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BASIC COMPARISON OF THE PROPERTIES OF THE LOOP AND FROTTE YARNS, WOVEN AND KNITTED FABRICS

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Abstract:

Both loop fancy yarns and frotte fancy yarns belong to the group of yarns with continuous effects. The difference between frotte and loop yarn relies on the fact that the loop yarn is constructed with two core yarns and the frotte yarn is constructed with only one core yarn. The differences are evident in the shape of these two types of fancy yarns. These shape differences are the functions of the tensions of component yarns during the twisting process. The shape and construction of the fancy yarn influence its properties. The properties of loop and frotte fancy yarns, woven and knitted fabrics are compared in this article in order to find out the optimal yarn's and fabric's production condition to satisfy the final user and maintain low production costs. In terms of economy aspects only, the frotte fancy yarns are believed to be cheaper in production due to lower quantity of components utilize for their production to compare with loop fancy yarns, under conditions of the same settings of ring twisting frame.

Keywords:

fancy yarn, loop yarn, frotte yarn, weaving and knitting with fancy yarns, fancy yarns' properties

Introduction

The loop yarn is characterized by distinct, rounded loops that occur on the surface of the thread. The loop yarn is formed as a result of the large overfeed of the effect yarn in relation to two core component yarns. The twist and the structure of the loop yarn are fixed by the binding yarn. The binding yarn is twisted, using low value twist, with the loop yarn in opposite direction and then the loop yarn is twisted. Therefore, the loop yarn is composed of four-component yarns: two core yarns, one effect yarn and one binding yarn. The structure of the loop yarn is presented in Figure 1 [1,2].

The frotte yarn is composed with three component yarns: one core yarn, effect yarn and binding yarn. The frotte yarn is characterized with wavy arrangement of the effect yarn. The structure of the frotte yarn is presented in Figure 2.

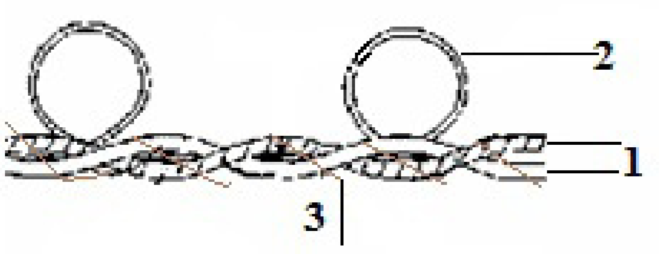

Figure 1. The structure of the loop yarn: 1 – core yarns, 2 – effect yarn and 3 – binding yarn [2].

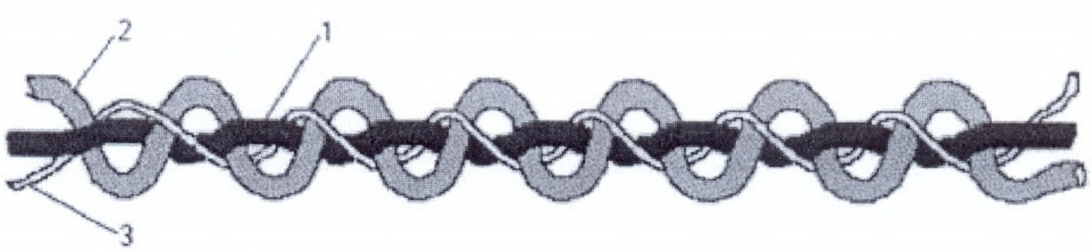

Figure 2. The structure of the frotte yarn: 1 – core yarn, 2 – effect yarn and 3 – binding yarn [3].

All types of fancy yarns can be produced by a ring twisting machine or by a hollow spindle machine. The different types of fancy yarns are produced using different types of component yarns and different settings on the twisting machine. The main difference between the hollow spindle machine and ring twisting machine relies on the efficiency of the production of the fancy yarns: the hollow spindle efficiency is near 70 m/min and the efficiency of the ring twisting machine is only 15 m/min. The differences in the efficiency of these two types of twisting machines result from the construction of the spindles and the system of the re-twisting process – in the case of hollow spindle machine, the twisting and re-twisting processes form one system; in the case of ring twisting machine, these processes are two different systems of twisting [3-6].

The differences in the shape of the loop yarn and frotte yarn are the result of the differences in the construction and laying of the component yarns in the guides during the twisting process. Laying of the component yarns on the ring-twisting machine in the case of the production of the loop yarn is shown in Figure 3. The two component yarns R1 and R2 (core) are delivered by guide PIII to the feed roller III. Next, the component core yarns are separated and introduced to the rocker arm shaft W, into two grooves on the pressure roller Nr and on this way they are twisted below guide Pn. The effect yarn Op is introduced (A) to the guide PII and to the slot guide S on the centre between the two grooves of the pressure roller Nr. Next, the effect yarn is introduced to the twisting zone through the guide Pn. In this manner, the effect yarn is introduced between two core yarns and using higher overfeed of the effect yarn, the regular loops are created on the core yarn. On the next stage and process, the loops are retwisted with the binding yarn [1,3-6].

The settings of the component yarns in the case of the production of the frotte yarn on the ring-twisting machine are presented in Figure 4. The one core yarn R is introduced through the guide PIII, feed roller III and the rocker arm shaft W. Next, the core yarn R is carried through the pressure roller Nr on the one groove to the guide Pn. The effect yarn

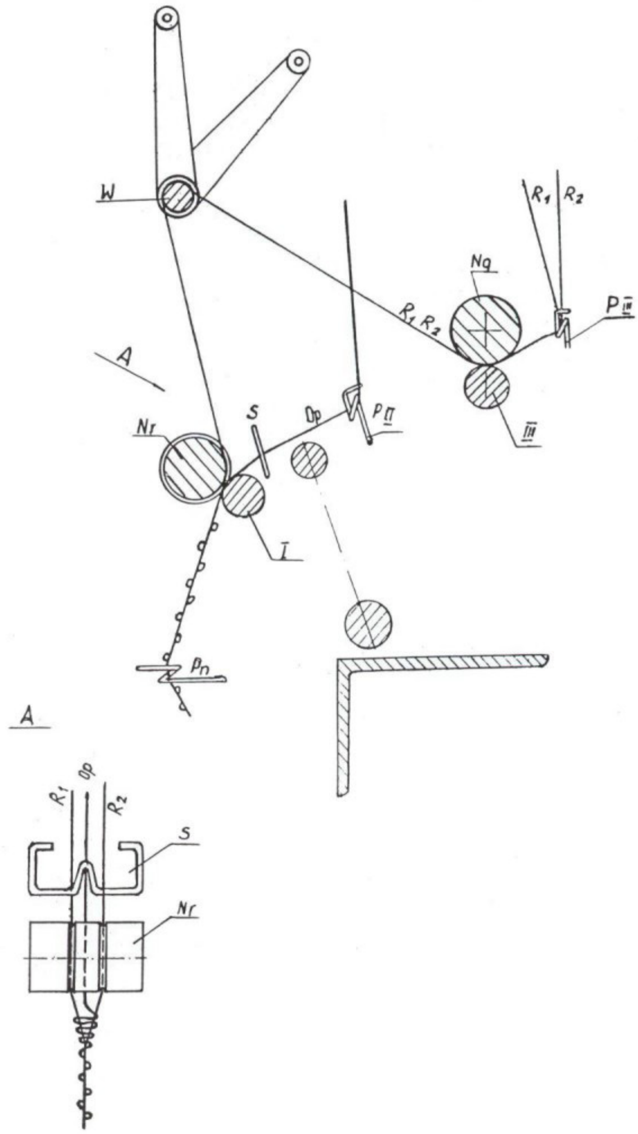

Figure 3. The scheme of the production of fancy loop yarn on the ring twisting machine: R1, R2 – the core yarns, PII, PIII – guide, III – feed roller, W – rocker arm shaft, Nr – pressure roller, Pn – spindle guide, Op – effect yarn, S – slot guide [1].

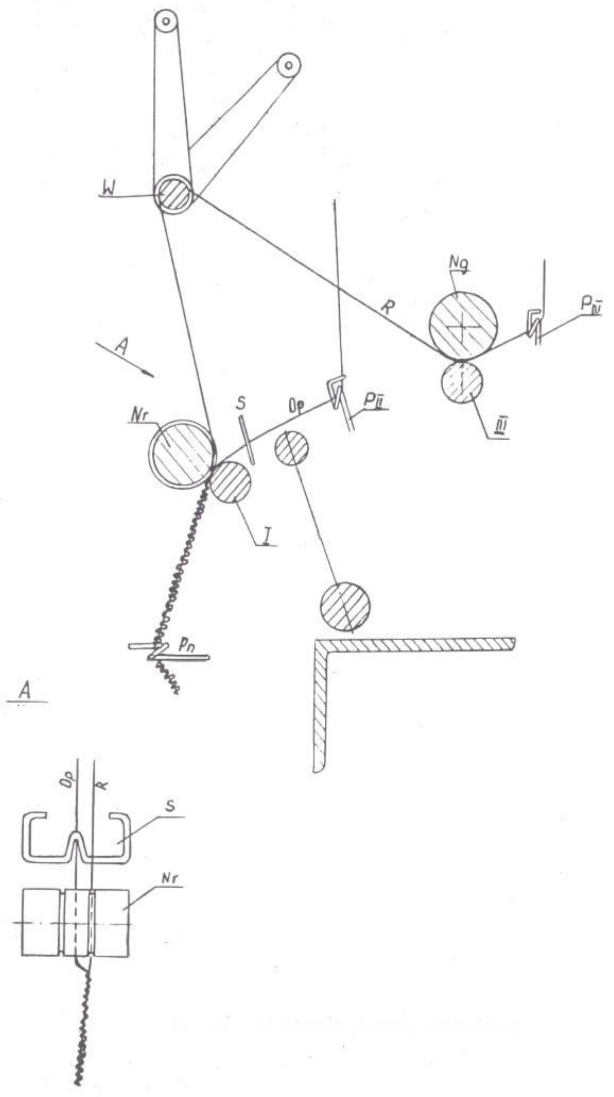

Figure 4. The scheme of the production of fancy frotte yarn on the ring twisting machine: R – the core yarn, PII, PIII – guide, III – feed roller, W – rocker arm shaft, Nr – pressure roller, Pn – spindle guide, Op – effect yarn, S – slot guide [3].

Op is introduced with higher overfeed than the core yarn R. The effect yarn is introduced through the guide PII and the slot guide S to the centre (A) between two grooves of the pressure roller Nr. In this manner, the effect yarn has the speed of the pressure roller Nr and the core yarn (carried through the groove of the pressure roller) has the speed of the feed roller III. The speed of the pressure roller Nr is higher than the speed of the feed roller III. In this case, the effect yarn is not bending between two core yarns. In this way, the effect yarn creates the waves on the core yarn. The last process is the fixing of the effects by re-twisting the frotte yarn in opposite direction with the binding yarn [1,3-6].

Experimental Part - Yarns

Nine types of loop yarns and nine types of frotte yarns were produced on the ring twisting machine using the different settings on the machine: the crimp of the effect yarn and the twist. The plan of the experiment is presented in Table 1 (a and b).

Table 1. The Plan of The Experiment:

(a) Loop Yarn:

		NOMINAL TWIST (Z)		
		200 rpm	300 rpm	400 rpm
Effect yarn nominal crimp [%]	90%	**a1**	**a2**	**A3**
	120%	**B1**	**B2**	**B3**
	150%	**C1**	**C2**	**C3**

(b) Frotte Yarn:

		NOMINAL TWIST (Z)		
		200 rpm	300 rpm	400 rpm
Effect yarn nominal crimp [%]	90%	**a1**	**a2**	**a3**
	120%	**b1**	**b2**	**b3**
	150%	**c1**	**c2**	**c3**

The raw materials were as follows:

- Core yarn(s) – PET yarns, 24 tex.
- Effect yarn – PET 32x2 tex.
- Binding yarn – filament 22 tex.

For the statistical analysis of test hypotheses on the base parameters Student's t-test was used. The aim of the tests was finding the source of the significance of differences between the height of loops in the case of two very similar types of fancy yarns: loop yarn and frotte yarns produced on the base the same raw materials and ring twisting machine settings. Also, we tried to answer what influences on the differences in yarns linear densities. The hypothesis zero was formulated as the lack of the significance differences between the chosen properties of loop and frotte yarns. Using the Shapiro–Wilk test, the normal distribution of the experiment data was proven. Using Student's t-test, the essentiality of differences was proved. The analysis of the essentiality of the differences between the high of the loops in the case of loop and frotte yarns was performed on the basis of analysis of the images taken from the produced yarns. The images were transferred to the computer memory using scanning method and stored in the form of a bitmaps, which were then analysed using the image computer program. Measurement of linear mass of produced yarns was made based on the standard PN-83/P-04653.

The analysis of the essentiality of the differences between the linear densities of the loop yarn and frotte yarn

The difference between the average linear densities of loop and frotte fancy yarns produced on ring-twisting machine is statistically significant assuming a constant value of crimp and the number of twist for a given variant thread. These differences are more significant when the crimp increases.

Table 2. presents the results of carried out experiments on the linear densities of:

(a) Loop yarns:

		Average value	Standard deviation	CV	Confidence interval for average value
Yarn linear density Tt [tex]	A_1 90% 200 rpm	169,600	4,949	1,49	167,180 ¸ 172,020
	A_2 90% 300 rpm	166,800	1,789	1,072	164,579 ¸ 169,021
	A_3 90% 400 rpm	161,000	2,000	1,242	158,517 ¸ 163,483
	B_1 120% 200 rpm	187,400	1,140	0,608	185,984 ¸ 188,816
	B_2 120% 300 rpm	184,400	2,881	1,562	180,823 ¸ 187,977
	B_3 120% 400 rpm	180,000	2,236	1,242	177,224 ¸ 182,776
	C_1 150% 200 rpm	230,000	2,236	0,972	227,224 ¸ 232,776
	C_2 150% 300 rpm	225,800	2,280	1,010	222,969 ¸ 228,631
	C_3 150% 400 rpm	218,400	4,159	1,904	213,236 ¸ 223,564

(b) Frotte yarns:

		Average value	Standard deviation	CV	Confidence interval for average value
Yarn linear density Tt [tex]	a_1 90% 200 rpm	143,600	1,140	0,794	142,184 ¸ 145,016
	a_2 90% 300 rpm	139,200	2,683	1,927	135,868 ¸ 142,532
	a_3 90% 400 rpm	136,400	1,949	0,696	133,980 ¸ 138,820
	b_1 120% 200 rpm	159,400	4,037	2,533	154,387 ¸ 164,413
	b_2 120% 300 rpm	158,600	1,140	0,719	157,184 ¸ 160,016
	b_3 120% 400 rpm	149,400	1,817	1,216	147,144 ¸ 151,656
	c_1 150% 200 rpm	169,800	1,483	0,873	167,958 ¸ 171,642
	c_2 150% 300 rpm	169,400	2,074	1,224	166,825¸ 171,975
	c_3 150% 400 rpm	167,400	1,817	1,085	165,144¸ 169,656

Table 3. presents the results of carried out Student's *t* statistics for the linear densities of loop and Frotte fancy yarns.

		Type of Fancy Yarn		Value of Student's t statistics	p
		Loop	Frotte		
Yarn linear density Tt [tex]	90% 200 rpm	169,600	143,600	25,744	0,000
	90% 300 rpm	166,800	139,200	19,137	0,000
	90% 400 rpm	161,000	136,400	19,696	0,000
	120% 200 rpm	187,400	159,400	14,924	0,000
	120% 300 rpm	184,400	158,600	18,619	0,000
	120% 400 rpm	180,000	149,400	23,750	0,000
	150% 200 rpm	230,000	169,800	50,167	0,000
	150% 300 rpm	225,000	169,400	40,917	0,000
	150% 400 rpm	218,400	167,400	25,126	0,000

The analysis of the essentiality of the differences between the altitudes of loops in the case of the loop yarn and frotte yarn

With increasing the twist, the reduction of the loop altitude occurs. The increase in crimp increases the loop altitude. This phenomenon occurs regardless of the type of yarn used in the experiment.

Table 5 presents the results of carried out Student's *t*-statistics for the loop altitudes of loop and Frotte fancy yarn.

Table 4. presents the results of carried out experiments on the altitudes of loops in the case of:
(a) Loop yarns:

		Average value	Standard deviation	CV	Confidence interval for average value
Loop altitude [mm]	A_1 90% 200 rpm	2,000	0,429	21,450	1,468÷2,532
	A_2 90% 300 rpm	1,484	0,305	20,580	1,104÷1,860
	B_1 120% 200 rpm	1,860	0,415	22,312	1,345÷2,375
	B_2 120% 300 rpm	1,524	0,290	19,094	1,163÷1,885
	C_1 150% 200 rpm	2,694	0,334	12,398	2,279÷3,109
	C_2 150% 300 rpm	1,496	0,216	14,438	1,228÷1,764

(b) Frotte yarns:

		Average value	Standard deviation	CV	Confidence interval for average value
Loop altitude [mm]	a_1 90% 200 rpm	2,488	0,379	15,233	2,017÷2,959
	a_2 90% 300 rpm	1,640	0,204	12,439	1,386÷1,894
	b_1 120% 200 rpm	2,872	0,359	12,500	2,426÷3,318
	b_2 120% 300 rpm	1,624	0,285	17,549	1,271÷1,977
	c_1 150% 200 rpm	3,254	0,297	9,127	2,885÷3,623
	c_2 150% 300 rpm	1,928	0,238	12,344	1,633÷2,223

Table 5. Results of Student's *t* statistics for detecting the differences between the loop altitudes in the case of loop and Frotte fancy yarn.

		Type of Fancy Yarn		Value of t-student statistics t	p
		Loop	Frotte		
Loop altitude [mm]	90% 200rpm	2,000	2,488	-1,906	0,093
	90% 300rpm	1,482	1,640	-0,963	0,364
	120% 200rpm	2,872	2,890	4,125	0,003
	120% 300rpm	1,624	1,63	0,550	0,597
	150% 200rpm	2,694	3,254	-2,798	0,023
	150% 300rpm	1,496	1,928	-3,009	0,017

The loops of Frotte Yarn are higher than those in the case of Loop yarn. It can be concluded that the differences between the mean values of loop altitude in the case of loop yarn and frotte yarns are becoming larger (statistically significant) with the escalation of the crimp and slightly decreasing with the accumulation of the number of turns.

Experimental Part – Weaving Fabrics

Two batches of fabrics were produced on the loom "The tread stretcher Control TC-1" with different kinds of yarns used as a weft – a total of 10 samples of weaving fabrics were produced. Five samples of fabrics involve loop yarns from pre-selected variants : A1 – 90% of the crimp and 200 rpm, A2 – 90%, 300 rpm, B2 – 120%, 300 rpm, C2 – 150%, 300 rpm, C3 – 150%, 400 rpm, and five samples of fabrics with frotte yarns types: a1, a2, b2, c2 and c3 with crimp and twist as above. For all fabrics, satin weave was used. The plan of experiment for weaving fabrics is presented in Table 6: variant A for loop yarns as the weft and variant b for frotte yarns as weft. As a warp PE 15´2 tex was used.

The aim of the analysis was the detection of the source of the differences of fabric thickness and surface mass. The fabric thickness was measured according to the standard PN-EN ISO 5084 and the fabric surface mass was measured according to PN/ISO 3801 standard. The statistical analysis used was Student's t-test.

The analysis of the essentiality of the differences between the fabric thickness with the weft of the loop yarn and frotte yarns

The summary of the results of carried out experiments on the fabric thickness in the case of the loop yarns (A) and frotte yarns (b) used as a weft is presented in Table 7.

Table 6. Plan of the experiments for weaving fabrics produced with loop (A) and frotte (b) yarn as a weft.
Loop yarn as a weft:

	YARN VARIANT				
	A_1 90% 200 rpm	A_2 90% 300 rpm	B_2 120% 300 rpm	C_2 150% 300 rpm	C_3 150% 400 rpm
Satin weave	**FL1**	**FL2**	**FL3**	**FL4**	**FL5**

Note: F, woven fabric; L, loop yarns; thus, e.g. FL2, woven fabric no. 2 made of loop yarn A2 (weft).

(b) frotte yarn as a weft:

	YARN VARIANT				
	a_1 90% 200 rpm	a_2 90% 300 rpm	a_2 120% 300 rpm	c_2 150% 300 rpm	c_3 150% 400 rpm
Satin weave	**Ff1**	**Ff2**	**Ff3**	**Ff4**	**Ff5**

Note: F, woven fabric; f, frotte yarn; thus, e.g. Ff3, woven fabric no. 3 made of frotte yarn a2 (weft).

Table 7. The fabrics thickness in the case of the loop yarns (A) and frotte yarns (b) used as a weft.
(a) Loop yarns as a weft:

		Average value	Standard deviation	CV	Confidence interval for average value
Fabric thickness [mm]	FL1 90% 200rpm	3,230	0,020	0,619	3,180÷3,280
	FL2 90% 300rpm	2,860	0,026	0,909	2,794÷2,926
	FL3 120% 300rpm	2,983	0,031	1,039	2,907÷3,059
	FL4 150% 300rpm	3,007	0,090	2,925	2,853÷3,301
	FL5 150% 400rpm	2,713	0,021	0,774	2,662÷2,765

(b) frotte yarns as a weft:

		Average value	Standard deviation	CV	Confidence interval for average value
Fabric thickness [mm]	Ff1 90% 200 rpm	3,067	0,351	11,444	2,979÷3,154
	Ff2 90% 300 rpm	2,570	0,347	13,502	1,709÷3,431
	Ff3 120% 300 rpm	2,740	0,010	0,365	2,715÷2,765
	Ff4 150% 300 rpm	2,913	0,159	5,458	2,517÷3,309
	Ff5 150% 400 rpm	2,613	0,040	1,531	2,513÷2,714

When the yarn twist is increasing, the fabric thickness decreases. This is result of the fact that with the yarn twit increasing the altitude of loops is increasing. When yarn crimp is increasing, the fabric thickness is increasing. This is simply the result of the fact that when the yarn crimp is increasing the altitude of loops is increasing. This phenomenon occurs regardless of the type weft used in the experiment. Table 8 presents the results of carried out Student's t statistics for the weaving fabric thickness in the case of different wefts used: loop and frotte fancy yarns.

Fabrics with loop yarn as a weft are thicker than fabrics with frotte yarn used as a weft. With the increase in yarn twist and crimp, the differences in the thickness of the fabrics with used different yarns as a weft are less statistically significant.

The analysis of the essentiality of the differences between the fabric surface mass with different wefts used – the loop yarn and frotte yarns.

The summary of the results of experiments carried out on the fabrics surface mass in the case of different wefts used – the loop yarns (A) and frotte yarns (b) – is presented in Table 9.

With the increase in yarn crimp, the mass surface of fabric increases. With increase in yarn twist, the mass surface of the fabric decreases. Table 10 presents the results of carried out Student's t statistics for the weaving fabric mass surface in the case of different wefts used: loop and frotte fancy yarns.

Table 8. Results of Student's t-statistics for detecting the differences between the thicknesses of weaving fabrics with different wefts used – loop yarn and frotte yarn.

		Yarn variant (used as a weft)		Value of Student's t statistics t	p
		Loop yarn	Frotte yarn		
Fabric thickness [mm]	90% 200rotr/m	3,230	3,067	7,000	0,02
	90% 300rpm	2,860	2,740	7,348	0,02
	120% 300rpm	3,077	2,570	-2,451	0,070
	150% 300/rot	2,983	2,913	0,747	0,497
	150% 400rpm	2,713	2,613	3,810	0,5

Table 9. The fabrics surface mass in the case of the loop yarns (a) and frotte yarns (b) used as a weft.
(a) Loop yarns as a weft:

		Average value	Standard deviation	CV	Confidence interval for average value
Fabric mass surface [g/m^2]	FL1 90% 200rpm	419,667	4,623	1,102	408,182÷ 431,151
	FL2 90% 300rpm	402,867	6,765	1,679	386,060÷ 419,673
	FL3 120% 300rpm	412,800	2,663	0,645	406,185÷ 419,415
	FL4 150% 300rpm	438,800	3,700	0,843	429,609÷ 447,997
	FL5 150% 400rpm	434,367	4,050	0,932	424,306÷ 444,428

(b) Frotte yarn used as a weft:

		Average value	Standard deviation	CV	Confidence interval for average value
Fabric mas surface [g/m^2]	Ff1 90% 200rpm	412,633	2,902	0,703	405,424÷ 419,843
	Ff2 90% 300rpm	371,433	4,136	1,113	361,160÷ 381,707
	Ff3 120% 300rpm	394,633	3,053	0,774	387,048÷ 402,218
	Ff4 150% 300rpm	409,867	4,600	1,122	398,439÷ 405,300
	Ff5 150% 400rpm	401,433	5,870	1,462	386,850÷ 416,017

Table 10. Results of Student's t statistics for detecting the differences between the mass surfaces of weaving fabrics with different wefts used – loop yarn and frotte yarn.

		Yarn variant		Value of Student's t statistics t	p
		Loop	Frotte		
Fabric mass surface [g/m^2]	90%, 200rpm	419,667	412,633	2,232	0,089441
	90%, 300rpm	402,867	371,433	6,866	0,002357
	120%, 300rpm	412,800	394,633	7,767	0,001481
	150%, 300rpm	438,800	394,100	14,145	0,000145
	150%, 400rpm	434,367	401,433	7,998	0,001325

The fabric mass surface is different in the case of used weft. The fabrics with loop weft are heavier than fabrics with frotte weft. The essentiality of these differences increases with the increase in yarn crimp and twist.

Experimental Part – Knitted Fabrics

The single jersey flat knitting machine was used for the production of two batches knitted fabrics with different kinds of yarn used – a total of 10 samples of knitted fabrics were produced – five samples involving selected variants of different loop yarns: A1 – 90% of crimp and number-of-turn 200 rpm, A2 – 90%, 300rpm, B2 – 120%, 300 rpm, C2 – 150% , 300 rot/m, C3 – 150%, 400 rot/m, and five samples involving forte yarns: a1, a2, b2, c2 and c3 with the number-of-turns and crimp as above. For all knitted fabrics, the plain stitch was used. The Plan of Experiment for Knitted Fabrics with Loop Yarn (A) and Frotte Yarn (b) is presented in Table 11.

The aim of the analysis was the detection of the source of the differences in knitting fabric thickness and surface mass. The fabric thickness was measured according to the standard PN-EN ISO 5084, and the fabric surface mass was measured according to PN/ISO 3801 standard. The statistical analysis used was –Student's t-test.

<u>The analysis of the essentiality of the differences between the knitting fabric thicknesses with different yarns used – the loop yarn and frotte yarns</u>

The summary of the results of carried out experiments on the knitting fabric thickness in the case of the loop yarns (A) and frotte yarns (b) is presented in Table 12.

Over the range of carried out experiment, both yarn twist and crimp changes do not affect a significant way on the thickness of knitted fabrics. Table 13 presents the results of carried out Student's t statistics for the thickness of the knitting fabric in the case of different yarns used: Loop and Frotte Fancy Yarns.

There is no significant difference between the thickness of knitted fabrics produced with loop and frotte yarns.

<u>The analysis of the essentiality of the differences between the knitting fabric mass surfaces with different yarns used – the loop yarn and frotte yarns.</u>

The summary of the results of carried out experiments on the knitting fabric mass surface in the case of the loop yarns (A) and frotte yarns (b) is presented in Table 14.

Table 11. The Plan of Experiment for Knitted Fabrics produced with:
(a) Loop Yarn:

	Yarn Variant				
	A_1 90%, 200 rpm	A_2 90%, 300 rpm	B_2 120%, 300 rpm	C_2 150%, 300 rpm	C_3 150%, 400 rpm
Plain Stitch	**KL1**	**KL2**	**KL3**	**KL4**	**KL5**

Note: K, knit fabric; L, loop yarns; thus, e.g. KL2, knit fabric no. 2 made of loop yarn A2.

(b) Frotte yarn:

	Yarn Variant				
	a_1 90%, 200 rpm	a_2 90%, 300 rpm	a_2 120%, 300 rpm	c_2 150%, 300 rpm	c_3 150%, 400 rpm
Plain Stitch	**KF1**	**KF2**	**KF3**	**KF4**	**KF5**

Note: K, knit fabric; F, frotte yarns; thus, e.g. KF3, knit fabric no. 3 made of frotte yarn a2.

Table 12. The knitted fabrics thickness in the case of the loop yarns (a) and frotte yarns (b) used.
(a) Loop yarns:

		Average value	Standard deviation	CV	Confidence interval for average value
Thickness of the knitting fabric [mm]	KL1 90%, 200 rpm	2,910	0,219	7,526	2,365÷3,455
	KL2 90%, 300,rpm	2,603	0,145	5,570	2,224÷2,963
	KL3 120%, 300,rpm	2,950	0,020	0,678	2,900÷3,000
	KL4 150%, 300,rpm	3,340	0,040	1,198	3,439÷3,300
	KL5 150%, 400,rpm	2,870	0,026	0,906	2,804÷2,936

(b) Frotte yarn:

		Average value	Standard deviation	CV	Confidence interval for average value
Knitting Fabric thickness [mm]	KF1 90%, 200 skr/m	2,580	0,026	1,008	2,514÷2,646
	KF2 90%, 300 skr/m	2,537	0,111	4,375	2,262÷2,811
	KF3 120%, 300 skr/m	2,887	0,075	2,598	2,700÷3,073
	KF4 150%, 300 skr/m	3,327	0,108	3,246	3,059÷3,595
	KF5 150%, 400 skr/m	3,237	0,057	2,009	2,695÷2,978

Table 13. Results of Student's t statistics for detecting the differences between the thicknesses of the knitted fabrics with different yarns used – loop yarn and frotte yarn.

		Yarn variant		Value of Student's t statistics	p
		Loop	Frotte		
Knitting Fabric Thickness [mm]	90%, 200 rpm	2,910	2,537	2,633	0,058
	90%, 300 rpm	2,603	2,580	0,275	0,797
	120%, 300 rpm	2,950	2,887	1,412	0,231
	150%, 300 rpm	3,340	3,327	0,201	0,851
	150%, 400 rpm	2,870	2,837	0,921	0,409

Table 14. The knitted fabrics mass surface in the case of the loop yarns (a) and frotte yarns (b) used.
(a) Loop yarns:

		Average value	Standard deviation	CV	Confidence interval for average value
Knitting Fabric mass surface [g/m^2]	KL1 90%, 20 rot/m	253,167	3,253	1,285	245,085÷ 261,248
	KL2 90%, 300 rpm	236,167	8,501	3,599	215,050÷ 257,284
	KL3 120%, 300 rpm	278,667	4,424	1,587	267,376÷ 289,657
	KL4 150%, 300 rpm	337,667	3,431	1,016	329,143÷ 346,190
	KL5 150%, 400 rpm	336,568	9,745	2,895	312,359÷ 360,774

(b) Frotte Yarns:

		Average value	Standard deviation	CV	Confidence interval for average value
Knitting Fabric mass surface [g/m^2]	KF1 90%, 200 rpm	203,967	9,103	4,463	181,354÷ 226,580
	KF2 90%, 300 rpm	198,833	4,452	2,238	187,773÷ 209,894
	KF3 120%, 300 rpm	236,100	7,333	3,106	217,884÷ 254,316
	KF4 150%, 300 rpm	303,933	4,544	1,495	292,644÷ 315,223
	KF5 150%, 400 skr/m	299,267	4,729	1,580	287,519÷ 311,014

Conclusions

The list of observations and conclusions made after analysis of all the samples ranges from very obvious to interesting. The selected conclusions concerning comparison of loop and frotte fancy yarns and both woven and knit fabrics made of these yarns are as follows:

Not only the linear density of the introduced yarns impact the mass density of the fabric but also the crimp of the component yarns constituting the final fancy yarn.

The yarn's linear density is higher if the crimp is higher due to wedge, jam of the greater quantity of component yarns in the architecture of the final yarn. This phenomenon occurs regardless of the type of yarn used in the experiment.

The loop size is reduced by the increased twist per meter and on the contrary, the loop size increases, when the crimp of the component yarns increases (in case of loop yarns).

The differences between the mean values of loop altitude in the case of loop yarn and frotte yarns are becoming larger (statistically significant) with the escalation of the crimp and slightly decreasing with the accumulation of the number of twists per meter.

In terms of economy aspects only, the frotte fancy yarns are believed to be cheaper in production due to lower quantity of components utilize for their production to compare with loop fancy yarns, under conditions of the same settings of ring twisting frame.

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