STUDY REGARDING YARN TENSION DURING KNITTING ON CIRCULAR MACHINE WITH SMALL DIAMETER

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Abstract: *If yarn tension is controlled properly during knitting, it gives an improved and uniform fabric appearance. The main objective of knitters is to feed yarn to the knitting point at a low and uniform tension.*
To ensure that the stress do not affect yarn properties, literature recommends that the yarn tension shall be so adjusted that it fits in the field elastic. The value of the yarn stress influences not only quality of knitted product, but also the value of the knitting machine production, by the frequency rupture of yarns. This is influenced directly by the yarn stress and yarn quality.
The value of this tension is influenced by a complex of factors, such as: technological diagram of the routing of the yarn from coils up to the knitting area, the structure and characteristics of the raw materials, the typo of knitting, type supply, etc.
In the present article, using practical method, we test some ecological yarns used to make sock, like cotton, organic cotton, bambooviscose, Tencel, according to 6 different fabric geometry: single jersey, plated single jersey, ribb 4:2, plated ribb 4:2, purl, plated purl. Was enregistered and discussed the values of yarn tension.

Key words: *cellulose yarns, socks, yarn tension, single jersey, purl, ribb*

1. INTRODUCTION

The yarn feeding tension in knitting means axial force in the yarn in the moment of its transformation into a loop [1], [2].

In the knitting industry maximum production speed is restricted to a certain limit such as 300m/min. on circular knitting machine. This limit is generally caused by yarn tension, wich breaks the yarn and create several process troubles. Yarn tension is one of the important factors in the knitting industry, not only to make high quality knitted products but also to prevent process faults. Hence, tension control should be properly maintained during knitting process [3].

Establish the yarn tension can be accomplished by practical methods (direct measurement with appropriate devices) and through theoretical methods (calculation of the tension at different points of the route travelled characteristic of yarn) [1], [2].

In circular weft knitting, the monitoring of ththe faults and at the same time controlled inside tight limits to prevent machine's premature stop due to yarn break [4].

Apart from the existing means of yarn tension control such as positive feed devices, yarn accumulating devices, yarn tension meter etc., innovative ways of monitoring and controlling yarn tension during knitting are always explored by scientists and researchers which benefits the manufacturer by lower costs and introduce a new concept on knitting machines, by using a full integrated information system with all sensing devices inter-connected [5].

2. METHOD AND APPARATUS

The "Matec Silver 1L" (fig. 1) is an automatic and computerized machine with two cylinder and two operating systems. These machine is for the production of socks from cotton and cotton type yarns, for children, women and men, in the structure jersey, rib and purl, with heal and top of product in swing motion.

Fig. 1: *Small cylinder knitting machine „SILVER 1L" [6]*

Fig. 2: *Mecanical tensiometer ZF2 – 10, model Schmidt*

Specifications of the knitting machine used to obtain samples [7]:

- Gauge: 14 E
- Diameter of cylinders: 3¾" (95, 25 mm)
- Number of neadles: 168
- Neadles tickness: 0,7 mm
- Number of cam systems: 2;
- Knitting speed: 300 rot/min. (circular motion), 180pend/min. (pendular motion)

Mecanical tensiometer ZF2 – 10, model Schmidt – figure 2 – was used for measure yarn feed tension in different point of yarn.

3. EXPERIMENTAL PART

To avoid obtaining knitted fabric with shades (different heights of loops in different rows), due to uneven usage cams from the two systems, were used only 1 knitting system for made samples.

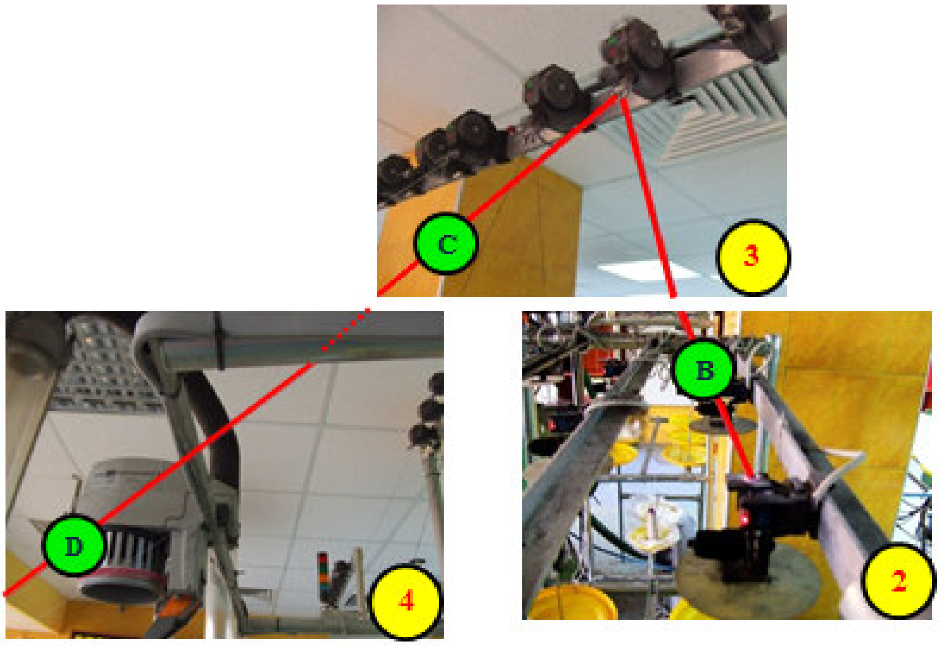
For the purpose to establish the yarn feeding tension we've chosen practical method, using mechanically with Tensionmeter ZF2 - 10, model Schmidt.

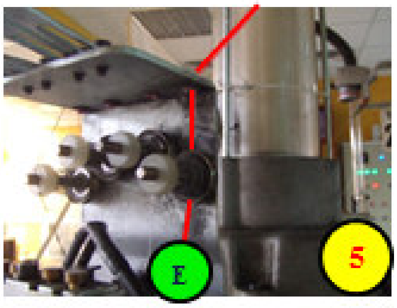
In figure 3, we have represented the route of yarn, from the bobbin up into the area of unloading to the knitting needles.

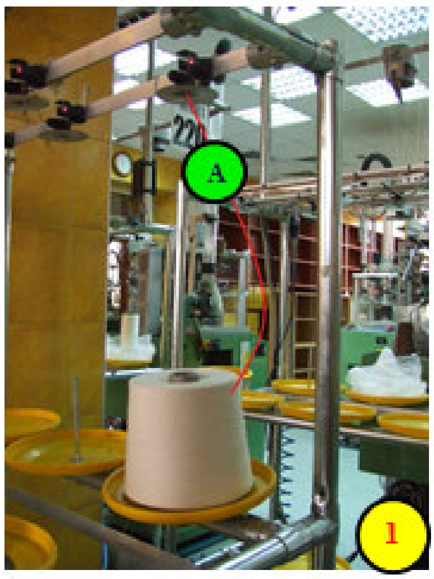
The circles (A) … (F) represent points in which we have measured the tension. In the table 1 were describe the steps from figure 3 and we showed the contact points of the yarn with the machine parts (1) … (7) [8].

Table 1: *Yarn contact points [8]*

Contact point	Description
1	Yarn bobbin unwinding
2	Tensioning device with plates + photocell for automatic stop if detect broken yarn
3	Yarn guide + automatic stopping device if detect small yarn tension
4	Contact with a metal part
5	Yarn guide + tensioning device with plates
6	Antenna for yarn recovery (negative feeding with yarn) + yarn guide
7	Final yarn guide.







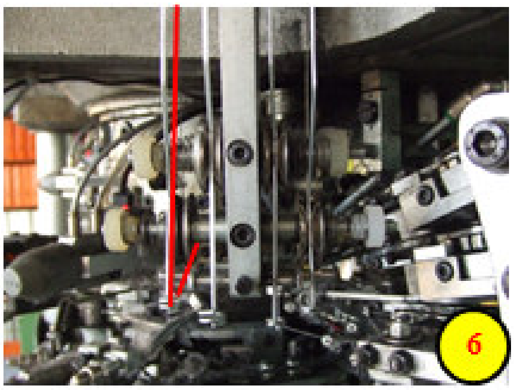
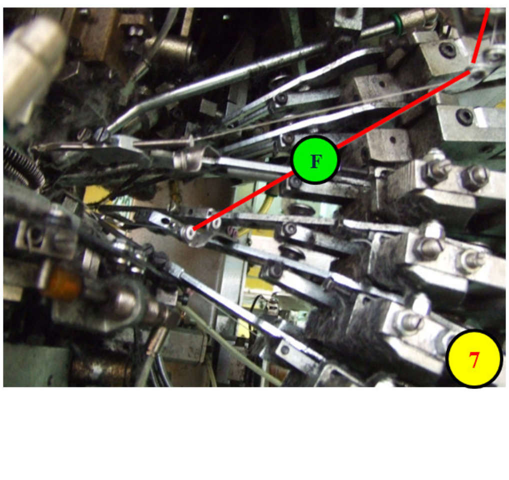


Fig. 3: The route of yarn in feeding system [8]



For study were chosed the samples knitted from 5 types of carded yarns, coded: **1MDX** (100% cotton, 34/1 Nm), **2MDX** (100% cotton, 40/1 Nm), **1DC** (100% organic cotton, 34/1 Nm), **9DC** (Tencel, 34/1 Nm), **10DC** (Bambooviscose, 34/1 Nm). The plated yarn is polyamide 6, 44/12x2 dtex.

4. RESULTS

The cumulated value of yarn tension (cN) is those measureated in the F point. Tests resultes are showed in tables 2 – 6.

*Table 2. Yarn tension for variant **1MDX** (**F**ond = cotton, 34/1Nm **+** Plating = Polyamide)*

Checkpoint for measured tension	Knitted fabric geometry								
	Single jersey	Plated single jersey		Ribb 4:2	Plated rib 4:2		Purl	Plated purl	
	F	F	P	F	F	P	F	F	P
A	1.1	1.2	1.1	1.1	1.2	1.1	1.2	1.3	1.2
B	2.4	2.8	1.8	2.2	2.4	1.7	2.6	2.8	2.4
C	2.6	2.2	2.2	2.3	2.5	2.2	2.6	2.8	2.5
D	2.6	2.5	2.2	2.3	2.5	2.2	2.8	2.8	2.4
E	2.8	2.6	2.4	2.6	2.5	2.4	2.8	3.2	2.6
F	8.5 cN	8.2 cN	10.2 cN	9.5 cN	9.5 cN	10.4 cN	9.8 cN	8.2 cN	10.2 cN

*Table 3. Yarn tension for variant **2MDX** (**F**ond = cotton, 40/1Nm + **P**lating = Polyamide)*

Checkpoint for measured tension	Knitted fabric geometry								
	Single jersey	Plated single jersey		Ribb 4:2	Plated rib 4:2		Purl	Plated purl	
	F	F	P	F	F	P	F	F	P
A	1.1	1.2	1.1	1.1	1.2	1.1	1.2	1.3	1.2
B	2.1	2.1	1.8	1.8	2.2	1.7	2.2	2.2	2.6
C	1.8	1.8	2.2	1.6	1.8	2.2	2.2	2.0	2.4
D	2.1	1.8	2.0	1.7	1.8	1.8	2.5	2.0	2.4
E	2.4	2.0	2.2	1.8	1.8	2.0	2.5	2.2	2.6
F	6.5 cN	7.5 cN	10.1 cN	6.2 cN	6.7 cN	10.3 cN	8.5 cN	8.2 cN	10.2 cN

*Table 4. Yarn tension for variant **1DC** (**F**ond = organic cotton, 34/1Nm **+** **P**lating = Polyamide)*

Checkpoint for measured tension	Knitted fabric geometry								
	Single jersey	Plated single jersey		Ribb 4:2	Plated rib 4:2		Purl	Plated purl	
	F	F	P	F	F	P	F	F	P
A	1.1	1.2	1.1	1.1	1.2	1.1	1.2	1.3	1.2
B	1.7	1.7	1.7	1.5	1.7	1.8	1.9	2.0	1.8
C	1.6	1.5	2.2	1.3	1.5	2.1	1.7	1.6	2.4
D	1.7	1.5	2.2	1.4	1.5	2.1	1.8	1.6	2.4
E	1.6	1.6	2.5	1.4	1.8	2.4	1.8	1.8	2.6
F	6.5 cN	5.2 cN	10.2 cN	5.2 cN	7.0 cN	10.2 cN	7.2 cN	6.7 cN	10.2 cN

*Table 5. Yarn tension for variant **9DC** (**F**ond = Tencel, 34/1Nm + **P**lating = Polyamide)*

Checkpoint for measured tension	Knitted fabric geometry								
	Single jersey	Plated single jersey		Ribb 4:2	Plated rib 4:2		Purl	Plated purl	
	F	F	P	F	F	P	F	F	P
A	1.1	1.2	1.1	1.1	1.2	1.1	1.2	1.3	1.2
B	1.8	1.8	1.8	1.8	1.8	2.2	1.8	2.0	1.8
C	1.6	1.5	2.2	1.5	1.5	1.5	1.6	1.6	2.5
D	1.7	1.6	2.2	1.6	1.6	1.6	1.6	1.7	2.6
E	1.8	1.6	2.4	1.6	1.7	1.7	1.6	1.6	2.6
F	5.3 cN	5.2 cN	10.2 cN	5.7 cN	5.2 cN	10.3 cN	5.5 cN	6.0 cN	10.5 cN

*Table 6. Yarn tension for variant **10 DC** (**F**ond = bamboo viscose, 34/1Nm **+ P**lating = Polyamide)*

Checkpoint for measured tension	Knitted fabric geometry								
	Single jersey	Plated single jersey		Ribb 4:2	Plated rib 4:2		Purl	Plated purl	
	F	F	P	F	F	P	F	F	P
A	1.1	1.2	1.1	1.1	1.2	1.1	1.2	1.3	1.2
B	2.0	1.8	1.8	1.8	2.0	1.5	2.3	2.2	1.7
C	1.8	1.9	2.2	1.5	2.0	2.2	2.6	2.5	2.4
D	2.0	1.9	2.2	1.7	2.1	2.2	2.7	2.6	2.5
E	2.1	1.8	2.0	1.7	2.1	2.2	2.6	2.5	2.4
F	9.1 cN	9.2 cN	10.1 cN	7.0 cN	7.8 cN	10.5 cN	10.5 cN	10.5 cN	10.5 cN

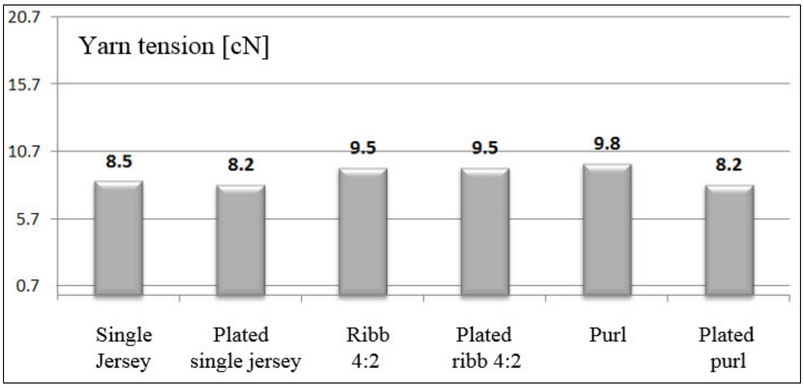


Fig. 4: Histogram of feeding yarn tension 1 MDX, according to different knitted fabric geometry

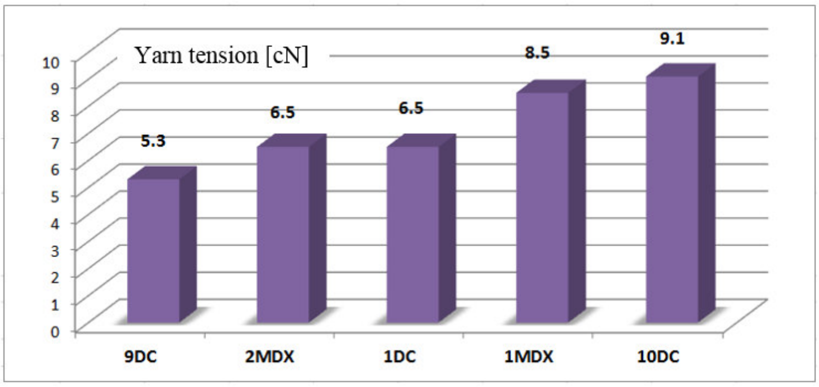


Fig. 5: Histogram of feeding yarn tension, according to single jersey fabric geometry, but different raw materials

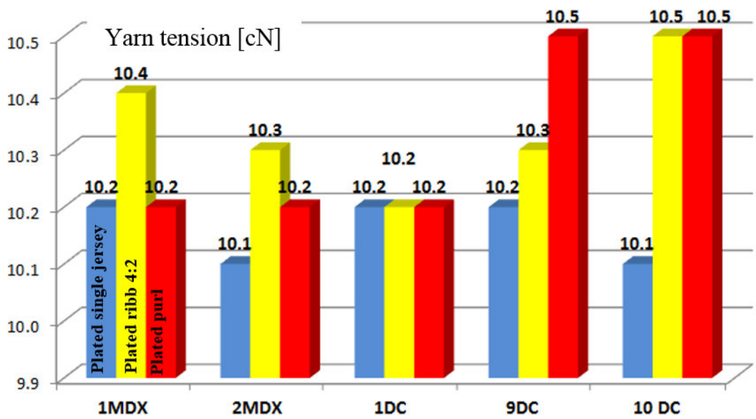


Fig. 6: Histogram of feeding yarn tension, according to plating yarn, polyamide 6 and different fabric geometry

CONCLUSIONS

In the case of same type of raw material - cotton 100 %, for a change of yarn fineness from 34/1 to 40/1 Nm, the yarn feeding tension decreases with 30,76 % (variants of knitted fabric G1.1MDX and G1.2MDX) – tables 2.- 6., fig. 6.

For the main yarn 1MDX, we find the same values the yarn feeding tension, in the case of knitted variants GV1 and LV1 – figure 4, 5.

The smallest value of yarn tension for the sample G1 is in the case of 9DC yarn. The highest is in the case of 10DC yarn, tables 2 - 6.

The medium yarn feeding tension for polyamide 6 (44/12x2dtex) is 10,2cN in all the cases, except the samples LV1 knitted from yarns 9DC and 10 DC, small increasing tension, tables 2 - 6, fig. 6.

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