SAWTRI TECHNICAL REPORT

No. 269

Cotton in Fine Gauge Single Jersey

Part 1: Plied Yarns

by

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

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

P. O. BOX 1124
PORT ELIZABETH
REPUBLIC OF SOUTH AFRICA

ISBN 0 7988 0698 2

COTTON IN FINE GAUGE SINGLE JERSEY
PART I : PLIED YARNS

by G.A. ROBINSON, M. CAWOOD AND D.A. DOBSON

ABSTRACT

The knitting of 100 per cent cotton yarns on a 28 gauge Jacquard Single Jersey machine was investigated. Both plain and simple Jacquard structures were knitted from unmercerised and mercerised yarns. Full details of yarns and fabrics are given and the fabric properties are discussed. Durable press treatments decreased the tensile properties of the fabrics but improved the durable press properties, and inhibited the area shrinkage during washing to acceptable limits.

KEY WORDS

28 Gauge – cotton – durable press – single jersey – Jacquard – mercerised – bleached – K-values – stitch length – physical properties.

INTRODUCTION

Fine gauge single jersey fabrics in textured polyester have enjoyed enormous popularity in recent years, but more recently, there has been a change in consumer preference in favour of natural fibres. Therefore, because of the fine yarns that can be spun from cotton, this fibre has become increasingly used in single jersey knits for outerwear, often in blends with polyester, especially with the development of fine gauge machines such as 28 gauge with Jacquard pattern wheels and selective tucking. Blouses, mens' shirts, ladies' body shirts, casual shirts and childrens' wear are some of the many fields in which cotton in single jersey has a great advantage over synthetics, especially so in hot humid climates.

At the request of the Rhodesian Cotton Promotion Council it was decided to carry out an investigation into the knitting of acceptable lightweight single jersey fabrics that can be produced from 100 *per cent* cotton yarns, using a 28 gg Bentley JSJ machine equipped with a selective tucking device. Mercerised and unmercerised yarns to be investigated.

Ward [1] reported that mercerising has an advantageous effect on dye-uptake, shade brightness, drape and fabric handle. There is a 14 *per cent* cost saving if the fabrics are mercerised in piece form rather than using mercerised yarns. He also found that the dimensional stability of a stenter

dried fabric was not as good as that of a calendered tubular fabric.

Black[2] compared open-end and ring spun cotton yarns knitted on 18 gg Single Jersey before and after treatment for durable press. Fabrics from open-end yarns pilled more, but showed less spirality, gave improvements in fabric appearance in respect of cloudiness, and better depths of shade after dyeing.

Frick *et al*[3] compared cotton and cotton/polyester blend Fabrics, untreated and DP treated, for durable press and easy-care properties. He showed that in the case of 100 *per cent* cotton fabric after crosslink finishing, the shrinkage was reduced from 28 *per cent* to 6,5 *per cent* and durable press ratings after tumble drying improved from 2,0 to 4,6. However, bursting strength and resistance to flat abrasion dropped by about 50 *per cent*.

In this report, the effect of mercerisation on the physical properties of 100 *per cent* cotton single jersey fabrics, plain and Jacquard, has been studied, and the effect of durable press treatment on these fabrics.

EXPERIMENTAL

Fibre:

A three component fibre blend of between 28,6 mm and 34,9 mm (1 1/8" — 1 3/8") staple length was processed to the combing stage and tested for the fibre parameters, micronaire, American staple length, uniformity ratio, and zero gauge bundle strength.

TABLE I

YARN DETAILS

Tex	Twist Constant	t.p.m	Resultant Folded Yarn
10,0	33	1 030	R20 tex S475/2Z 1030
8,5	33	1 140	R17 tex S515/2Z 1140
7,6	32	1 140	R15,2 tex S550/2Z 1140

Yarns:

The cotton blend was spun to *three* different linear densities, viz. 7,6 tex (78's cc), 8,5 tex (69's cc) and 10 tex (59's cc) and the yarns were folded using a hosiery twist factor (33). Table I gives the details of the yarns.

The yarns were cleared on an Uster Classimat during rewinding prior to yarn twisting. Each lot of yarn was divided into four parts:-

(a) bleached;
(b) bleached + dyed;
(c) mercerised + bleached; and
(d) mercerised + bleached + dyed.

Mercerisation:

The mercerisation process was carried out under mill conditions. The yarn was gassed, hank-reeled and mercerised (Caustic soda) in a Jaeggli mercerising machine, the hanks being shrunk and then stretched before rinsing and squeezing in hot water. The hanks were then neutralised (15 baths), and finally dried.

The yarns were then bleached and dyed in hank form before winding and waxing (Paraffin wax, m.p. 60 – 63°C.)

All the yarns were tested at each stage of finishing to determine the effect of the various processes on the yarn physical properties.

Knitting:

The machine details were as follows:

Machine	:	Bentley JSJ
Gauge	:	28
Diameter	:	66 cm (26 inches)
Yarn input tension (g)	:	3
No. of feeds in use	:	16
Machine speed (r.p.m)	:	14
Designs	:	Plain or 2-colour Jacquard
Type of positive feed	:	Plain : Trip tape; Jacquard : None
Take down tension	:	Medium

Two basic fabrics, viz. (a) a plain jersey, and (b) a small repeating Jacquard pattern were knitted from each yarn linear density. The plain jersey fabrics were knitted from dyed yarns, and the Jacquard patterned fabrics from bleached and dyed yarns to produce a two colour pattern effect. (See Appendix II for designs and samples). Each experiment was repeated in both unmercerised and mercerised yarns, making 12 fabrics in total.

In the case of plain single jersey, trip tape positive feed was used, but

in the case of the Jacquard structures this was not possible due to the nature of the designs. In order to compare the physical properties of the plain and Jacquard fabrics it was essential that both structures had similar surface appearance, i.e. the same knit stitch (loop) length (ℓ_k). The only way in which this could be achieved, bearing in mind that positive feed could not be used, was, to knit the Jacquard structures using the same stitch cam settings as for plain single jersey. The course lengths of the two colours used per design were measured over the 16 courses in the repeat and the knit stitch length (ℓ_k) calculated by a method described later (see Appendix I). It can be seen that these stitch lengths were also kept constant within the limits imposed by the three different structures used. Tucking was so arranged that the long floats were tucked in selectively on the back of the fabric. 10 m of fabric was knitted from each of the 12 lots of yarn and all the yarns were knitted into the various structures without any faults.

For simplicity these 12 untreated fabrics were coded M to X.

Finishing:

Each fabric was divided into two parts and one part retained as a control. The other was drycleaned in a Permac Bõwe drycleaning machine to remove the paraffin wax which had been applied to assist in knitting.

Edge curling normally poses a problem when finishing single jersey fabrics, and the present fabrics were no exception. It was decided to hold the curled edges flat thus ensuring good results in finishing, and therefore a cotton fusible interlining tape 3,5 cm wide was fused onto the fabrics at the cutting line using dry heat and pressure. The fabrics were then slit open to a standard width of 170 cm and sewn together end-to-end.

Permanent Press Treatment of Fabrics:

Preliminary experiments were carried out with various percentages of Hercosett 57 (Hercules Powder Co.) DC 109 (Dow Corning) and Aminoplast resins. Subjective evaluation of these treated fabrics indicated that an aminoplast resin (8 *per cent*) and Dow Corning DC 109 (10 *per cent*) gave the best results in respect of wrinkling and handle. The DC 109 treatment appeared to give the better result in preventing edge curling but it was decided, because of the limited experience available regarding the use of DC 109 on cotton goods, to use the more proven treatment with aminoplast resin[4].

The *Plain Jersey fabrics* were padded to 80 *per cent* pick-up with a solution comprising:-

5 *per cent* Aerotex M3 (Cyanamid) – (aminoplast resin)
5 *per cent* Fixapret CP concentrated – (aminoplast resin) (BASF)
1 *per cent* Mystolube S (Catomance) – (polyethylene emulsion)
0,5 *per cent* Zinc nitrate hexahydrate – (catalyst) (i.e. 10% on mass of resin)
0,2 *per cent* Tergitol Speedwet – (wetting agent) (Union Carbide)

made up to 20 ℓ with water at room temperature.

The approximate pick-up on the fabric was 8 *per cent* (on mass of fabric). After padding, the fabrics were stentered at 160°C for 4 – 5 minutes and then washed in a rotating drum type washing machine (normal cycle) in a washing solution containing 0,5 g/ℓ Lissapol N (I.C.I.). After rinsing, the fabrics were tumble-dried and finally decatised.

It was subjectively assessed that the untreated Jacquard fabrics had better wrinkle resistance than the plain fabrics and therefore it was decided that a lower percentage resin application would suffice.

The Jacquard fabrics were padded to 80 *per cent* pick-up with the following solution:

2,5 *per cent* Aerotex M3
2,5 *per cent* Fixapret CP concentrated
1,0 *per cent* Mystolube S
0,5 *per cent* Zinc nitrate hexahydrate (i.e. 10% on mass of resin)
0,2 *per cent* Tergitol Speedwet

The approximate pick-up on the fabrics was 4 – 5 *per cent* on mass of fabric. The after treatment was identical to that described for the plain fabrics. These 12 treated fabrics were coded A to L.

Test Procedures:

The thickness of the fabrics was measured (in mm) on a Reynolds and Branson tester under a pressure of 5 gf/cm^2, the results representing the means of five determinations. A WIRA Air-permeameter was used to measure the air permeability of the fabrics at a water pressure of 5 cm. The fabric bursting strength was determined on a standard Mullen tester with ten tests carried out on each fabric. The fabrics were wrinkled at 75 *per cent* RH and 27°C for 20 minutes on an AKU tester and allowed to recover under standard (65% RH, 20°C) atmospheric conditions.

The wrinkling performance of the fabrics was assessed in terms of the standard deviation of the wrinkling curve obtained after 1 hr and 24 hr recovery respectively, following a method developed by Slinger[6]. Prior to wrinkling the fabrics were de-aged.

The abrasion resistance of the fabrics, in terms of percentage mass loss at 10 000 cycles, was measured on a Martindale Abrasion Tester with a 794 g headweight. The pilling propensity of the fabrics was rated by comparing with IWS photographs. The method of pilling was as described in TM 196[7] except that the comparison was made using the 40 mm disc instead of the 140 mm disc because it has been found that in the majority of cases the pills adhere to the top disc and not the bottom one. Bagging was measured using the Celanese method[8]. Fabric stability was measured as shrinkage during washing[9] and the durable press assessment was also compared before measuring the shrinkage after washing under the same conditions[10].

RESULTS AND DISCUSSION

Preparation:

The characteristics of the combed sliver made from the tertiary blend are shown in Table II.

TABLE II

COMBED SLIVER CHARACTERISTICS

Micronaire value	4,1
2,5% Span length after combing	32,49 mm
Uniformity ratio (length)	56%
Zero gauge bundle strength	42,8 gf/tex

Yarns:

Table III lists the physical properties of the yarns at various stages of finishing. The extension at break was reduced during processing, from bleached to bleached + dyed, to mercerised + bleached, to mercerised + bleached + dyed, and the extensibility was lowered from 6,8 *per cent* to 4,8 *per cent* in the case of the R20 tex yarn, from 6,1 *per cent* to 4,9 *per*

TABLE III

RESULTS OF PHYSICAL TESTS ON YARNS AT VARIOUS STAGES OF FINISHING

Yarn (tex)	Yarn State	Friction (gf)	Actual yarn tex	Breaking strength (gf)	CV (%)	Extension (%)	Irregularity (CV %)	Thin places per 1 000 m	Thick places per 1 000 m	Neps per 1 000 m
R20	n	31 — 32	20,2	335	6,5	6,8	Weighted Averages			
	bw	13 — 14	19,2	365	10,3	5,8				
	mbw	17 — 19	19,4	388	7,4	4,4				
	bdw	11	19,6	324	9,1	5,9	13,8	5	28	88
	mbdw	18	19,3	405	12,4	4,8				
R17	n	30	17,8	272	10,1	6,1				
	bw	14	17,4	372	7,9	6,0				
	mbw	14 — 17	16,9	344	7,9	4,9	14,4	5	55	132
	bdw	11 — 12	17,7	303	10,7	5,9				
	mbdw	11 — 12	17,0	335	9,4	4,9				
R15	n	31	15,6	264	7,1	6,2				
	bw	7 — 11	14,9	298	8,6	6,3				
	mbw	17 — 18	15,0	295	11,0	5,4	14,1	3	38	118
	bdw	15 — 17	15,3	323	9,1	6,5				
	mbdw	14 — 18	14,6	311	7,5	5,2				

n = natural
b = bleached
m = mercerised
d = dyed
w = waxed

cent in the case of the R17 tex yarn and from 6,2 *per cent* to 5,2 *per cent* in the case of the R15 tex yarn. The heavier the linear density of the yarns the greater the reduction in extensibility, indicating that these yarns were stronger but more brittle.

PLAIN SINGLE JERSEY FABRICS

Table IV gives a comparison of a *plain fabric* at various stages of relaxation for both unmercerised and mercerised yarns.

TABLE IV

DETAILS OF A PLAIN FABRIC AT VARIOUS STAGES OF RELAXATION

Lot	Relaxed State	Stitch length (cm)	c.p.cm	w.p.cm	c x w	K_1 (cxwxℓ^2)	K_2 (c x ℓ)	K_3 (w xℓ)
Unmercerised								
M	After dry relaxing	0,273	18,3	13,4	245,2	18,3	5,0	3,7
	After washing	0,272	20,7	15,4	318,8	23,6	5,6	4,2
A	After Treating	0,268	19,1	13,2	252,1	18,1	5,1	3,5
	After washing	0,269	18,6	13,9	258,5	18,7	5,0	3,7
Mercerised								
S	After dry relaxing	0,274	18,1	13,1	237,1	17,8	5,0	3,6
	After washing	0,273	19,1	15,7	299,9	22,4	5,2	4,3
G	After Treating	0,270	19,3	12,3	237,4	17,3	5,2	3,3
	After washing	0,266	19,4	13,0	252,2	17,8	5,2	3,5

TABLE V

A COMPARISON OF THE PHYSICAL PROPERTIES OF PLAIN SINGLE JERSEY FABRICS KNITTED FROM MERCERISED AND UNMERCERISED YARNS, DP TREATED AND UNTREATED

LOT	FABRIC MASS (g/m^2)	FABRIC THICKNESS (mm) (at 5 g/m^2)	BURSTING STRENGTH (kg/cm^2)	AIR PERMEABILITY $\frac{cm^3 \text{ per sec}}{cm^2 \text{ per cm}}$ (3 layers of fabric)	MARTINDALE ABRASION		AREA SHRINKAGE (%)	DP RATING	BAGGING (IR %)	AKU WRINKLING (DE-AGED) *** S.D. of AKU wrinkling curve (mm)					
					% Mass loss after 1 000 cycles	Pilling ** after 2 000 cycles				1 hr recovery			24 hr recovery		
										Wales creased	Courses creased	Mean	Wales creased	Courses creased	Mean
DP TREATED															
A	139	0,493	4,0	40	5,3	5	4,4	3,9	53,5	0,25	0,48	0,37	0,22	0,28	0,25
G (m)	123	0,488	6,2	81	4,9	5	5,6	4,0	51,6	0,21	0,51	0,36	0,15	0,28	0,22
B	108	0,483	4,0	68	2,9	5	6,6	3,8	55,6	0,26	0,19	0,23	0,17	0,12	0,15
H (m)	101	0,435	4,9	127	7,5	5	6,7	3,8	54,6	0,14	0,22	0,18	0,12	0,44	0,28
C	96	0,449	3,4	91	6,9	5	7,1	3,9	54,4	0,51	0,22	0,37	0,16	0,15	0,16
I (m)	83	0,391	4,3	148	10,0	5	5,2	4,6	53,2	0,20	0,30	0,25	0,11	0,11	0,11
UNTREATED															
M	123	0,495	7,2	60	0,7	2 – 3	29,5	2,4	41,3	0,30	0,21	0,26	0,25	0,18	0,22
S (m)	118	0,461	7,5	89	1,6	3 – 4	26,2	2,9	46,8	0,31	0,16	0,24	0,29	0,10	0,20
N	107	0,461	6,1	82	0,7	2 – 3	28,1	3,3	45,5	0,23	0,12	0,18	0,16	0,10	0,13
T (m)	100	0,427	6,5	139	2,3	3 – 4	27,0	2,0	39,1	0,21	0,10	0,16	0,13	0,09	0,11
0	88	0,435	6,4	98	0,7	2 – 3	29,4	3,1	46,4	0,24	0,08	0,16	0,18	0,12	0,15
U (m)	81	0,380	5,5	162	2,3	3 – 4	28,2	2,0	45,4	0,37	0,11	0,24	0,33	0,08	0,21

*Measured at 1 cm water pressure.

** IWS rating

1 = poor; 5 = good.

*** To cancel any ageing effects the fabrics were soaked in water at 20°C for 30 min, centrifuged, steam pressed while still damp before being conditioned at 27°C and 75% RH for 24 hours before being creased.

TABLE VI

A COMPARISON OF THE PHYSICAL PROPERTIES OF JACQUARD SINGLE JERSEY FABRICS KNITTED FROM MERCERISED AND UNMERCERISED YARNS, DP TREATED AND UNTREATED

LOT	FABRIC MASS (g/m^2)	FABRIC THICKNESS (mm) (at 5 g/m^2)	BURSTING STRENGTH (kg/cm^2)	AIR PERMEABILITY $\frac{cm^3 \text{ per sec}}{cm^2 \text{ per cm}}$ (3 layers of fabric)	MARTINDALE ABRASION		AREA SHRINKAGE (%)	DP RATING	BAGGING (IR %)	AKU WRINKLING (DE-AGED) *** S.D. of AKU wrinkling curve (mm)					
					% Mass Loss after 1 000 cycles	Pilling ** after 2 000 cycles				1 hr recovery			24 hr recovery		
										Wales creased	Courses creased	Mean	Wales creased	Courses creased	Mean
DP TREATED															
D	156	0,692	5,6	33	2,7	3,0	9,8	4,5	49,4	0,19	0,39	0,29	0,13	0,31	0,22
J (m)	150	0,633	8,2	52	3,4	5	9,3	4,3	47,5	0,24	0,40	0,32	0,14	0,40	0,27
E	128	0,664	4,5	46	3,1	2,7	9,4	5,0	47,3	0,25	0,19	0,22	0,22	0,23	0,23
K (m)	118	0,568	6,1	83	3,0	5	10,0	4,5	45,2	0,17	0,38	0,28	0,15	0,23	0,19
F	108	0,596	4,2	59	3,7	3,2	11,1	4,8	47,5	0,19	0,18	0,19	0,12	0,14	0,13
L (m)	102	0,529	5,8	89	7,4	5	9,5	4,0	45,1	0,11	0,35	0,23	0,09	0,26	0,18
UNTREATED															
P	145	0,672	8,7	42	0,4	3 – 4	31,7	2,5	45,8	0,34	0,20	0,27	0,17	0,17	0,17
V (m)	144	0,610	9,7	76	1,4	4 – 5	33,9	3,3	40,5	0,32	0,25	0,29	0,22	0,21	0,21
Q	121	0,609	7,2	60	0,8	3 – 4	31,8	3,5	47,6	0,28	0,15	0,22	0,21	0,15	0,18
W (m)	110	0,562	7,1	124	1,6	4 – 5	33,0	3,0	42,1	0,27	0,24	0,26	0,27	0,19	0,23
R	102	0,583	7,3	84	0,6	3 – 4	35,0	3,1	47,6	0,19	0,25	0,22	0,14	0,16	0,15
X (m)	100	0,510	6,5	128	1,7	3 – 4	32,9	2,6	40,0	0,31	0,18	0,25	0,22	0,14	0,18

* Measured at 1 cm water pressure

** IWS rating
1 = poor; 5 = good

*** To cancel any ageing effects the fabrics were soaked in water at 20°C for 30 min, centrifuged, steam pressed while still damp before being conditioned at 27°C and 75% RH for 24 hrs before being creased.

It can be seen that there was only a very slight change in k-values and courses and wales per centimetre after DP treatment and therefore it can be concluded that the DP treatment arrested the relaxation and it can be assumed that these results are representative of all six sets of fabrics.

Table V gives the results of the physical tests carried out on the plain DP *treated* and *untreated* fabrics respectively. The results have been grouped for easy comparison, e.g. M and S are both plain fabrics made from bleached and mercerised + bleached yarns respectively and any differences in physical properties can be attributed to the different chemical treatments carried out on the yarns.

It can be seen that all the mercerised fabrics were of lighter mass, and in all cases the fabrics were thinner. This difference in mass and thickness increased the air permeability. All the untreated fabrics had fairly good abrasion resistance, the mercerised fabrics having a higher mass loss at 1 000 cycles. The mercerised fabrics had a slightly better pill rating than the unmercerised fabrics.

All the *untreated* plain fabrics in both unmercerised and mercerised form suffered severe area shrinkage during washing, and their DP ratings were unsatisfactory. Because of edge curling, taped edges were used to control the fabrics during the wrinkling tests and in some cases this caused puckering and high wrinkle heights.

Similar trends were observed for the DP treated, unmercerised and mercerised fabrics. The effect of the DP treatments on the plain fabrics, was to increase the mass per unit area, increase thickness, reduce bursting strength and to increase the air permeability. The abrasion resistance of the fabrics deteriorated after the DP treatments but the fabrics did not pill, probably because the pills dropped off due to fibre breakage.

Area shrinkage was arrested (as confirmed in Table IV) and brought down to acceptable limits. The DP ratings were improved but bagging increased. It can be seen that in the case of the DP treated fabrics, the wrinkling heights were generally higher than for those of the untreated fabrics. After washing, however, the DP results indicated an improvement in the appearance of the DP treated fabrics over those of the untreated fabrics.

JACQUARD SINGLE JERSEY FABRICS

The physical properties of the Jacquard, treated and untreated fabrics respectively, are listed in Table VI. The results have once again been grouped for easy comparison, e.g. D and J are both Jacquard fabrics produced from 20 tex 100 *per cent* cotton yarn, Yarn D was unmercerised and Yarn J was mercerised, and therefore, any differences between these two fabrics which were knitted under identical conditions can be ascribed to the different chemical treatments of the respective yarns.

From Table VI it can be seen that the Jacquard fabrics produced from the *mercerised* yarns were of lighter mass than those made from bleached yarn, and can probably be attributed to the lower linear density of the yarns after mercerising + bleaching (see Table III). The fabrics were also slightly thinner. The DP treated, mercerised fabrics had a slightly higher bursting strength than the unmercerised fabrics. For reasons mentioned earlier mercerisation under the present conditions caused a large increase in air permeability.

Mercerisation generally increased the percentage mass loss after 1 000 cycles (Martindale) indicating a lower abrasion resistance. Pilling, however, was improved.

Area shrinkage values of the *untreated* Jacquard fabrics were considered very high, with no significant differences between bleached and mercerised fabrics. The DP ratings for the DP treated fabrics were fairly good but the bagging results were rather poor with the mercerised fabrics consistently better than the unmercerised ones. Comparing, therefore, the DP treated and untreated Jacquard fabrics similar trends were observed to those found for plain fabrics.

PLAIN vs JACQUARD

Comparing plain and Jacquard fabrics, it can be seen that the Jacquard fabrics were about 15 – 20 *per cent* heavier in mass than the plain fabrics. They were also about 40 *per cent* thicker, with a slightly higher bursting strength and an appreciably less air permeability. Abrasion resistance of the fabrics was similar, but these appeared to have different pilling properties. Although the untreated Jacquard fabrics had slightly better pilling propensity than the untreated plain fabrics, this trend was not maintained after the fabrics were DP treated. After DP treatment the plain fabrics did not pill at all whereas the unmercerised DP treated Jacquard fabrics pilled. The mercerised fabrics, however, did not. Because the Jacquard fabrics had a loose construction their constituent fibres could possibly be released more easily during rubbing which would account for their higher pilling rates; this could happen in both unmercerised and mercerised form, but the mercerised fibres, being more brittle would break and the pills fall off and therefore would not be recorded. It can be seen that the area shrinkage of the Jacquard fabrics was considerably higher than that of the plain fabrics, and the DP rating marginally better in the case of the untreated fabrics and slightly better after DP treatment. The DP treated Jacquard fabrics had slightly improved deformability than the plain fabrics.

SUMMARY AND CONCLUSIONS

Plain and Jacquard structures from a range of linear densities of both unmercerised and mercerised 100 *per cent* cotton yarns were knitted on a 28 gg Jacquard Single Jersey machine and no problems were encountered. Full details of yarns and fabrics are given and a durable press treatment for 100 *per cent* cotton single jersey fabrics is described.

It was shown that mercerised + bleached yarns generally showed a reduction in linear density which adversely affected fabric thickness, bursting strength, air permeability and abrasion resistance. The pilling propensity of the fabrics, however, improved. It can, therefore, be concluded that an allowance must be made if mercerised + bleached yarns are used and this should be in the range of about a 5 *per cent* increase in linear density over that of normal cotton yarns.

Single Jersey fabrics knitted from 100 *per cent* cotton generally had good abrasion resistance, although they pilled and had a high area shrinkage during washing. The fabrics were given a durable press treatment which although it degraded the tensile properties and the abrasion resistance, decreased air permeability and pilling, and it reduced the area shrinkage to reasonable limits. The wrinkling properties of the single jersey fabrics, however, were generally poor in spite of the fairly good DP ratings. This appeared contradictory and it was concluded that the wrinkling propensity was not really a measure of the severity of the wrinkling because of the fusible tapes used to control the fabric from curling, and in actual fact was due to some degree of puckering caused by the restrictive action of the taped edges.

The physical properties of the Jacquard fabrics generally followed the same trends as those observed for the plain fabrics except that they were heavier, thicker, stronger and less air permeable. They also had improved abrasion resistance but tended to pill more. Their area shrinkage was significantly higher, but they had better DP ratings and lower deformability than the plain fabrics.

ACKNOWLEDGEMENTS

The authors wish to thank members of the Departments of Cotton Spinning, Dyeing and Finishing, and Physical Testing, for spinning, bleaching and dyeing the yarns, finishing the fabrics, and carrying out the physical tests on the fabrics respectively. Appreciation is also expressed to Messrs Wellington Industries (Pty) Ltd Cape for mercerising the yarns. Permission by the Rhodesian Cotton Promotion Council to publish these results is appreciated.

THE USE OF PROPRIETARY NAMES

The fact that chemicals with proprietary names have been mentioned in this report does not in any way imply that SAWTRI recommends them or that there are not substitutes which are of equal or better value.

REFERENCES

1. Ward, D., Research Reveals Hidden Potential in Cotton. *Knitting Times*, **43**, No. 19, 34 – 35 (May, 1974).
2. Black, D.H., Knitting with Cotton and Cotton Blend Open-End Spun Yarns. *Text. Res. J.*, 48 – 53 (January, 1975).
3. Frick, J.G., Jr. *et al*, Durable-Press Knits of Cotton and Polyester. *The Knitter*, AT-3(4), (April, 1974).
4. Hanekom, E.C., Shiloh, Miriam and Slinger, R.I., The Effect of Some Durable Press Treatments on the Properties of Wool/Cotton and Cotton Fabrics. *S. African Wool & Text. Res. Inst. Tech. Rep. No.* 173 (1972).
5. Method of Test for the Wrinkle Recovery of Fabrics: Recovery Angle Method. AATCC Test Method 66 (1968).
6. Slinger, R.I., The Influence of Fabric Geometry and Certain Fibre Parameters on the Mechanical Properties of Wool Worsted Fabrics. Ph.D. Thesis, Dept. of Text. Sc. University of Port Elizabeth (October, 1970).
7. I.W.S. Pilling Test – Test Method 196.
8. Thomas, W., Celanese Bagging Test for Knit Fabrics. *Text. Chemist & Colourist*, **3**, No. 10, 57/230 (October, 1971).
9. AATCC. Shrinkage During Washing. AATCC Test Method, 135 – 1970 (IIIB).
10. AATCC. Appearance After Washing. AATCC Test Method, 124 – 1969 (IIIB).

APPENDIX I

DETERMINATION OF THE STITCH LENGTH FOR JACQUARD SINGLE JERSEY FABRICS

Consider the design – e.g. Fabric D

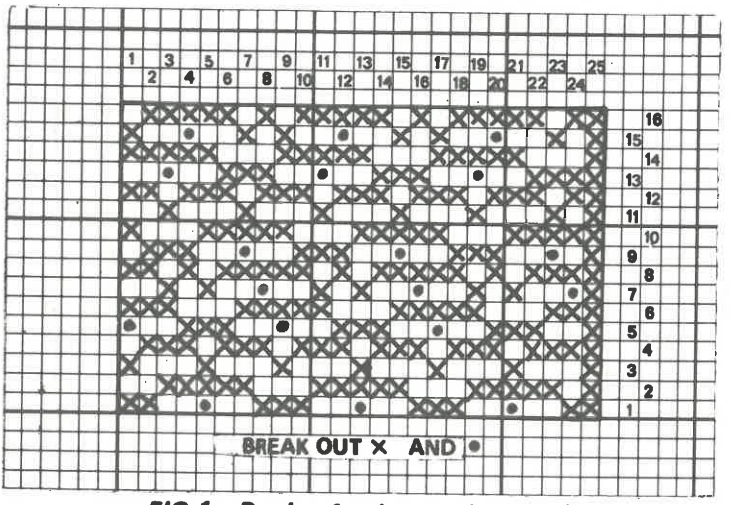

FIG 1 Design for Jacquard Fabric D

Mark out the structural knit cell (SKC) as shown in Fig 1 of the Jacquard design (i.e. the repeat of the design in both the wale and course directions) and determine the number of needles knitting (k), the number of needles tucking (t) and the number of needles missing (m) in this repeat.

Next, determine the total length (L_T) of yarn knitted in one repeat of the pattern i.e. 16 courses, on all the needles of the machine.

Then the total length of yarn in the SKC

$$\ell_{(SKC)} = \frac{L_T \times n}{N} \qquad \text{.....(1)}$$

Where n = the number of needles in the width of the SKC
and N = the total number of needles in the machine.

The stitch length (ℓ_k) of the knitted face stitches can then be determined from the equation:

$$\ell_{(SKC)} = k.\ell_k + t.\ell_t + m.\ell_m \quad \text{.....(2)}$$

where ℓ_k = length of a knitted loop

ℓ_t = length of a tuck loop

and ℓ_m = length of a float (miss) across one needle space.

Let us assume that $\ell_k = \ell_t$ since the same amount of yarn is drawn during the knitting operation, and $\ell_m = 1/$ gauge of the machine

therefore $\ell_{(SKC)} = k.\ell_k + t.\ell_k + \frac{m}{g}$ .....(3)

Since $\ell_{(SKC)} = \frac{L_T \times n}{N}$

then $\frac{L_T \times n}{N} = k.\ell_k + t.\ell_k + \frac{m}{g}$

$$\ell_k\ (k+t) = \frac{L_T \times n}{N} - \frac{m}{g}$$

$$\ell_k = \frac{\frac{L_T \times n}{N} - \frac{m}{g}}{(k+t)}$$

$$\ell_k = \frac{g.L_T.n - mN}{(k+t).g.N} \text{ centimeters}$$

Example:- Fabric D

$k = 64$ $\quad \frac{1}{g} = 0{,}0907$ cm

$t = 6$ $\quad n = 8$

$m = 58$ $\quad N = 2\,256$

and L_T by measurement $= 6\,662$ cm

$$\therefore \quad l_k = 0{,}2622 \text{ cm}$$

ISBN 0 7988 0698 2

Published by
The South African Wool and Textile Research Institute
P.O. Box 1124, Port Elizabeth, South Africa,
and printed in the Republic of South Africa
by P.U.D. Repro (Pty) Ltd., P.O. Box 44, Despatch