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Single Jersey Knitting Performance Part II:

The Influence of Machine Speed, Yarn Input Tension and Yarn Linear Density on the Knitting Performance of Fine Worsted Yarns Knitted on a 28 gg Single Jersey Machine

by

M.P. Cawood, G.A. Robinson
and
D.A. Dobson

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

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PORT ELIZABETH
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SINGLE JERSEY KNITTING PERFORMANCE PART II: THE INFLUENCE OF MACHINE SPEED, YARN INPUT TENSION AND YARN LINEAR DENSITY ON THE KNITTING PERFORMANCE OF FINE WORSTED YARNS KNITTED ON A 28 gg SINGLE JERSEY MACHINE

by M. P. CAWOOD, G. A. ROBINSON and D. A. DOBSON

ABSTRACT

Those knitting variables which are considered critical in the knitting of fine staple yarns on a single jersey circular machine have been investigated in terms of knitting performance. Machine speed, within the limits investigated, had no marked effect on the knitting performance. The input tension between the positive feed and the knitting zone did not significantly effect the number of yarn breakages, but a tension of one centiNewton between the yarn package and the positive feed generally gave the best knitting performance. Improvement in the knittability of waxed yarns relative to unwaxed yarns became more pronounced as the yarn linear density increased.

INTRODUCTION

With the development of fine gauge machines and increased machine speeds, the machine settings are becoming increasingly critical, especially in the knitting of staple yarns which have inferior tensile properties when compared to filament yarns. It is therefore important that the optimum knitting conditions (machine speed, yarn input tension, take down tension and yarn linear density) are employed to achieve the best knitting performance.

Buys *et al*[1–3] investigated the influence of certain machine settings on the knitting performance of wool worsted yarns knitted into a Punto-di-Roma structure. However, their investigations concerned variables unique to double jersey machinery such as timing, dial-height and gating.

Black and Munden[4] reported that increased machine speed (up to 100 r/min) increased the measured force on the cam track due to the force resisting the vertical movement of the needles.

An increase in yarn input tension (tension on the yarn between the positive feed and the knitting zone) was found[5] to have only a slight effect on the "work to knit". The percentage robbing back, however, was fixed with the result that yarns of low tensile properties became more susceptible to failure at increased input tensions. Knapton[6] suggested that for double jersey machines the optimum yarn input tension is 0,1 cN/tex for both staple and filament yarn. He recommended that the tension above the positive feed should be kept at about 10 cN.

Take-down tension on a sinker top machine is not considered a critical variable provided that excessively high take-down tensions are avoided. By assisting knock-over, the sinker performs part of the function of a take-down mechanism and therefore only a low take-down tension is required to remove the fabric.

Hunter and Andrews[7] reported that when knitting a 22 tex wool worsted yarn on a single jersey machine, an increase in the yarn breakage rate was associated with an increase in the mass of the lubricant disc and not with the amount of wax applied to the yarn. This was attributed to mechanical damage suffered by the fine yarn during the waxing and winding process. Other publications[8, 9] have dealt with the determination of suitable yarn linear densities for different machines and machine gauges.

The object of this report, then, is to find the best knitting conditions, in terms of the knitting performance, for knitting fine worsted yarns on fine gauge single jersey machines.

EXPERIMENTAL

Yarns:

A range of fine worsted yarns (18 tex Z608, 20 tex Z576, 22 tex Z550 and 24 tex Z526) were spun from a lot of 64's quality wool of mean fibre length 64,0 mm and mean fibre diameter 20,7 μm. All the yarns were spun with less than one end down per 100 spindle hours.

Knitting details:

The yarns were knitted on a 60 feeder, 28 gauge, 66 cm (26 inches) diameter Bentley JSJ single jersey knitting machine equipped with Rosen trip-tape positive feed. A low take-down tension was employed throughout the experiment. A plain single jersey structure was knitted and for each different knitting variable used, samples of 2 000 courses (500 revolutions, 4 feeds) of fabric were knitted.

TABLE I

THE EFFECT OF MACHINE SPEED ON THE NUMBER OF YARN BREAKAGES (PER 2000 COURSES OF FABRIC KNITTED) AT A CONSTANT STITCH LENGTH OF 0,231 cm

YARN LINEAR DENSITY (tex)	NUMBER OF YARN BREAKAGES PER 2000 COURSES AT DIFFERENT MACHINE SPEEDS				
	12 r/min	14 r/min	16 r/min	18 r/min	20 r/min
18	155	128	122	141	137
20	143	92	127	116	123
22	140	148	105	145	109
24	143	150	136	146	131

Knitting variables:

(a) **Machine speed**

The four lots of yarn (linear densities 18, 20, 22 and 24 tex) were cleared and waxed, and then knitted at a constant stitch length over a range of machine speeds (12 r/min to 20 r/min). The number of yarn breakages were recorded. These results are shown in Table I.

TABLE II

THE EFFECT OF VARIOUS INPUT TENSIONS ON THE NUMBER OF YARN BREAKAGES (PER 2000 COURSES OF FABRIC KNITTED) AT A STITCH LENGTH OF 0,231 cm

YARN LINEAR DENSITY (tex)	INPUT TENSION (T_i) (cN)	NUMBER OF YARN BREAKAGES AT DIFFERENT POSITIVE FEED INPUT TENSION (T_o)		
		1 cN	5 cN	10 cN
18	2	96	114	104
	3	92	119	83
	4	110	142	94
	6	93	129	87
	8	108	136	98
20	2	85	89	89
	3	62	72	106
	4	78	91	93
	6	72	103	108
	8	70	98	98
22	2	119	137	139
	3	100	141	107
	4	91	148	121
	6	97	164	181
	8	92	179	186
24	2	107	133	169
	3	113	122	134
	4	133	214	136
	6	157	158	145
	8	129	193	122

(b) **Yarn input tension**

Similar yarns, again cleared and waxed, were knitted at five different knitting input tensions ($T_i \equiv$ tension between positive feed and the knitting needles) varying from 2 cN to 8 cN at a constant stitch length (ℓ) and constant positive feed input tensions ($T_o \equiv$ tension of yarn being fed to the positive feed) of 1 cN, 5 cN and 10 cN respectively. Fig. 1 shows the positions where T_i and T_o were measured. The number of yarn breakages were recorded and are shown in Table II.

(c) **Lubrication**

Yarn from each of the four lots was split into two sub-lots. One of the sub-lots was lubricated with paraffin wax using the *minimum* tension during winding

TABLE III

THE NUMBER OF YARN BREAKAGES (PER 2000 COURSES OF FABRIC KNITTED) FOR THE DIFFERENT YARN LINEAR DENSITIES, WAXED AND UNWAXED

YARN LINEAR DENSITY (tex)	MEAN YARN FRICTION (cN)		STITCH LENGTH (cm)	NUMBER OF YARN BREAKAGES PER 2000 COURSES KNITTED	
	Waxed	Unwaxed		Waxed	Unwaxed
18	12	24	0,236 0,231 0,225 0,219	62 50 100 140	47 52 137 191
20	14	23	0,236 0,231 0,225 0,219	36 53 130 135	53 101 145 180
22	12	26	0,236 0,231 0,225 0,219	42 65 140 154	56 79 183 220
24	13	29	0,236 0,231 0,225 0,219	70 109 149 185	86 152 233 275

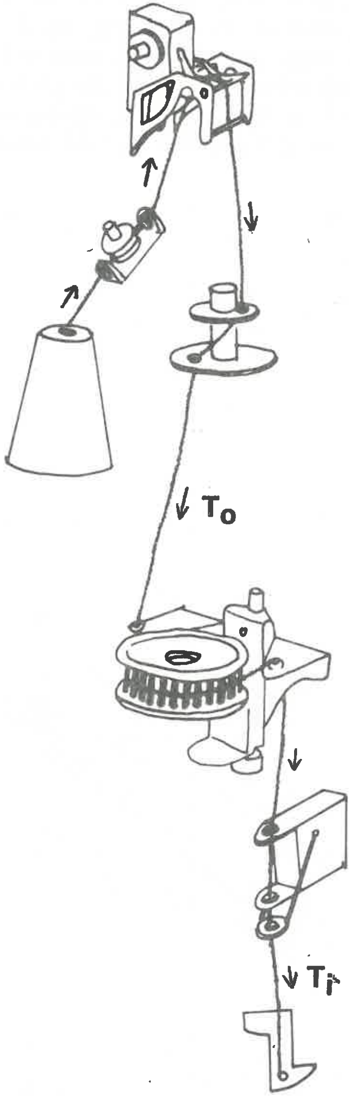

FIGURE 1

Illustration showing the path of the yarn from the cone to the knitting zone, indicating the positions at which T_i and T_o were measured

(tension disc was set at zero) and optimum load on the lubricating disc. The other sub-lot was wound at the same minimum tension but without waxing. Any difference in the knitting performance, therefore, could be attributed to waxing. Each yarn linear density, waxed and unwaxed, then was knitted at four different tightness factors. An unwaxed yarn was knitted for a few courses between yarn lots to remove any wax present on the needles and guides of the machine. Again the yarn breakages were analysed and recorded and the results are shown in Table III.

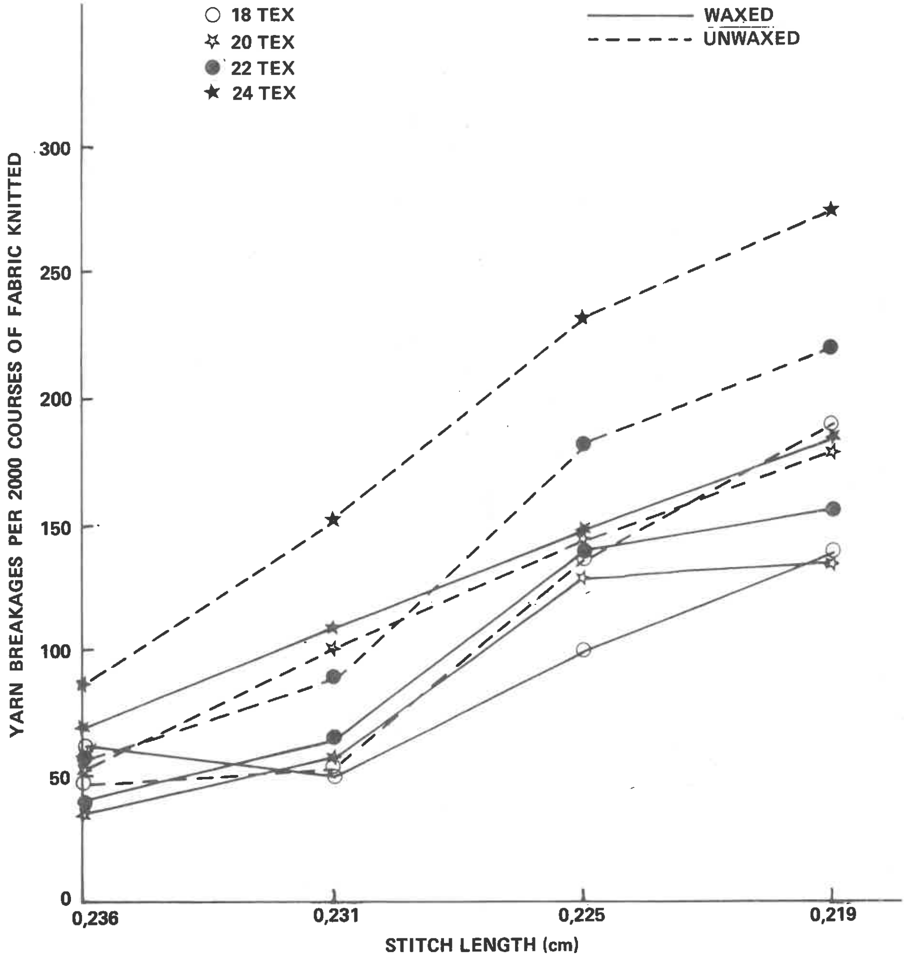

FIGURE 2

The effect of waxing on the number of yarn breakages for the different yarn linear densities

RESULTS AND DISCUSSION

(a) Effect of machine speed:

From Table I it can be seen that the number of yarn breakages at the different machine speeds, shows no clear trend, and therefore it would appear that the speed of the machine does not play an important part in the knitting performance of fine worsted yarns, provided that the machine speed lies within the range of speeds recommended by the manufacturer.

(b) Effect of input tension:

Table II shows the number of yarn breakages per 2 000 courses of fabric knitted for the various combinations of input tension (T_i and T_o). An increase in the positive feed input tension (T_o) from 1 cN to 5 cN resulted in an increase in the number of yarn breakages in every case. However, from a T_o of 5 cN to 10 cN there appeared to be no clear trend. At a high T_o (10 cN) press-offs occurred when knitting with the 18 tex yarn due to the yarn breaking at the positive feed mechanism. A variance analysis of the results indicated that a T_o of 1 cN gave the best knitting performance whereas the knitting input tension (T_i) had no significant influence on the knitting performance of the all-wool yarns.

(c) The effect of waxing and yarn linear density:

From Fig. 2 and Table III it can be seen that the waxed yarns always had the better knittability (less yarn breakages per 2 000 courses knitted) except in the case of the 18 tex yarn when at the highest stitch length the effect was found to be reversed. It can also be seen that as the stitch length decreased, the differences between the knittability of the waxed and the unwaxed yarns became more pronounced, with the waxed 24 tex yarn having the greatest and the waxed 18 tex the least improvement. It is therefore possible that for fine yarns, 18 tex and finer, the mechanical damage during waxing overcomes the advantage of waxing the yarn. Hunter *et al*[7] observed this effect for 22 tex yarns but the tensions employed during winding were not at a minimum. This illustrates the importance of controlling the tension during the winding process and that rewinding must be avoided if possible. However, a more thorough investigation using different structures, yarn linear densities, machine gauges and machines (single and double jersey) to find out more specific effects of yarn lubrication, is being undertaken.

SUMMARY AND CONCLUSIONS

The effect of various knitting variables such as machine speed, yarn input tension and yarn friction have been investigated to find their influence on the knitting performance of fine worsted yarns knitted on a 28 gg single jersey machine.

The speed of the machine, within the limits used in the investigations, had no definite influence on the knitting performance of the four yarn linear densities knitted. A tension of 1 cN (T_o) on the yarn entering the positive feed gave the least number of yarn breakages whereas the tension on the yarn between the positive feed and knitting zone (T_i) had no significant influence on the knitting performance. The waxing of fine worsted yarns improves knitting performance but the winding tensions and the number of winding operations must be controlled and kept to a minimum.

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