Instron tensile tester according to Standard ISO 2062. The machine was operated with a gauge length of 500 mm, at a cross-head speed (test velocity) of 5000 mm/minute, and with a pretension of 0.5 cN/tex. All the measurements and tests were performed on the chenille yarns before and after the vacuum steaming processes.

Table 1. *Steaming cycles for chenille yarns.*

Process	Pressure, kPa	Temperature, °C	Period, minute
Pre-heating	101.3	40	3
Wait in heated state	101.3	40	3
Initial vacuum	101.3 → 40.0	40	4
Heating	40.0 → 97.0 40.0 → 97.0 40.0 → 97.0	40 → 60 40 → 80 40 → 110	9
Steaming	97.0	60	20 40 60
		80	20 40 60
		110	20 40 60
Final vacuum	97.0 → 40.0	60 → 40 80 → 40 110 → 40	15
Pressure balance	40.0 → 101.3	40	4

Table 2. *t-Test results for yarn count and twist values of chenille yarns; * The results were assessed at a significance level of 5%, t-table =* $t_{n1+n2-2, \alpha/2}$ == $t_{10+10-2, 0.025}$ = $t_{18, 0.025}$ = *2.10.*

Yarn code	Yarn count, tex				t-test	Yarn twist, tpm				t-test	Significance*
	Pre-vacuum steaming		Post-vacuum steaming			Pre-vacuum steaming		Post-vacuum steaming			
	mean	s.d.	mean	s.d.		mean	s.d.	mean	s.d.		
V11	188	1.4	201	2.0	16.84	809	2.1	815	2.1	6.33	Significant
V12	189	1.6	204	4.1	10.78	809	2.1	821	2.1	12.66	Significant
V13	189	1.2	207	2.9	18.14	809	2.1	826	1.6	19.39	Significant
V21	189	1.5	208	3.1	17.45	810	1.6	827	2.8	16.56	Significant
V22	189	1.2	211	1.7	33.43	810	1.6	827	2.9	16.81	Significant
V23	189	2.2	214	1.2	31.55	809	2.1	830	2.1	21.59	Significant
V31	189	1.4	212	1.8	31.90	810	2.1	835	2.2	26.47	Significant
V32	189	1.0	214	1.9	36.82	810	2.6	839	3.0	23.21	Significant
V33	189	1.1	215	1.7	40.61	810	2.3	841	2.5	29.15	Significant
A11	249	3.7	269	3.0	13.28	809	3.1	822	3.1	8.75	Significant
A12	250	3.5	274	3.3	15.78	810	2.7	840	3.5	21.50	Significant
A13	249	3.8	281	3.1	20.63	809	2.5	860	3.5	37.01	Significant
A21	249	4.1	278	2.8	18.47	810	1.8	874	2.9	59.77	Significant
A22	250	3.1	285	3.5	23.67	810	2.8	879	4.7	39.55	Significant
A23	249	3.7	285	3.3	22.96	810	2.1	882	4.1	50.22	Significant
A31	250	4.8	285	3.9	17.90	810	2.6	893	1.4	90.10	Significant
A32	249	3.6	286	3.9	22.04	810	1.9	915	3.3	88.24	Significant
A33	249	4.1	288	6.7	15.70	810	2.6	965	2.9	123.0	Significant

Abrasion tests of the woven chenille fabric samples were conducted on a Martindale Wear and Abrasion Tester (James Heal & Co. Ltd., Halifax, England) in accordance with BS 5690 [15]. Abrasion cycles were limited to 10,000 rubs and mass losses in milligrams were determined for 10,000 cycles. Mass loss ratios were obtained by dividing the mass loss after the test by the initial mass of the samples. Measurements were repeated three times for each fabric type. Mass loss measurements were taken for the fabrics woven with vacuum steamed and unsteamed chenille yarns.

A Costat Statistical package was used for all statistical procedures. Test results were analysed using completely randomised two-factor analysis of variance (ANOVA) as a fixed model for viscose and acrylic chenille yarns in order to understand the statistical importance of the vacuum steaming parameters for the properties of yarns and fabrics measured. The means were compared using Student-Newman-Keuls (SNK) tests. T-tests were applied to see the significance of the differences between the values obtained from the vacuum steamed and unsteamed chenille yarns. All results were assessed at a significance level of $\alpha \leq 0.05$.

Results and discussion

Change in yarn count and twist values

Table 2 shows the t-test results for yarn count and twist values of chenille yarns,after having been vacuum steamed at different temperatures and periods.

According to the results of the t-tests applied to the mean values of yarn count and twist, there were significant differences between the count and twist values obtained for chenille yarns before and after vacuum steaming at a significance level of 5 %.

Figures 2 and 3 illustrate the average yarn count and twist values of viscose and acrylic chenille yarns for pre-vacuum steaming and post vacuum steaming versus three vacuum steaming temperatures and three vacuum steaming periods, respectively.

Figures 2 and 3 show that there is an increase in yarn count and yarn twist values just after vacuum steaming for both viscose and acrylic chenille yarns. The rate of yarn count increase varies between 1.40% and 14.13%, and the twist increase varies between 18.17% and 14.71% depending on the period and temperature of the process.

According to the variance analysis results for viscose and acrylic chenille yarns, both the vacuum steaming temperature and period were significant factors affecting yarn count and twist values. However the yarn count and yarn twist values of viscose and acrylic chenille yarns were not affected by the interaction of the vacuum steaming temperature and period. SNK test results of viscose and acrylic chenille yarns are given in Table 3.

Table 3. Effects of vacuum steaming temperature and period on the change in yarn count, twist, tenacity, elongation and work-of-break values of chenille yarns, Student-Newman-Keuls Test: (a) for viscose chenille yarns, (b) for acrylic chenille yarns; * The different letters next to the counts indicate that they are significantly different from each other at a significance level of 5%.*

(a)-Parameter		Increase in yarn count, %	Increase in yarn twist, %	Increase in tenacity, %	Increase in elongation at break, %	Increase in work of break, %
Temperature, °C	60	8.17 a	1.40 a	8.29 a	80.93 a	94.94 a
	80	11.68 b	2.22 b	10.51 a	85.10 a	90.05 a
	110	13.09 c	3.54 c	12.89 a	83.29 a	95.33 a
Period, minute	20	9.56 a	1.97 a	6.83 a	75.27 a	79.98 a
	40	11.16 b	2.41 b	10.56 ab	86.23 a	96.51 a
	60	12.22 c	2.77 c	14.30 b	87.82 a	103.83 a
(b)-Parameter		**Increase in yarn count, %**	**Increase in yarn twist, %**	**Increase in tenacity, %**	**Increase in elongation at break, %**	**Increase in work of break, %**
Temperature, °C	60	10.13 a	3.81 a	2.26 a	71.65 a	31.98 a
	80	13.19 b	8.45 b	10.73 b	73.49 a	21.73 a
	110	14.71 c	14.13 c	40.05 c	21.09 b	44.13 a
Period, minute	20	11.00 a	6.53 a	12.80 a	59.58 a	29.27 a
	40	12.79 b	8.42 b	16.38 a	54.49 a	33.71 a
	60	14.23 c	11.44 c	23.86 b	52.18 a	34.87 a

When we evaluated the SNK test results for viscose and acrylic chenille yarns in terms of the vacuum steaming temperature, there was a tendency towards increased yarn count with the application of steaming at higher degrees. It was also observed that, the twist level increased with an increase in steaming temperature for both viscose and acrylic chenille yarns. The increase in yarn count and twist for acrylic chenille yarns were greater than those for viscose chenille yarns at all temperatures.

These results can be interpreted as being due to the temperature and moisture physical properties of viscose undergoing some changes. A common feature of viscose yarn is high hygroscopicity and swelling. Swelling is accompanied by a considerable increase in fibre diameter by 25 - 52% [16]. The cause of this change is that the cellulose macromolecules which form viscose fibres are short, and the amorphous rate is high. If twisted yarn swells in a free state, its cross section increases and shrinkage of yarn is observed. The setting of twist in the case of thermoplastic yarns is accomplished only by heating but without the swelling

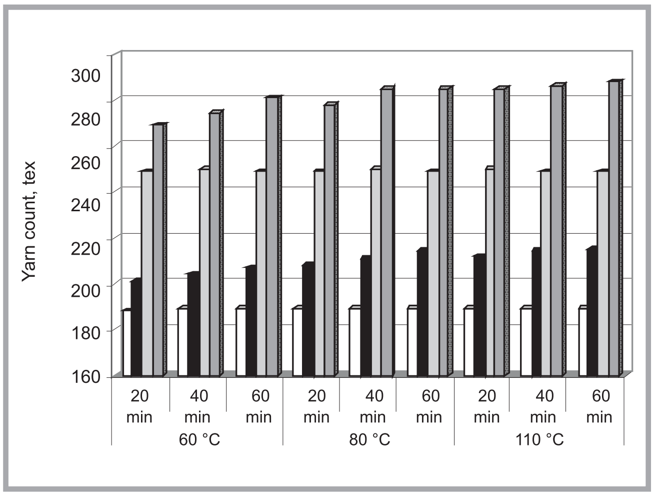

Figure 2. Yarn count values versus vacuum steaming temperature and period; □ - Viscose, pre-vacuum steaming, ■ - Viscose, post-vacuum steaming, ▒ - Acrilic, pre-vacuum steaming, ▓ - Acrilic, post-vacuum steaming.

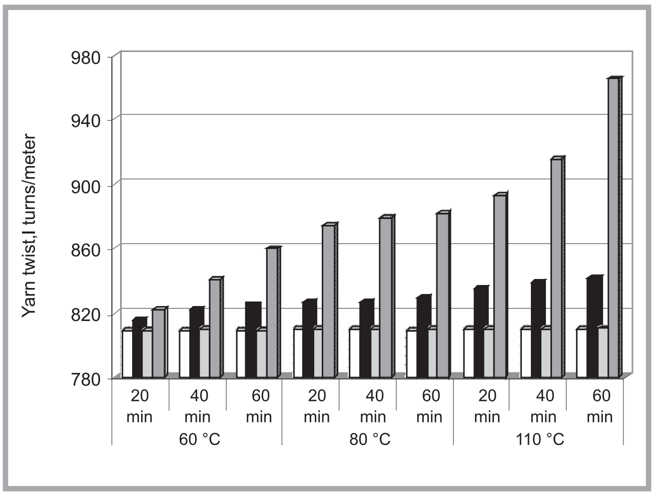

Figure 3. Yarn twist values versus vacuum steaming temperature and period; □ - Viscose, pre-vacuum steaming, ■ - Viscose, post-vacuum steaming, ▒ - Acrilic, pre-vacuum steaming, ▓ - Acrilic, post-vacuum steaming.

of yarns [17]. The shrinkage behaviour of natural and regenerated cellulosic fibres is lower than that for synthetic fibres when immersed in hot/boiling water or when exposed to shrinkage media for a fixed length of time [12, 16].

From the SNK test results of viscose and acrylic chenille yarns, in terms of the vacuum steaming period, there is a tendency toward increased yarn count with the application of steaming at higher for longer periods. The twist level increased with an increase in the steaming period for both viscose and acrylic chenille yarns. The increase in yarn count and increase in twist for acrylic chenille yarns were greater than those for viscose chenille yarns for all periods.

The vacuum steaming of viscose chenille yarns results in up to 13.09% and 12.22% higher yarn count, and that of acrylic chenille yarns can be up to 14.71% and 14.23% for a temperature of 110 °C and period of 60 minutes, respectively. Moreover, the vacuum steaming of viscose chenille yarns results in up to 3.54% and 2.77% higher yarn twist, whilst that of acrylic chenille yarns can be up to 14.13% and 11.44% for a temperature of 110 °C and period of 60 minutes, respectively.

Change in yarn tensile properties

Table 4 shows t-test results for tenacity and elongation at breake values of chenille yarns after having been vacuum steamed at different temperatures and periods.

The t-tests performed indicated that vacuum steaming affected the tensile properties of the chenille yarns. There were significant differences between the tenacity, elongation at break and work-of-break values obtained for chenille yarns before and after vacuum steaming at a significance level of 5%.

Table 4. *t-test results for yarn tenacity and elongation values of chenille yarns.*

Yarn code	Tenacity, cN/tex				t-test	Elongation at break, %				t-test	Significance*
	Pre-vacuum steaming		Post-vacuum steaming			Pre-vacuum steaming		Post-vacuum steaming			
	mean	s.d.	mean	s.d.		mean	s.d.	mean	s.d.		
V11	4.25	0.29	4.51	0.26	2.12	9.16	1.95	15.83	1.20	9.22	Significant
V12	4.26	0.35	4.64	0.17	3.04	9.18	1.85	17.21	0.90	12.33	Significant
V13	4.24	0.32	4.62	0.19	3.21	9.20	1.71	15.14	0.68	10.23	Significant
V21	4.20	0.11	4.31	0.14	2.11	9.19	1.41	14.63	1.19	9.33	Significant
V22	4.24	0.38	4.67	0.28	2.90	9.18	2.03	16.05	0.97	9.66	Significant
V23	4.26	0.34	5.02	0.32	5.18	9.16	2.31	17.94	2.10	8.90	Significant
V31	4.23	0.32	4.69	0.23	3.74	9.17	1.80	15.58	1.13	9.52	Significant
V32	4.22	0.34	4.71	0.26	3.66	9.16	1.73	15.87	0.88	10.96	Significant
V33	4.22	0.34	4.87	0.31	4.45	9.19	1.61	17.39	1.90	10.41	Significant
A11	4.14	0.05	4.22	0.11	2.11	22.55	1.78	38.79	2.19	18.17	Significant
A12	4.11	0.05	4.21	0.14	2.15	22.18	1.83	37.99	3.38	13.01	Significant
A13	4.14	0.08	4.28	0.18	2.23	22.30	1.17	38.33	2.92	16.12	Significant
A21	4.14	0.08	4.42	0.33	2.72	22.33	1.37	37.05	2.82	14.84	Significant
A22	4.14	0.09	4.63	0.36	4.27	22.37	1.26	39.77	2.35	20.67	Significant
A23	4.17	0.09	4.73	0.15	9.95	22.47	1.67	39.37	2.65	17.06	Significant
A31	4.17	0.12	5.42	1.02	3.85	22.44	1.49	31.76	8.54	3.40	Significant
A32	4.15	0.10	5.63	0.63	7.27	22.49	3.72	25.92	2.95	1.12	Significant
A33	4.17	0.12	6.47	0.18	34.1	22.45	2.53	24.48	1.50	1.49	Significant

Figures 4 and 5 show average tenacity and elongation at break results for viscose and acrylic chenille yarns after pre-vacuum steaming and post vacuum steaming, versus vacuum steaming temperatures to compare 20, 40 and 60 minute vacuum steaming periods, respectively.

As can be seen in Figures 4 and 5, the vacuum steaming process brings about considerable improvement in the yarn tenacity and elongation at break values for both viscose and acrylic chenille yarns. Also the work-of-break values were drastically improved by the process.

The tenacity increase in all the chenille yarns is within the range of 0.12 to 2.30 cN/tex. This corresponds to an increase rate of 2.26% and 40.05%. The rate of elongation at break increase varies between 21.09% and 87.82%, and the work-of-break increase is between 21.73% and 103.83%, depending on the period and temperature of the process. The improvements observed in the tenacity, elongation at breake and work-of-break of the yarns after vacuum steaming can be interpreted as the structure of

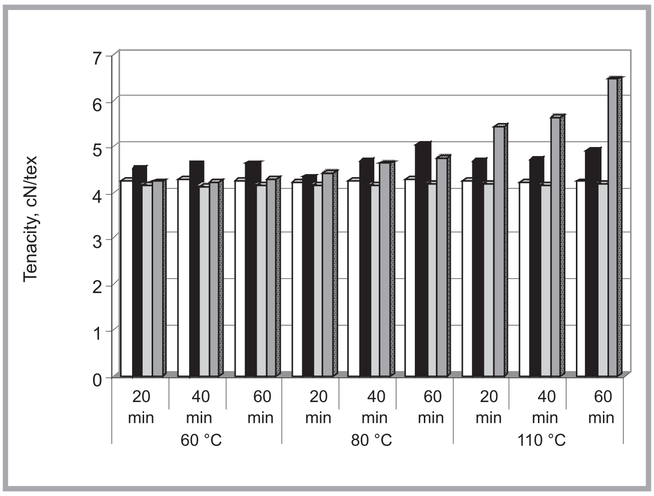

Figure 4. *Yarn tenacity values versus vacuum steaming temperature and period; □ - Viscose, pre-vacuum steaming, ■ - Viscose, post-vacuum steaming, ▒ - Acrilic, pre-vacuum steaming, ▒ - Acrilic, post-vacuum steaming.*

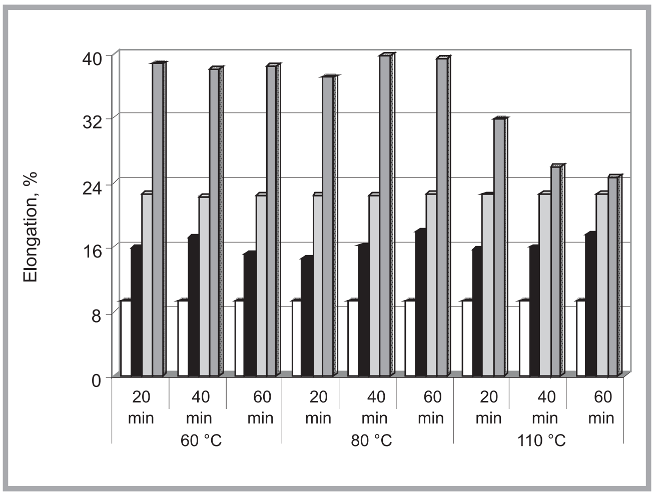

Figure 5. *Yarn elongation at break values versus vacuum steaming temperature and period; □ - Viscose, pre-vacuum steaming, ■ - Viscose, post-vacuum steaming, ▒ - Acrilic, pre-vacuum steaming, ▒ - Acrilic, post-vacuum steaming.*

chenille yarn resembling to that of two fold yarns, thus the increase in the twist level of the chenille yarn due to steaming causes an increase in the tensile characteristics.

Based on the variance analysis results, the tenacity values of acrylic chenille yarns were significantly affected by the vacuum steaming temperature and period, while those of viscose chenille yarns were significantly affected only by the vacuum steaming period. The vacuum steaming temperature factor was insignificant for the tenacity results of viscose chenille yarns.

The elongation at break values of viscose chenille yarns were not significantly affected by temperature and period, while those of acrylic chenille yarns were significantly affected only by the temperature factor. We observed that the work-of-break values of viscose and acrylic chenille yarns were not significantly affected by temperature and period. However, the tenacity, elongation at break and work-of-break values of viscose and acrylic chenille yarns were not affected by the interaction of the vacuum steaming temperature and period.

The SNK test results for viscose and acrylic chenille yarns showed that tenacity had a tendency to increase when steaming was applied at higher degrees. The increments in tenacity after vacuum steaming were statistically the same for viscose chenille yarns, but there was substantial improvement in tenacity for acrylic chenille yarns at high temperature (110 °C). The substantial increase in tenacity of acrylic chenille yarns after having been vacuum steamed at 110 °C temperature, in comparison with those vacuum steamed at 60 and 80 °C, can be attributed to the better penetration of water molecules inside the yarn core.

The increases in elongation values for acrylic chenille yarns were less than those for viscose chenille yarns at all temperatures. The increases in elongation at break values of viscose chenille yarns were nearly same for different temperatures, whereas the increase in breaking elongation values of acrylic chenille yarns dropped with increasing steaming temperature. The elongation at break increase of acrylic chenille yarns dropped from 73.49% to 21.09% when the vacuum steam temperature was increased from 80 °C to 110 °C. This situation suggests that the use of high-temperature steam causes oversteaming. Oversteaming is the cause of poor physicomechanical properties in yarns and the reason for excessive stiffness [17]. The increase in work-of-break values for acrylic chenille yarns was less than those for viscose chenille yarns at all temperatures. Also, the increments in work-of-break values were not affected by the temperature factor.

When the SNK test results for viscose and acrylic chenille yarns were compared with regard to the vacuum steaming period, there was a tendency towards increased tenacity with the application of steaming for longer periods. The increases in tenacity values for acrylic chenille yarns were more than those for viscose chenille yarns for all periods. However, the increases in elongation at break and work-of-break values for acrylic chenille yarns were lower than those for viscose chenille yarns for all periods. This is due to the fact that the increase in twist values for acrylic yarns was higher than that for viscose yarns. Hence, the tenacity increase will be higher for acrylic yarns. But this increase leads to stiffness and the elongation increase will be lower than that of viscose chenille yarns. However, the effect of the period was found to be insignificant for the increments in elongation and work-of-break values for both viscose and acrylic chenille yarns.

Table 5. *Effects of vacuum steaming temperature and period on the change in mass loss values of viscose and acrylic chenille fabrics, Student-Newman-Keuls Test. The different letters next to the counts indicate that they are significantly different from each other at a significance level of 5 %.*

Parameter		Decrease in mass loss, %	
		viscose	acrylic
Temperature, °C	60	18.09 a	16.67 a
	80	21.31 a	32.55 b
	110	37.06 b	60.70 c
Period, minute	20	17.77 a	29.00 a
	40	24.51 b	35.77 b
	60	34.18 c	45.15 c

The vacuum steaming of viscose chenille yarns results in up to 12.89% and 14.30% higher tenacity values, and that of acrylic chenille yarns can in up to 40.05% and 23.86% for temperature of 110 °C and period of 60 minutes, respectively. Furthermore, the vacuum steaming of viscose chenille yarns results in up to 85.10% and 87.82% higher elongations for a temperature of 80 °C and period of 60 minutes, whilst that of acrylic chenille yarns results in up to 73.49% and 59.58 % higher elongations at break for a temperature of 80 °C and period of 20 minutes, respectively.

Change in fabric abrasion properties

According to the t-test results for mass loss values of chenille fabrics, there was a significant difference between the mass loss values obtained for chenille fabrics woven with unsteamed yarns and those woven with yarns vacuum steamed at different temperatures and periods. The average mass loss results for fabrics woven with steamed and unsteamed viscose, and acrylic chenille yarns, versus vacuum steaming temperatures and periods, are presented in Figure 6.

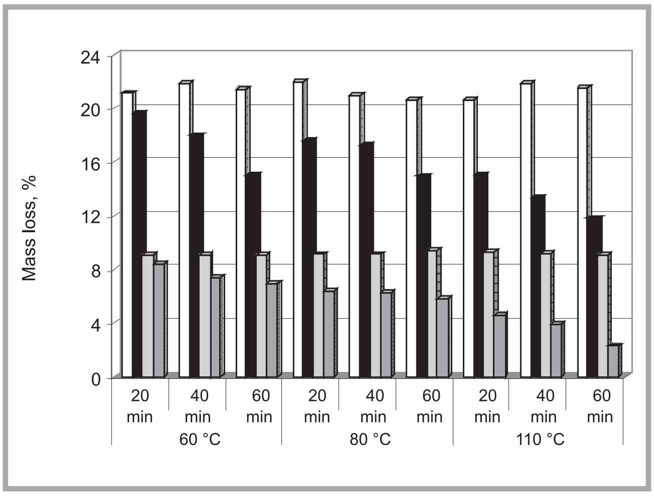

Figure 6. Fabric mass loss values versus vacuum steaming temperature and period; ☐ *- Viscose, pre-vacuum steaming,* ■ *- Viscose, post-vacuum steaming,* ▢ *- Acrilic, pre-vacuum steaming,* ▩ *- Acrilic, post-vacuum steaming.*

Figure 6 illustrates that there is a decrease in mass loss ratios when fabrics are woven with vacuum steamed chenille yarns. The decrease in mass loss ratios is between 16.67% and 60.70% depending on the period and temperature of the process. This finding indicates that the increase in the twist level of vacuum steamed chenille yarns enhances the abrasion resistance of fabrics made from them. Twist is an important structural parameter which has an effect on the abrasion resistance of chenille yarns. It is stated in the literature that a high twist level makes the yarn more compact, will retain cohesiveness, produces a smaller total surface to be abraded and increases the pile fibre adherence. At low twist levels cut yarns can easily be removed from the yarn [5, 11].

The results of variance analysis of viscose and acrylic chenille fabrics revealed statistically significant (5% significance level) differences between the mass loss values for different vacuum steaming temperatures and periods. However, the mass loss rates of the fabrics were not affected by the interaction of the vacuum steaming temperature and period.

The SNK test results for both viscose and acrylic chenille fabrics are presented in Table 3 and showed that the decrease in mass loss rates had a tendency to rise with increasing temperature and period. The vacuum steaming of viscose chenille yarns results in up to 37.06% and 34.18% lower fabric mass losses, whilst those of acrylic chenille yarns can be up to 60.70% and 45.15% for a temperature of 110 °C and period of 60 minutes, respectively.

Depending on the above-mentioned finding, it can be pointed out that the resistance of chenille woven fabrics to abrasive forces depends not only on the properties of pile yarn fibre, but also on the twist level of chenille yarn. The increase in twist for acrylic chenille yarns was greater than that for viscose chenille yarns after vacuum steaming. As a result, the decrease in mass loss for acrylic chenille fabrics was greater than that for viscose chenille fabrics.

Conclusions

The objective of this study was to investigate the interrelationships and specific influences of vacuum steaming parameters on the physical and mechanical properties (twist level, yarn count, tenacity, elongation at break and work-of-break) of chenille yarns as well as on the abrasion properties of woven fabrics made from chenille yarns.

- Vacuum steamed chenille yarns were constantly compared with unsteamed reference yarns. Significant changes take/took place in the count and twist values of the yarn after vacuum steaming. The yarn count in tex increased by 8.2 - 14.7%, while the twist increased by 1.4 - 14.1%. This process fixes yarn twisting and eliminates yarn liveliness, thus preventing snarling. Because of all these, higher yarn performance can be obtained.
- Vacuum steaming increases the moisture level in the yarns, resulting in an increase in yarn tenacity. The moisture absorption of the yarns produces higher elongation at break. The consequent relative improvement in yarn tenacity, elongation at break and work-of-break (of 6 - 40%, 21 - 87% and 21 - 103%, respectively) contributes to improved performance in the subsequent processes of chenille yarns.
- The use of vacuum steamed chenille filling yarns for the production of woven fabrics leads to an improvement in the abrasion resistance of fabrics. This situation is caused by the increase in the twist level of chenille yarns.
- Although all the effects (temperature and period) are statistically significant regarding change in chenille yarn count, twist values and chenille fabric abrasion resistance, they are not significant when it comes to change in work-of-break values at a significance level of 5%. Temperature is not a significant factor regarding change in the tenacity of viscose chenille yarn, although it is a significant factor regarding change in the elongation at break values of acrylic chenille yarns.
- Furthermore, it will be useful to carry out studies about the influence of dyeing processes on the change in the physical properties of chenille yarns.

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