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Pad-Roll Mercerising of Cotton Single Jersey

by

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Contents

1. Introduction

In early 1976 TRD was engaged in a programme of development in the area of piece-goods mercerising of knitted cloth. At that time, there was some interest in the process from the trade, but it seemed as though two factors (at least) were inhibiting its rapid adoption.

- The fact that no "optimal" knitgoods mercerising machine was available.
- The high capital cost of available equipment.

Therefore, we decided to try and find out whether a mercerising process could be devised which would utilise simple existing equipment, as a stop-gap measure, so that people could undertake in-house trials to see the effects of the process on a range of their own fabrics, and possibly as a way of introducing the product on a low-risk basis.

TNO was given the job of looking at this problem, using fabric supplied by TRD. By supplying a controlled range of fabrics we also hoped to derive some systematic information about the response of single jersey cloth to piece mercerising.

In a fairly wide range of preliminary trials TNO looked at various combinations of conventional machinery with the emphasis upon the padder, the jig and the winch.

It soon became clear - as indeed was predicted - that the winch alone was not suitable either for application of caustic or for washing off impregnated cloth, due to the development of non-uniform (streaky) effects. Uniformity of treatment was assessed by dyeing with a direct dyestuff. The winch could only be used for final washing and dyeing after a preliminary rinse on the jig. The final recommendation of TNO was to apply the caustic soda by padding mangle, followed by a short dwell in a scray and rolling up, then to transfer the roll to a jigger for rinsing. Final washing, scouring and dyeing could then be carried out either on the jig or in the winch. Using this method a good uniform mercerising effect, including good lustre was claimed.

2. Experimental

Fabrics

Fabrics with the following nominal specifications were knitted at TRD and supplied to TNO for trials.

Series A	1/20 Ne	18G	TF: 13.5, 15.0 and 16.5
Series B	1/24 Ne	24G	TF: 13.5, 15.0 and 16.5

Full knitting details of these six fabrics are given in *Appendix 1*.

Six processing variants were applied at TNO in order to check the effect of tension and to evaluate the dyeing behaviour (colour yield). The variants were as follows.

Mercerising Treatments

Treatment 1

Tensionless process: Padded in 18% w/w NaOH + 5 g/1 Mercerol QW, followed by hand rinsing and neutralisation. Drying by suspending in a drying chamber.

Treatment 2

Low tension short jig process: Impregnation on the padding mangle, as in 1, followed by a short dwell in a scray and rolling up under low tension. Transfer to the jig for rinsing and neutralising. Tension on the jig kept to a minimum. Drying on a stenter frame by laying the cloth onto a pair of endless plastic-covered ropes for support. The stenter pins were not used, i.e. drying was under minimum tension.

Treatment 3

Exactly as 2 except that the treatment on the jig was extended to include a scouring process - 1% caustic soda + l g/l Ateban AB for one hour at the boil.

Treatment 4

Control: Exactly as 3 except that the padding with 18% NaOH was omitted.

Treatment 5

Dyeing: Only two fabrics were included, the 18G - TF 13.5 and the 24G - TF 13.5. Impregnation, rinsing, scouring and neutralisation as in 3, followed by reactive dyeing on the jig as follows.

Liquor Ratio 20:1 l g/l Matexil PH-L

80 g/l Sodium Sulphate

3% Procion Blue HE 6R

Running for 20 minutes at 40°C then adding 4 g/l Caustic Soda 10 minutes at 40°C raising the temperature to 80°C and maintaining this for one hour. Rinsing cold and hot, soaping, rinsing, neutralising and rinsing again. Drying was on the stenter frame and this time, the pins were used, applying minimal width tension. (TNO did not say whether any overfeed was applied).

In addition, samples were taken from these two fabrics before dyeing to be used in the laboratory dyeing experiments.

Treatment 6

Effect of NaOH Concentration: Fabric types 18G - TF 15.0, 18G - TF 16.5, 24G - TF 15.0 and 24G - TF 16.5 were processed exactly as in 2, except that the caustic soda solution was only 12% w/w and the stenter pins were used during drying.

On the grey fabrics marks had been made exactly 50cm apart in length and width directions so that the change in dimensions, due to the processing, could be assessed.

Laboratory Dyeings

Samples had been removed, at the appropriate stages during processing, from the 18G - TF 13.5 and the 24G - TF 13.5 fabrics to yield the following variants.

A scoured, rinsed and dried.

B mercerised, scoured and rinsed but not dried

C mercerised, scoured, rinsed and dried

Dyeings were carried out at 6 different dyestuff concentrations, 1 … 6% as follows.

Liquor Ratio 40:1

Procion Blue HE-6R, g/l	0.25	0.5	0.75	1.0	1.25	1.5
Matexil PA-L, g/l	1.0	1.0	1.0	1.0	1.0	1.0
Sodium Sulphate anh., g/l	60	60	80	80	100	100
NaOH addition, g/l	2.0	2.0	3.0	3.0	5.0	5.0

The bath was set at 40°C and the cloth was immersed at this temperature for 15 minutes before the caustic soda was added. 40°C was maintained for a further 10 minutes before raising the temperature to 80°C and dyeing at this for a further 60 minutes. Samples were then rinsed before clearing with 1 g/l Ateban at the boil for 10 minutes followed by final rinsing and drying.

From all dyebaths, the final dyestuff concentration was measured spectrophotometrically so that the dye uptake could be estimated. Losses during soaping were neglected. After conditioning, the dyed samples were measured for reflection using an Elrepho instrument.

TRD Evaluations

All the treated fabrics, together with untreated residues, were returned to TRD where we have determined the fully relaxed structure, measured shrinkage, strength and spirality, and have carried out some further laboratory dyeings.

TRD dyeings were carried out in 2%, 4% and 6% baths of Levafix Brilliant Blue EBRA or Navy Blue E4RA, setting at 40°C with 50 g/l Glaubers Salt and 15 g/l soda ash. Liquor ratio was 20:1 and dyeing was for 1½ hours at 40°C. Goods were washed off for 30 minutes at the boil in 2 cc/l of Lissapol NX.

Although testing was carried out on treatments 5 and 6, they will not be discussed in what follows, since treatment 5 was included only to have samples for dyeing tests and to show that the mercerisation was generally uniform, whilst treatment 6 was only included as a check on the tendency of caustic-impregnated cloth to stretch or shrink in processing. The detailed results are in the project file.

3. Results

Dimensional Changes During Processing

Table 1 shows the changes in dimensions which occurred during processing as determined by measuring between the 50cm markers which were made on the grey cloth. Clearly these data can give only a rough indication of the changes which might be expected during scaled-up operations and should be taken with a pinch of salt. However, presumably the relative effect of the different tightness factors is a real enough one and broad conclusions may be justifiable.

Thus it seems clear that:-

1. The extra shrinkage in the width caused by mercerising, compared to the scoured control, was generally rather small, i.e. the cloth is not difficult to handle.

2. The scoured control extended by up to nearly 30% in length whereas the mercerised and scoured sample extended by rather less. The difference was particularly noticeable with the lowest tightness factor.
3. In general, the tighter was the cloth, the more it extended in length, and the more it shrunk in width during the process.

Note that no corrections have been made to the data to account for spirality.

Lustre

The lustre of the mercerised cloth was judged to be surprisingly good in view of the processing conditions (no width control) but was definitely inferior to that which is obtained from a "proper" mercerising machine.

Yarns

The yarns were tested for Uster evenness U% and imperfections, Uster single thread strength, CV of strength, and extension at break, and coefficient of friction against steel. The tests were carried out by Shirley Institute and *Appendix 2* is a copy of their report, where the two yarns are identified as 1/20 TNO and 1/24 TNO.

Later, some indication of the effect of the fabric treatments upon yarn strength was obtained by removing yarns from the treated fabrics and testing them on the TRD Instron machine. A comparison between the Shirley and the TRD results is given in *Table 2*.

In this table, the value for the grey yarn as measured by TRD is the average, for each count, of the individual results from each tightness factor (TF) variant, after extraction from the grey cloth.

Coefficients of variation of strength for the TRD results were about the same as for Shirley's on the grey yarns but, after washing, the CV's were considerably higher (around 20%). Apparently, the mere act of knitting the yarns into cloth caused a reduction in yarn strength of 9 - 16%. However, at least a part of this difference may also be attributable to the different methods of test (rate of extension, twist losses etc.).

The results of the strength tests upon yarns removed from the treated fabrics are in *Table 3*, where the effect of the treatment is shown by averaging over tightness factors.

According to these results, the mercerising treatments may have given a small increase in yarn strength but, if so, then this increase was apparently eliminated after the fabrics had been given 5 washes.

Burst Strength

Figures 1 - 5 show the detailed burst strength results whilst *Table 4* compares the treatments by averaging over tightness factors. In most cases, the graphs show the expected effects of yarn count and tightness factor, and also confirm the loss of strength brought about by the five washes of the treated fabric. *Table 4* shows that, as with yarn strength, the mercerising treatments gave some improvement which was eliminated by subsequent washing. However, in this case, the unmercerised control (Treatment 4) has also lost strength and so the mercerised fabrics maintain an advantage.

At this stage it should be pointed out that the tightness factors will have been changed by the mercerising process and it may be worthwhile to try to correct this effect before comparing strength (and later spirality) between treatments. This point will be taken up again in the discussion.

Spirality

Spirality angles were measured on samples as received and after 5 washes and the results are shown in *Figures 6 to 10* and *Table 6*. From these it is clear that:-

1. Mercerising reduces spirality considerably.
2. The tighter the fabric, the less the spirality.

At this stage, it was not clear whether the beneficial effect of the mercerising was due to a setting effect or to an increase in the fabric tightness. This aspect will be dealt with later.

The Relaxed Structure

Relaxation was achieved by washing and tumbling five times. The shrinkage, stitch length, weight and courses / wales were measured as received and after relaxation.

The shrinkage results are detailed in *Table 5* and those for the constructional parameters in *Table 6*.

Dyeing Behaviour

The graph of Reflection vs. dye uptake provided by TNO is shown as *Figure 11* and in the Project File are mounted the samples from lab dyeings at TNO using Procion Blue HE-6R and at TRD using Levafix Brilliant Blue EBRA and Levafix Navy Blue E4RA.

Exhaustion values for the EBRA were only 23 - 58% (according to depth) for the scoured control and 56 - 72% for the mercerised material. The E4RA dye was better with figures of 69 - 77% and 84 - 89% respectively. The appearance of the dyed cloth was also, as we have come to expect, heavily in favour of the mercerised material. In every case, the 2% shade on the mercerised cloth was as dark or darker than that of the 6% unmercerised shade.

4. Discussion

Shrinkage

Inspection of *Table 5* shows that, in every case, the tighter the fabric the less it shrinks in length but the more it shrinks (or the less it extends) in width during relaxation. These are the same trends as were seen for the change in dimensions during the processing stage (*Table 1*). Generally speaking, the changes in dimensions during relaxation are less for the mercerised fabrics than for the controls.

In principle one could combine *Tables 1 and 5* arithmetically to arrive at an estimate of the overall change in dimensions, but it is simpler and more informative to make this comparison by inspecting the data of *Table 6*.

Yarn Tex and Tightness Factor

The first interesting point to emerge from Table 6 is that the scouring treatment alone has had a real effect upon the relaxed structure. Thus there are generally fewer courses and more wales compared to the relaxed grey cloth, the weight is lower and the spirality is less, but it is not clear whether there is a change in the stitch length; probably not. The average "loss" in weight is about 6½% and possibly this could be accounted for in the removal of waxes and impurities, if the number of stitches per unit area had remained about the same. In fact, the number of stitches was less in the scoured cloth by an average of about 3%, so the net loss in yarn weight is only around 3% (assuming no change in loop length).

In fact, the actual yarn tex in a given sample can be estimated from the relation

$$\text{Weight g/m}^2 = \text{courses x wales x loop length x Tex x F}$$

where F is a dimensioning factor. The results of applying this calculation to the data of *Table 6* are shown in *Table 7,* and the resulting Tex values are averaged over tightness factors in *Table 8.*

Several points are immediately obvious from these calculations:-

1. Yarn tex for a given treatment is surprisingly constant and we can take this as an indication that the calculation is a reasonable one to make.
2. Just the scouring treatment alone has changed the yarn count by very little - the differences are barely significant.
3. Differences between the three different mercerising treatments are also remarkably small and probably insignificant.
4. If we take the mean of grey and scoured fabrics as our control, then the effect of mercerising on yarn count is an increase of about 6% for the 1/20 Ne and 6% for the 1/24 Ne. Likewise, the effect upon tightness factor is 10% and 13% respectively.

Spirality

Having determined the "true" tightness factors of the fabrics, it is now pertinent to re-examine the spirality and burst strength data.

Figures 12 and 13 show spirality as a function of calculated tightness factor for the 18G and 24G fabrics respectively. The grey fabrics are clearly different in trend from the others, but it is difficult to say whether the scoured and the mercerised samples show separate trends. This point is more clearly made in *Figure 14* where no distinction is made between the symbols for scoured and mercerised samples. In addition, *Figure 14* demonstrates no difference between the 18G and 24G series. The clear conclusion is that tightness factor is the dominant - possibly the only - factor governing spirality.

Burst Strength

Table 9 lists the burst strength data for the relaxed fabrics and these are shown graphically in *Figures 15 and 16.*

Figure 15 shows a clear trend for burst strength to increase with tightness factor but the scatter is large and so conclusions are difficult. In *Figure 16,* however, a very close relationship seems to have emerged with only two "wild" points to mar the perfection.

The line is quite probably rectilinear over the range studied and suggests an increase of about 70 Kn/m^2 for every increase of one unit in TF and no influence of either scouring or mercerising. Such a line would also be an acceptable description of the 18G results in *Figure 15*.

Despite the scatter of *Figure 15*, one feels intuitively justified in concluding that (as with spirality) the caustic soda treatment had no influence *per se*, but that the observed changes in burst strength are due only to the changes in TF.

In this case, however, there is a clear effect of machine gauge which is undoubtedly due to the different yarn strength. In this context it is interesting to note that the line which has been drawn on *Figure 15* is the one taken from *Figure 16*, but multiplied by the factor $\sqrt{30} / \sqrt{24}$, the ratio of the square roots of the nominal yarn counts.

Courses and Wales

Figures 17 and 18 show the plots of courses and wales against TF. Here again, it is difficult to distinguish between the three different mercerising processes and hard to attribute differences between grey, scoured and mercerised to anything but the changes in TF. The gauge effect can be eliminated by applying the factor $\sqrt{30} / \sqrt{24}$ again, so there are no obvious interactions with yarn count here either.

Stitch Length

Earlier it was pointed out that the yarn Tex had increased by about 6% as a result of the mercerising treatment. This effect is presumably due to a combination of weight losses and yarn shrinkage. The shrinkage effect can presumably be isolated by looking at the stitch length data which are presented in *Table 10*, where stitch lengths have been averaged over treatments.

According to these, the yarn shrinkage must have been of the order of 8% so the weight loss must have been about 2% which seems a reasonable figure.

These changes in yarn count and stitch length are, of course, the foundation for all the changes in properties which have already been noted.

Dyeing Behaviour

The dyeing behaviour of the mercerised materials turned out much as expected. *Figure 11* shows the additional benefit to be obtained by not having a drying stage before dyeing. An important feature which could not be demonstrated within the scope of this small operation, however, is the reproducibility of the dyeing over a long length of cloth.

When we consider the quite large effects upon the final shade of:-

1. the intensity of drying before dyeing,
2. the concentration of the dye liquor,
3. the concentration of caustic soda

during mercerising, it is clear that a mill which was considering the introduction of such a process could easily end up with long-term (piece-to-piece) variations unless a strict control of these (and maybe other) factors were maintained.

In addition, it may turn out that quality differences in the starting fabric are accentuated by the mercerising processes and these could result in shade differences in the final goods.

5. Conclusions

1. A pad-roll mercerising process using simple, existing equipment appears to be feasible and relatively easy to carry out.
2. The process results in equivalent dyeing behaviour but somewhat inferior lustre to that obtained from a purpose-built mercerising machine.
3. The main effect of the mercerising on fabric quality is a change in the relaxed structure brought about by a change in yarn count and loop length due to yarn shrinkage.
4. All changes in fabric properties can be explained on the basis of the change in tightness factor, i.e. no “loop-setting” hypothesis is necessary to explain the relaxed structure and no yarn-strengthening hypothesis is necessary to explain the improved burst strength.
5. The increase in tightness factor can result in fabrics which are difficult or even impossible to knit directly.
6. Relaxed grey cloth is apparently not a very good indicator of the performance or construction of relaxed scoured cloth or relaxed mercerised cloth.

TABLE 1

TWO FABRICS: CHANGE IN DIMENSIONS DURING PROCESS

TREATMENT		1		2		3		4	
		l	w	l	w	l	w	l	w
18g	13.5	-12.0	-21.9	-9.1	-30.1	+7.2	-34.2	+22.2	-29.4
	15.0	-5.2	-24.3	-0.9	-33.6	+15.2	-34.8	+27.4	-29.7
	16.5	+0.4	-28.3	+6.0	-34.6	+19.1	-37.3	+28.9	-32.9
24g	13.5	-27.3	-17.1	-10.7	-24.0	+2.8	-30.4	+12.8	-25.2
	15.0	-21.4	-23.8	-5.8	-30.1	+6.0	-31.8	+13.0	-26.2
	16.5	-14.0	-26.5	-0.2	-31.6	+11.0	-31.1	+20.9	-29.2

1. 18% NaOH Slack : Pad, and rinse by hand

2. 18% NaOH Pad - Roll - Jig Rinse

3. 18% NaOH Pad - Roll - Jig Scour

4. Control - Jig Scour

TABLE 2

YARN STRENGTH AND ELONGATION AT BREAK

	STRENGTH grammes 1/20	1/24	ELONGATION % 1/20	1/24
SHIRLEY	472	305	7.7	8.9
TRD grey	430	256	10.3	10.0
TRD 5 washes	408	252	11.3	10.2

TABLE 3

YARN STRENGTH AVERAGED OVER TIGHTNESS FACTORS

	1/20 Ne		1/24 Ne	
	As Rec.	5 washes	As Rec.	5 washes
GREY	430	408	256	252
Treatment 1	482	430	357	298
2	446	384	311	266
3	457	436	298	275
4	433	446	297	280

TABLE 4

BURST STRENGTH AVERAGED OVER T.F.

	1/20 Ne		1/24 Ne	
	As Rec.	5 washes	As Rec.	5 washes
GREY	757	738	579	586
Treatment 1	800	742	693	674
2	806	734	676	635
3	827	725	670	638
4	749	652	648	584

TABLE 5

CHANGE IN DIMENSIONS DURING RELAXATION

		GREY		1		2		3		4	
		l	w	l	w	l	w	l	w	l	w
18g	13.5	-18.5	-18.9	-13.8	+0.6	-18.4	+3.0	-23.9	+9.0	-34.0	+12.9
	15.0	-9.0	-23.6	-7.8	-8.0	-12.5	+1.8	-19.4	+6.7	-21.6	+7.5
	16.5	-1.3	-29.1	-3.2	-1.6	-9.3	+1.2	-15.8	+4.4	-15.0	+3.0
24g	13.5	-22.4	-12.0	-8.7	+0.1	-18.7	+4.6	-24.1	+8.9	-26.6	+7.0
	15.0	-13.5	-19.3	-7.5	+0.1	-13.8	+2.8	-19.5	+5.9	-20.7	+3.4
	16.5	-5.7	-24.3	-3.5	-0.4	-8.4	+1.0	-15.0	+3.9	-18.8	+3.0

TABLE 6

STRUCTURAL PARAMETERS OF THE RELAXED FABRICS

		18g			24g	
	13.0	15.0	16.5	13.0	15.0	16.5
WEIGHT G	193	212	234	173	188	205
g/m² 1	210	226	238	207	219	228
2	219	234	243	196	205	220
3	210	222	232	190	203	211
4	181	195	216	166	175	193
COURSES G	37	43	49	40	45	50
per in 1	41	46	51	46	50	56
2	41	46	50	42	47	53
3	38	43	47	40	45	50
4	35	39	46	37	40	47
WALES G	28	30	32	32	34	36
per in 1	29	31	33	34	36	38
2	30	32	34	36	38	39
3	31	33	34	36	38	39
4	30	32	32	34	36	37
STITCH G	3.85	3.51	3.18	3.50	3.20	2.95
LENGTH 1	3.62	3.25	2.99	3.19	2.90	2.67
mm 2	3.52	3.17	2.99	3.20	2.94	2.69
3	3.60	3.20	2.97	3.30	2.95	2.70
4	3.88	3.45	3.17	3.60	3.13	2.89
SPIRAL.G	21	14	12	26	21	17
degrees 1	11	6	4	9	7	4
2	9	7	6	10	8	6
3	11	8	5	12	9	3
4	17	13	10	22	16	14
c/w G	1.32	1.43	1.53	1.25	1.32	1.39
1	1.41	1.48	1.55	1.35	1.39	1.47
2	1.37	1.44	1.47	1.17	1.24	1.36
3	1.23	1.30	1.38	1.11	1.18	1.28
4	1.17	1.22	1.44	1.09	1.11	1.27

TABLE 7

CALCULATED* YARN TEX AND TIGHTNESS FACTORS FOR RELAXED FABRICS

	18g			24g		
	13.0	15.0	16.5	13.0	15.0	16.5
TEX G	31.2	30.2	30.3	24.9	24.8	24.9
1	31.5	31.5	30.5	26.8	27.1	25.9
2	32.6	32.4	30.8	26.1	25.2	25.5
3	31.9	31.5	31.5	25.8	26.0	25.9
4	28.7	29.2	29.9	23.6	23.7	24.8
TF G	14.5	15.7	17.3	14.3	15.6	16.9
1	15.5	17.3	18.5	16.2	17.9	19.1
2	16.2	17.9	18.6	16.0	17.1	18.8
3	15.7	17.6	18.9	15.4	17.3	18.8
4	13.8	15.7	17.2	13.5	14.7	17.2
1 + 2 + 3	15.8	17.6	18.7	15.9	17.4	18.9
G + 4	14.2	15.7	17.3	13.9	15.2	17.1

* Using Tex = $\frac{\text{weight}}{\text{c.w.l.}} \cdot F$ and the data from Table 6

TABLE 8

CALCULATED YARN TEX FOR RELAXED FABRICS
AVERAGED OVER TIGHTNESS FACTORS

	18g		24g	
	$\bar{x}$	σ	$\bar{x}$	σ
GREY	30.6	0.6	24.9	0.1
1	31.2	0.6	26.6	0.6
2	31.9	1.0	25.6	0.5
3	31.6	0.2	25.9	0.1
4	29.3	0.6	24.0	0.7
1+2+3	31.6	0.7	26.0	0.6
G+4	29.9	0.9	24.5	0.6

TABLE 9

BURST STRENGTH OF RELAXED FABRICS (Kn/m^2)

	18g			24g		
	13.0	15.0	16.5	13.0	15.0	16.5
GREY	661	748	807	528	591	641
1	671	702	852	599	679	743
2	702	719	781	552	647	705
3	644	774	757	587	646	681
4	672	588	595	584	538	664

TABLE 10

STITCH LENGTH (mm) AVERAGED OVER TREATMENTS

		G + 4 a	1 + 2 + 3 b	a/b
18g	13.0	3.87	3.58	1.08
	15.0	3.48	3.21	1.08
	16.5	3.18	2.98	1.07
24g	13.0	3.55	3.23	1.10
	15.0	3.17	2.93	1.08
	16.5	2.92	2.69	1.09

Figure 1

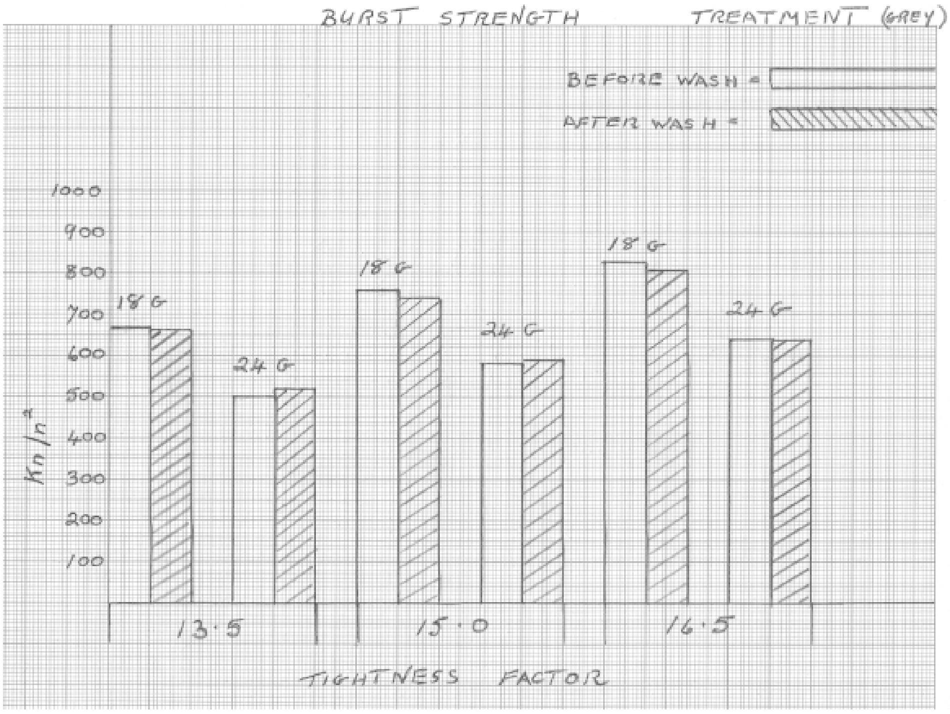


Figure 2

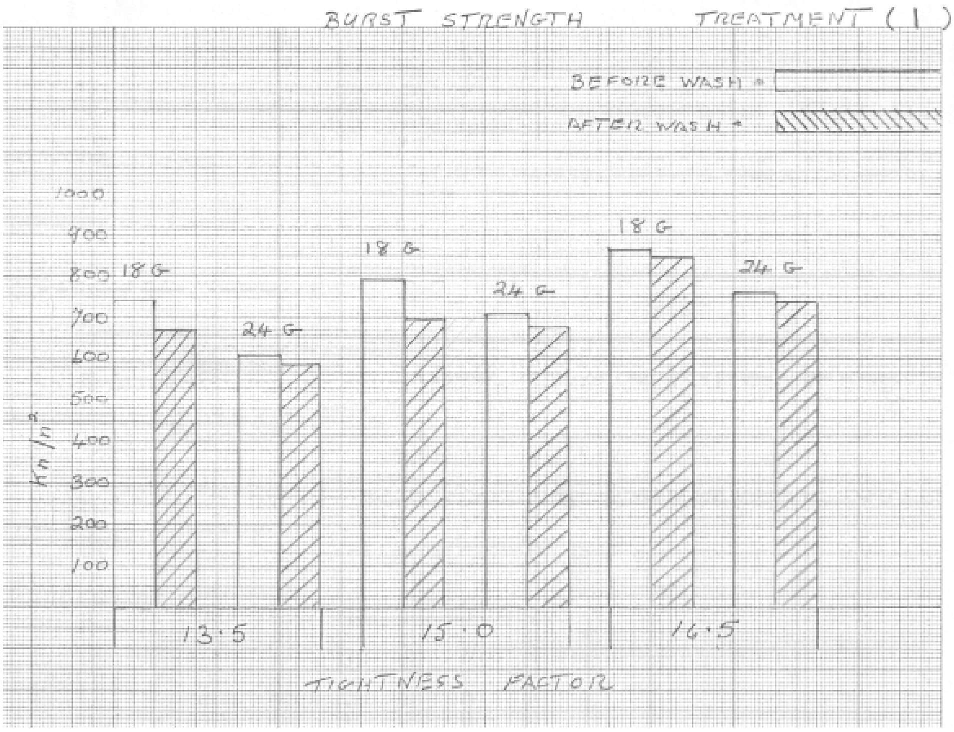


Figure 3

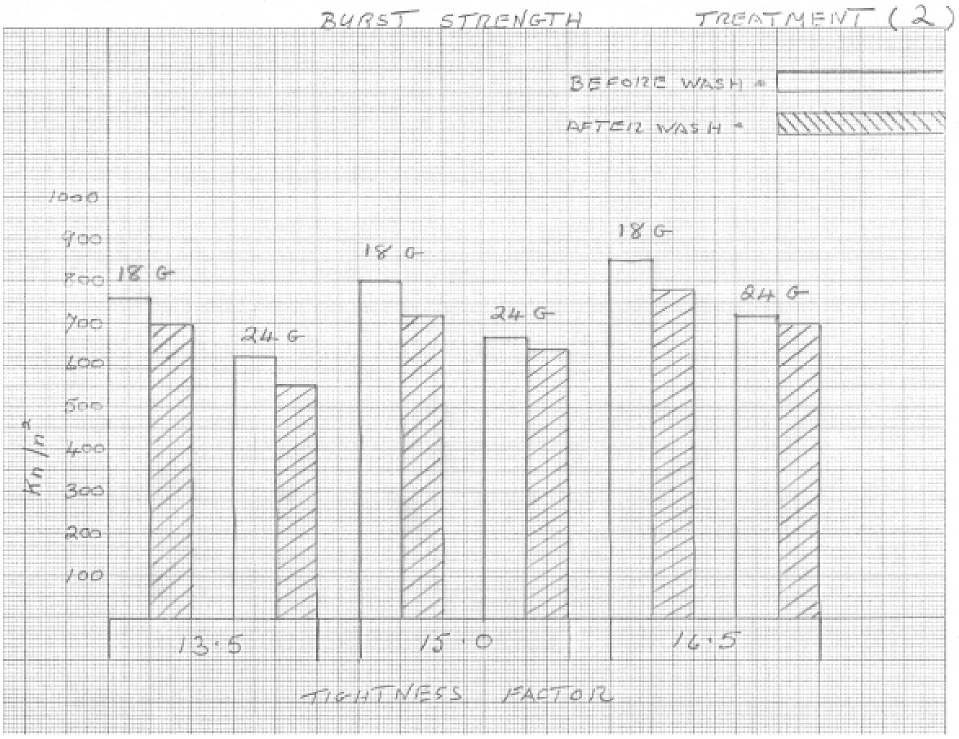


Figure 4

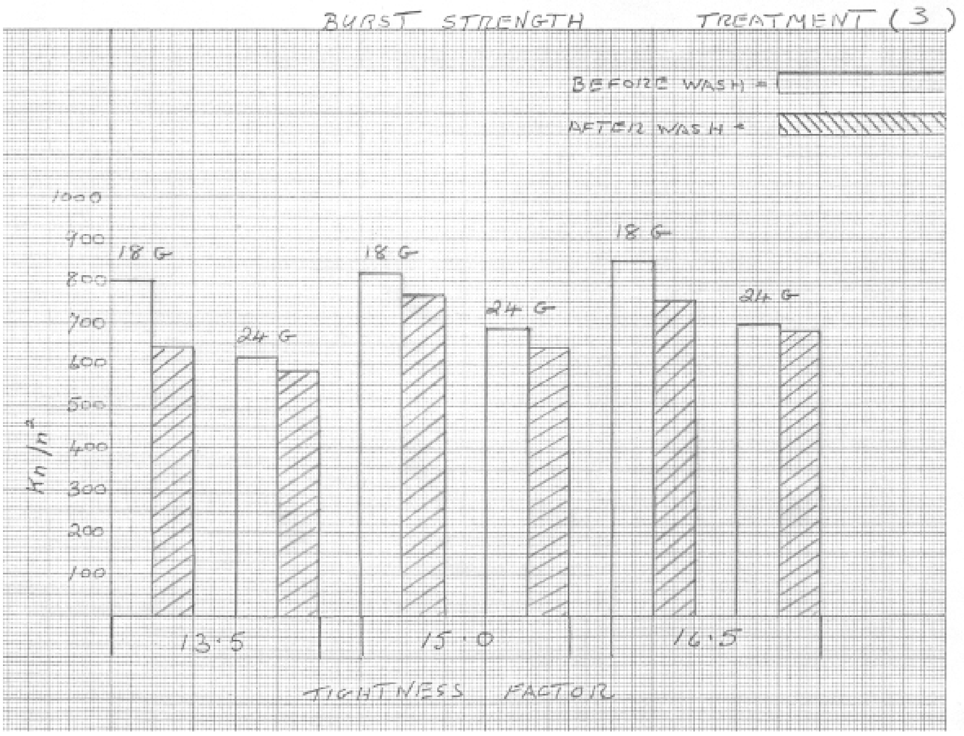


Figure 5

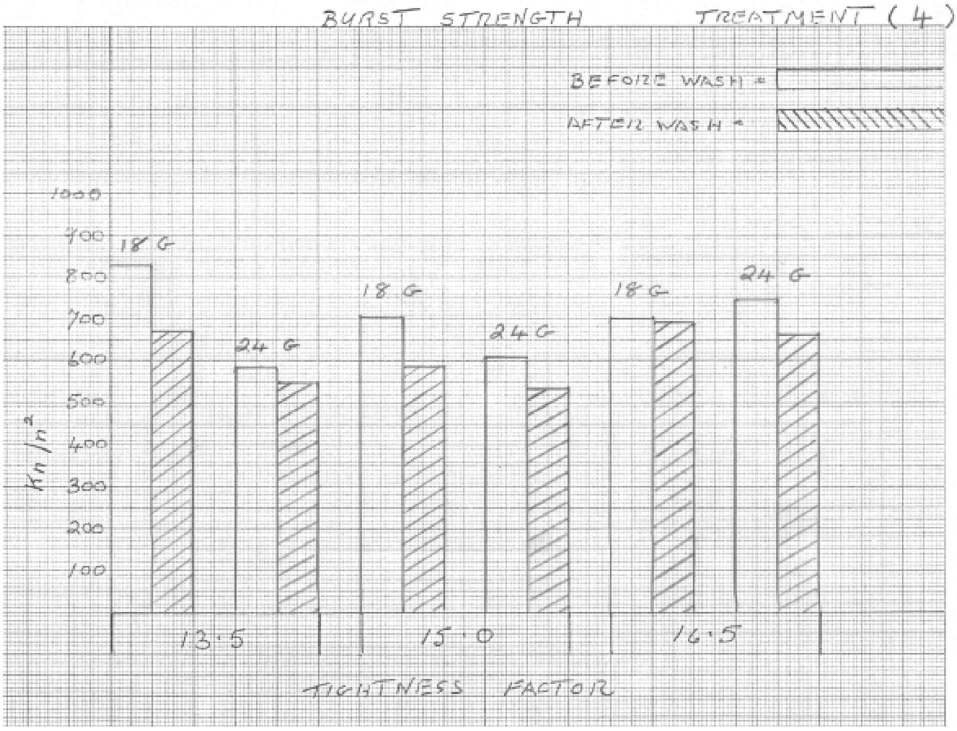


Figure 6

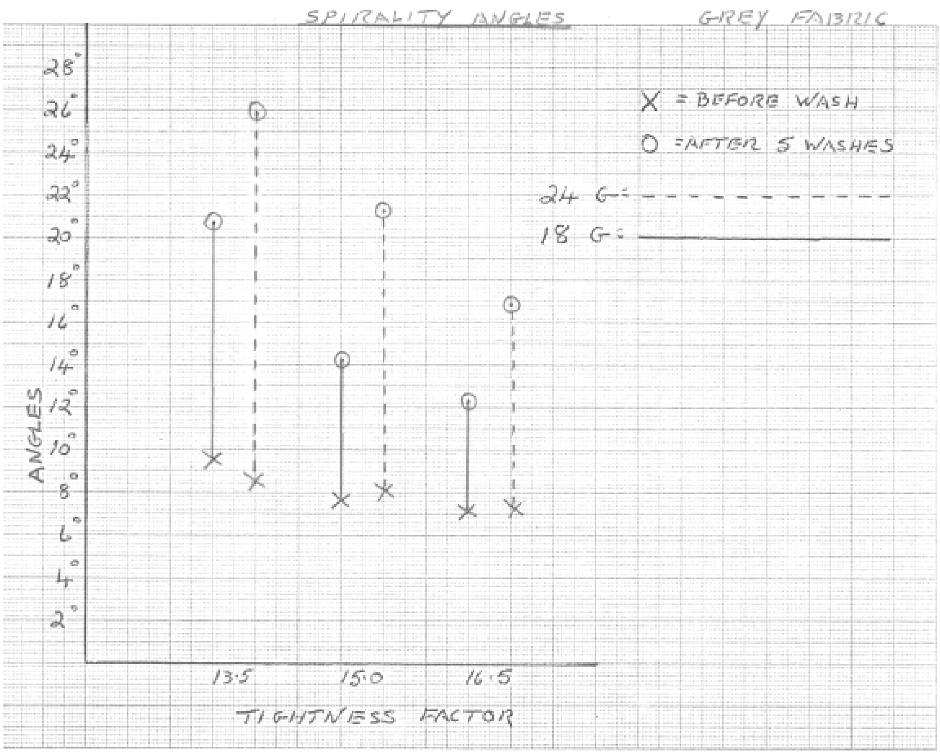


Figure 7

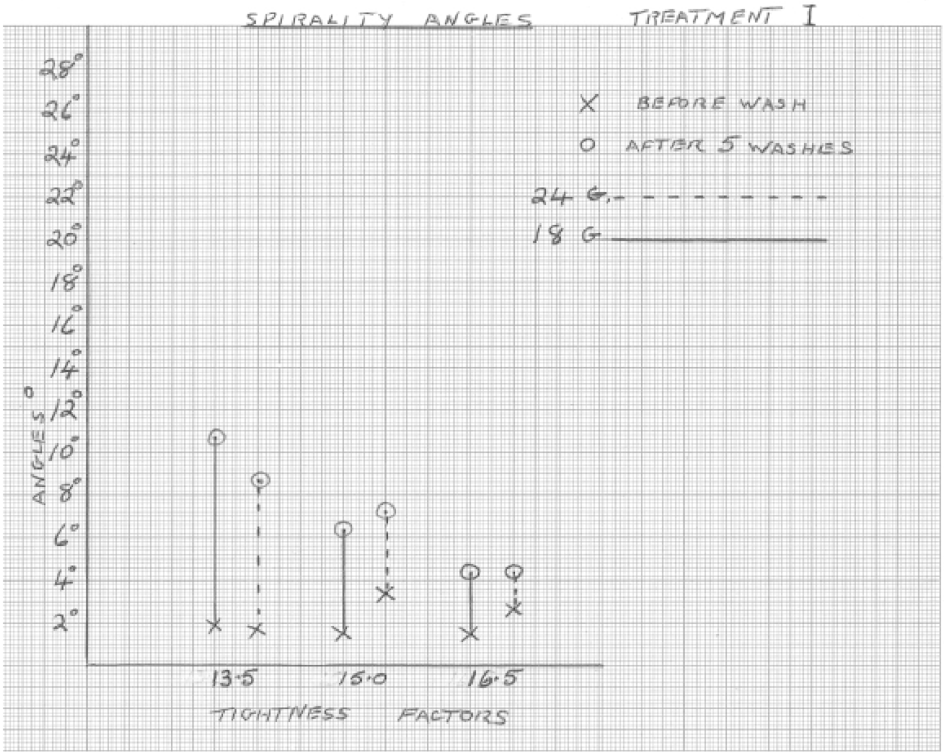


Figure 8

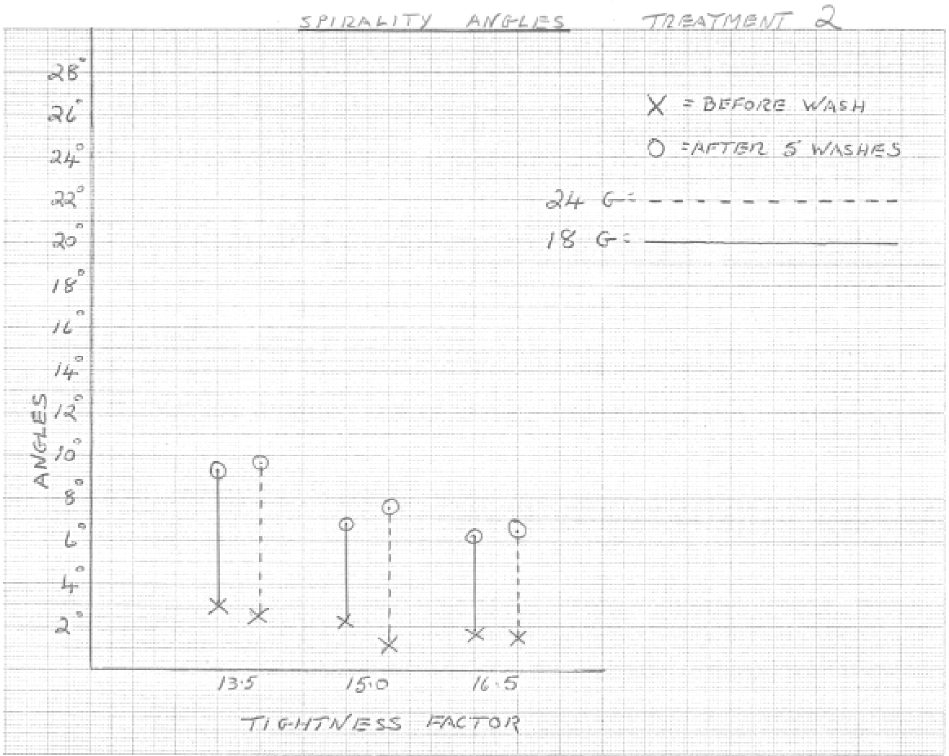


Figure 9

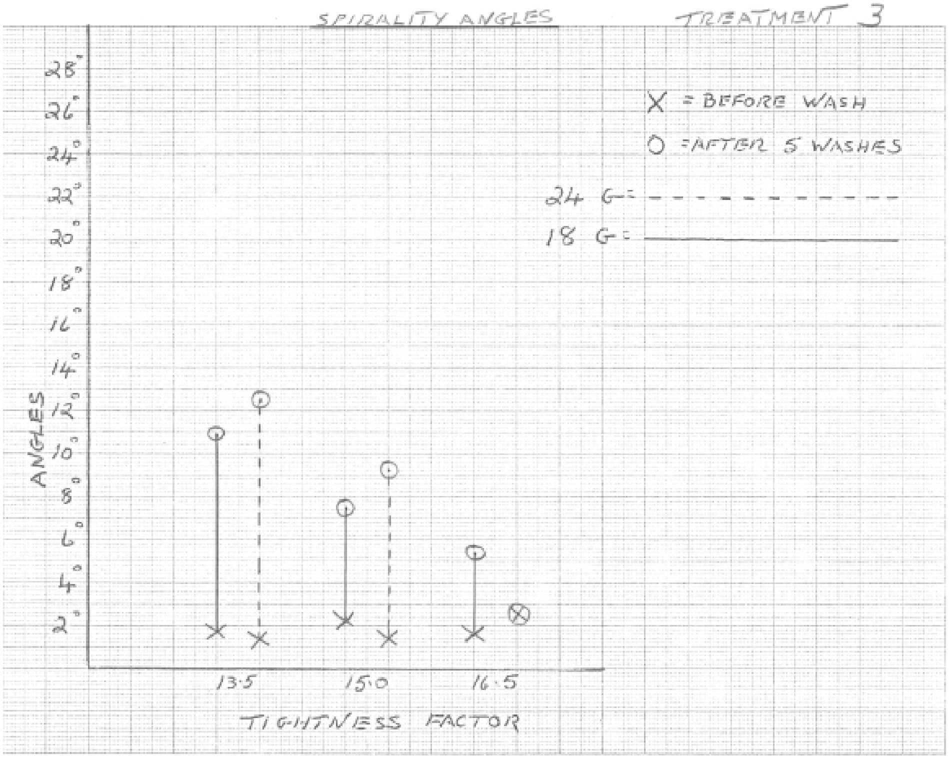


Figure 10

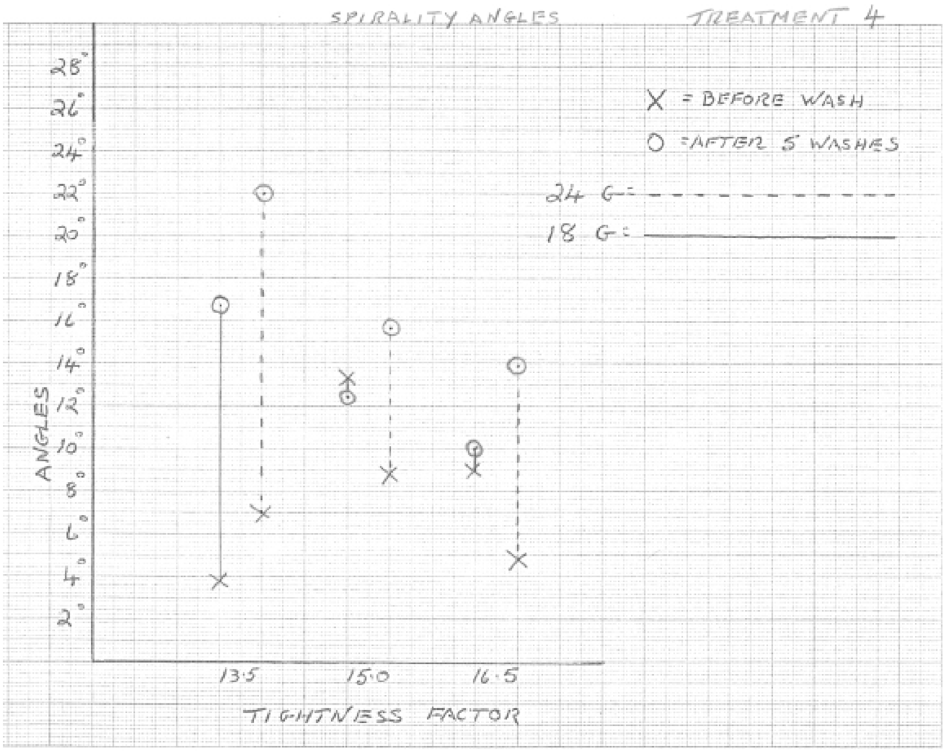


Figure 11

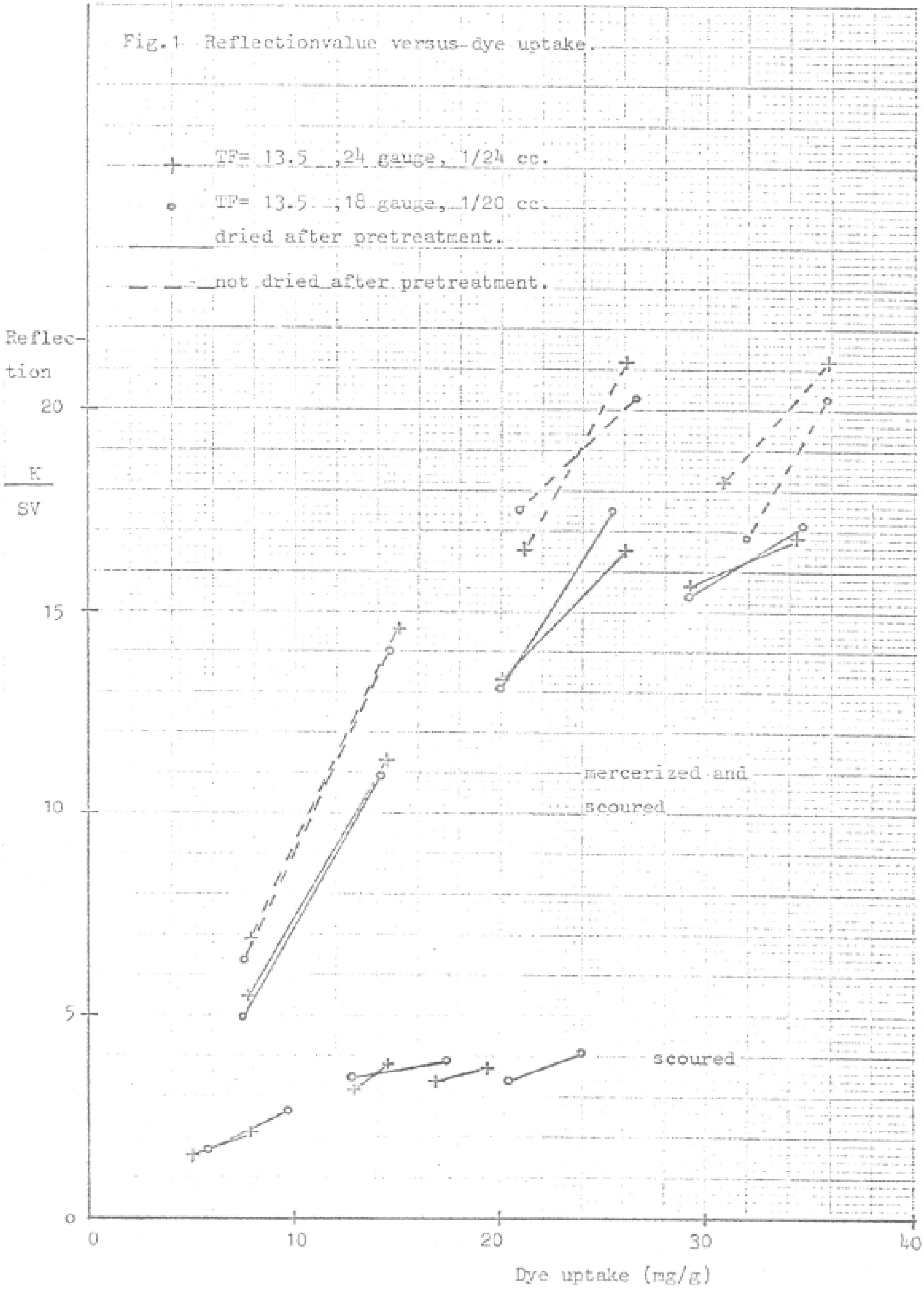
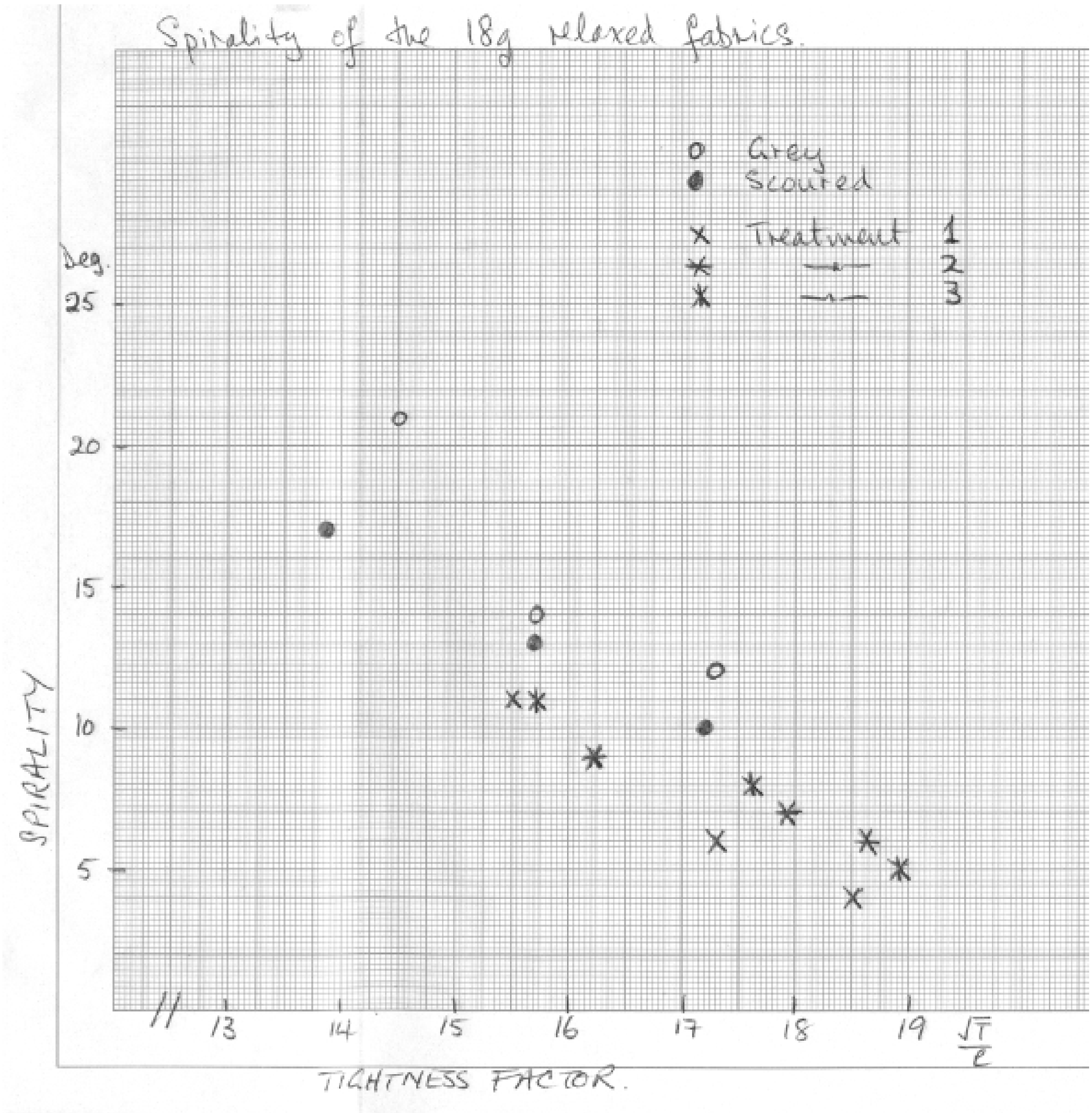


Fig. 1 Reflectionvalue versus dye uptake.
TF= 13.5 , 24 gauge, 1/24 cc.
TF= 13.5 , 18 gauge, 1/20 cc.
dried after pretreatment.
not dried after pretreatment.
Reflection
K
SV
20
15
10
5
0
mercerized and
scoured
scoured
0
10
20
30
40
Dye uptake (mg/g)

Figure 12



Spirality of the 18g relaxed fabrics.
Grey
Scoured
Treatment 1
2
3
Deg.
25
20
15
10
5
SPIRALITY
13
14
15
16
17
18
19
TIGHTNESS FACTOR.

Figure 13

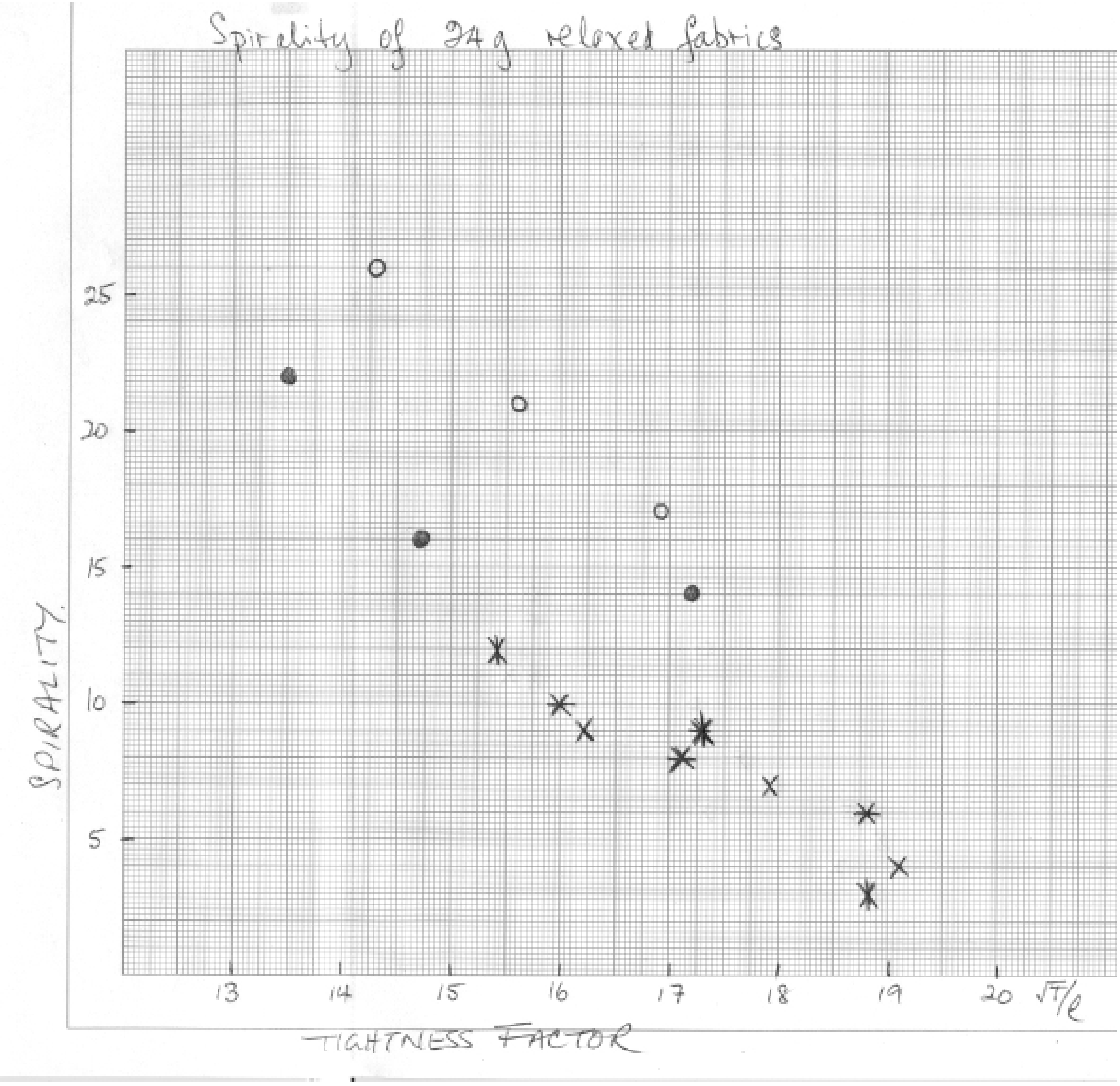

Spirality of 24g relaxed fabrics
SPIRALITY
25
20
15
10
5
13
14
15
16
17
18
19
20
√T/l
TIGHTNESS FACTOR

Figure 14

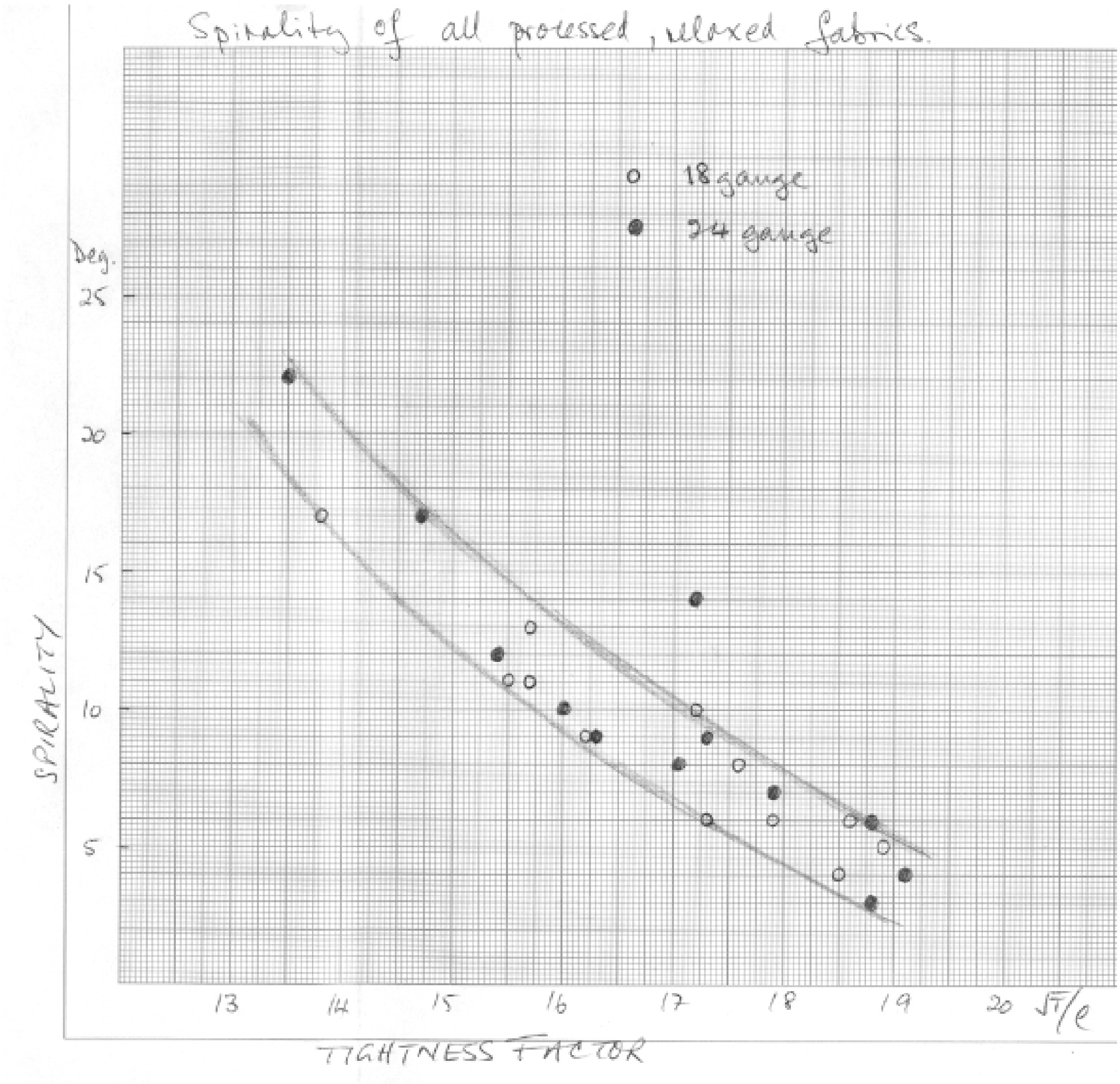
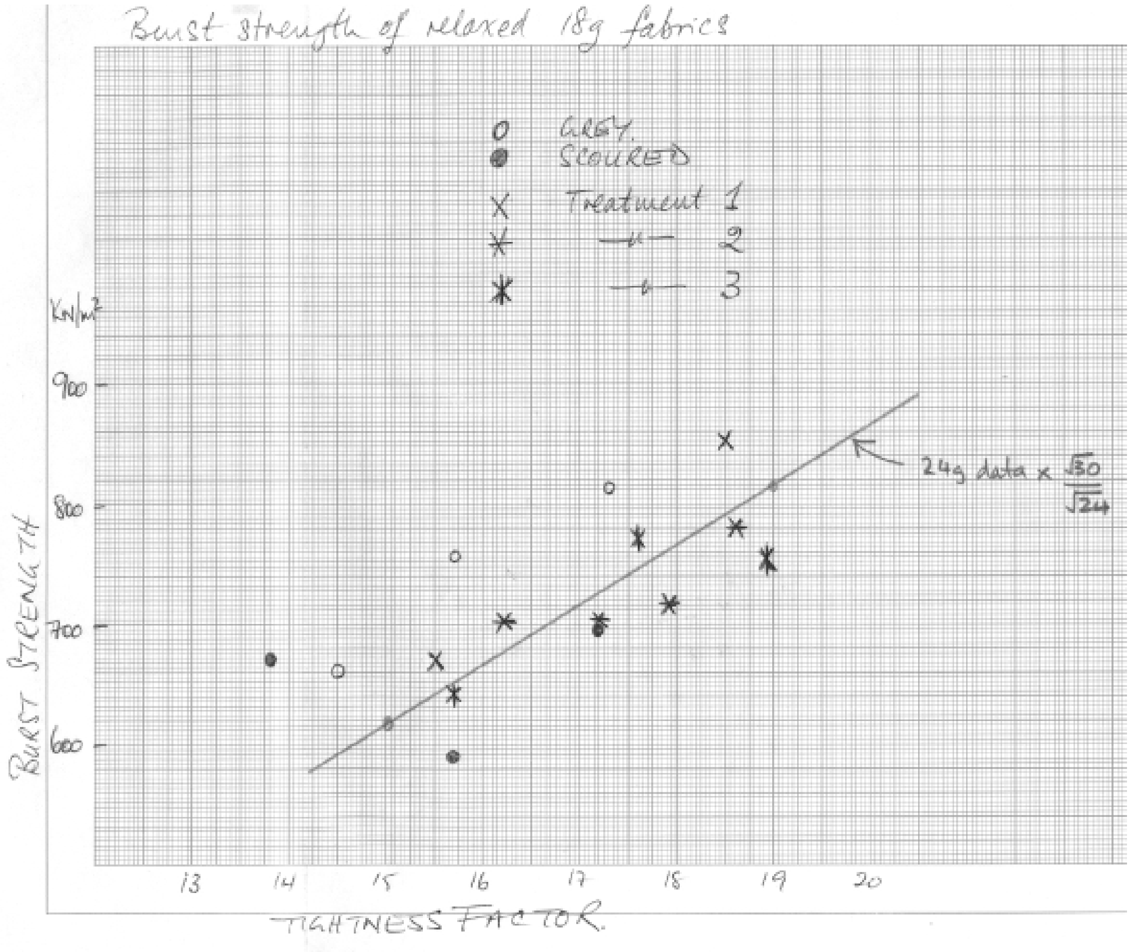

Spirality of all processed, relaxed fabrics.
18 gauge
24 gauge
Deg.
25
20
15
10
5
SPIRALITY
13
14
15
16
17
18
19
20
TIGHTNESS FACTOR

Figure 15



Burst strength of relaxed 18g fabrics
o GREY
SCOURED
X Treatment 1
2
3
KN/m²
900
800
700
600
BURST STRENGTH
24g data x √30/√24
13
14
15
16
17
18
19
20
TIGHTNESS FACTOR.

Figure 16

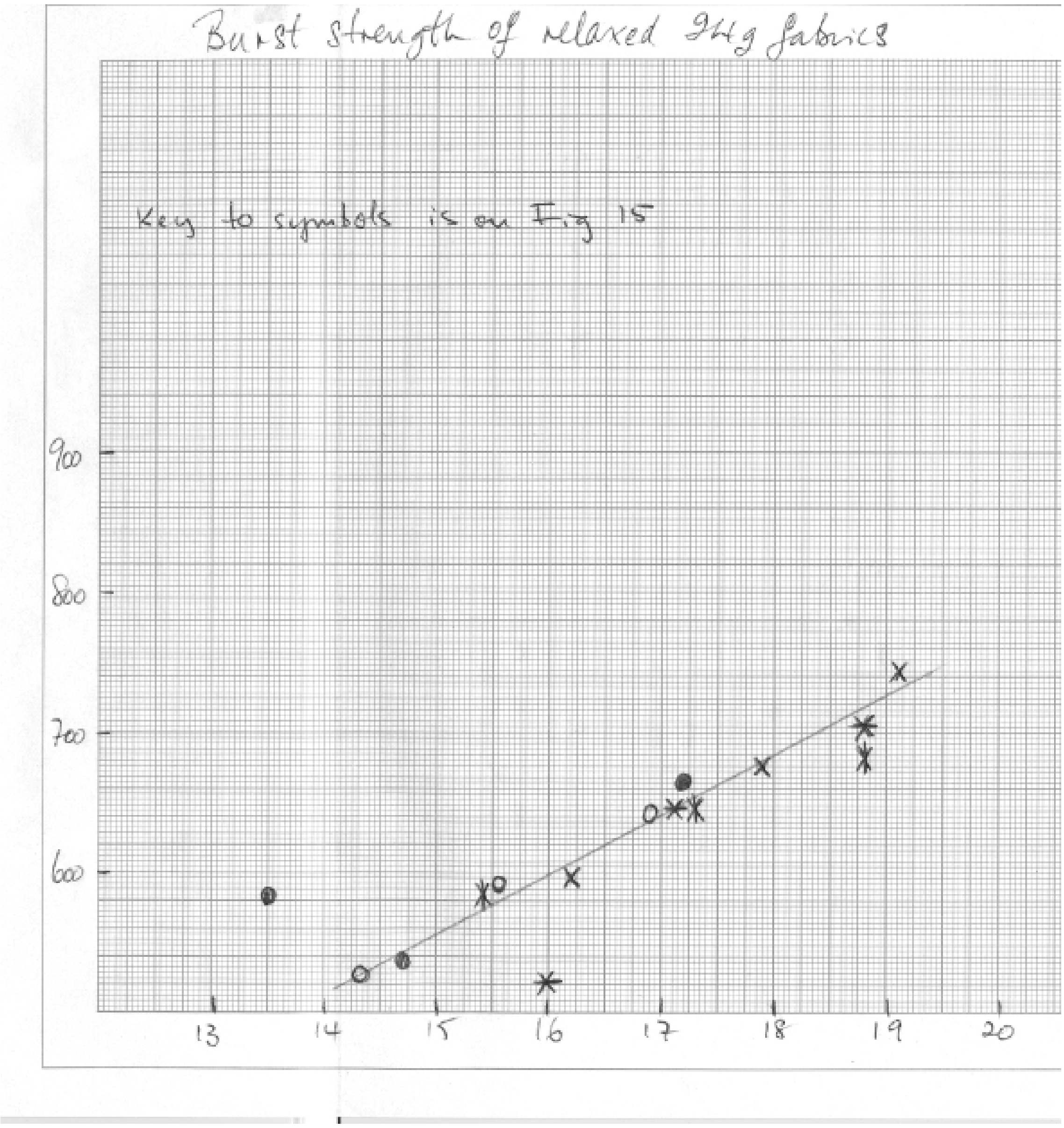

Burst strength of relaxed 94g fabrics
Key to symbols is on Fig 15
900
800
700
600
13
14
15
16
17
18
19
20

Figure 17

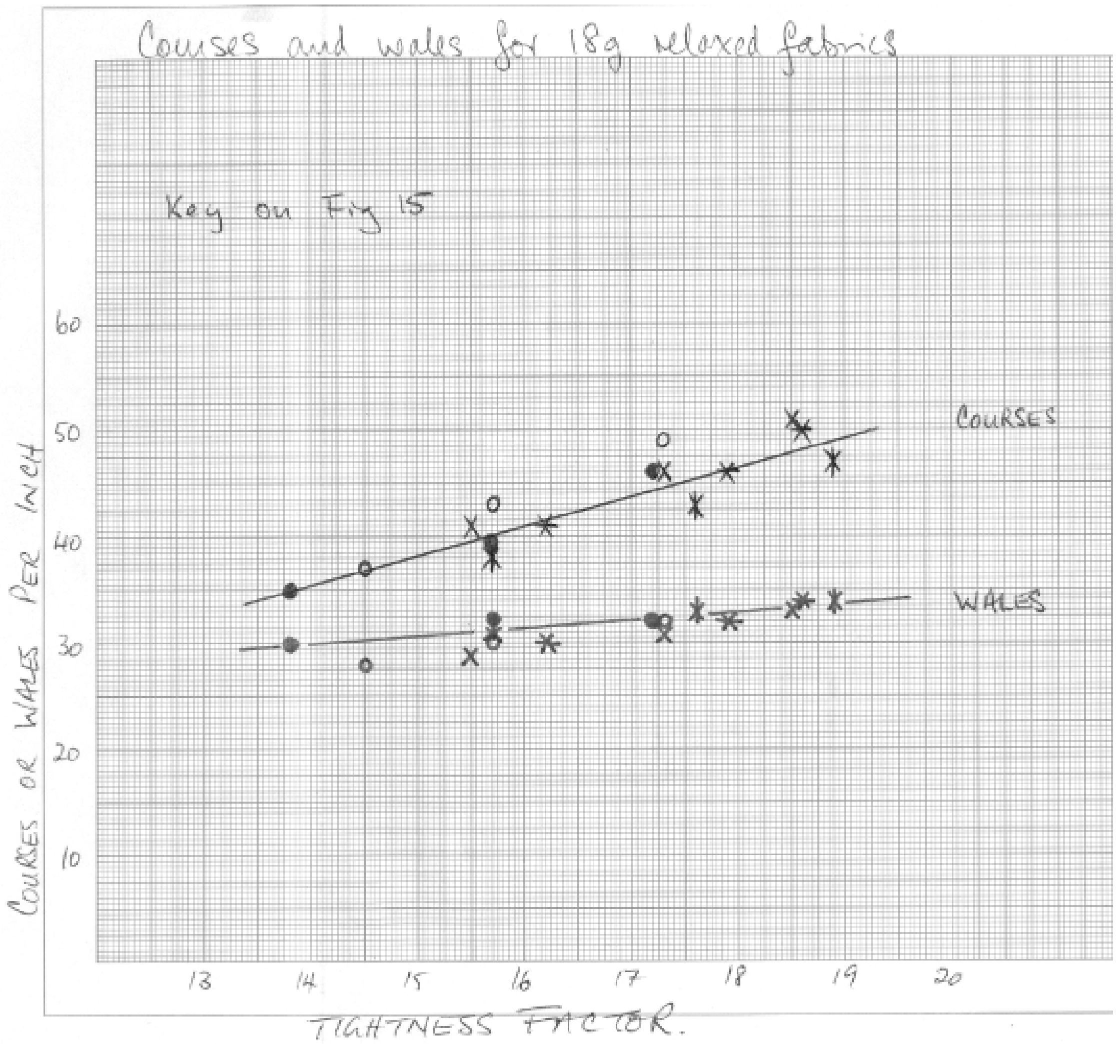
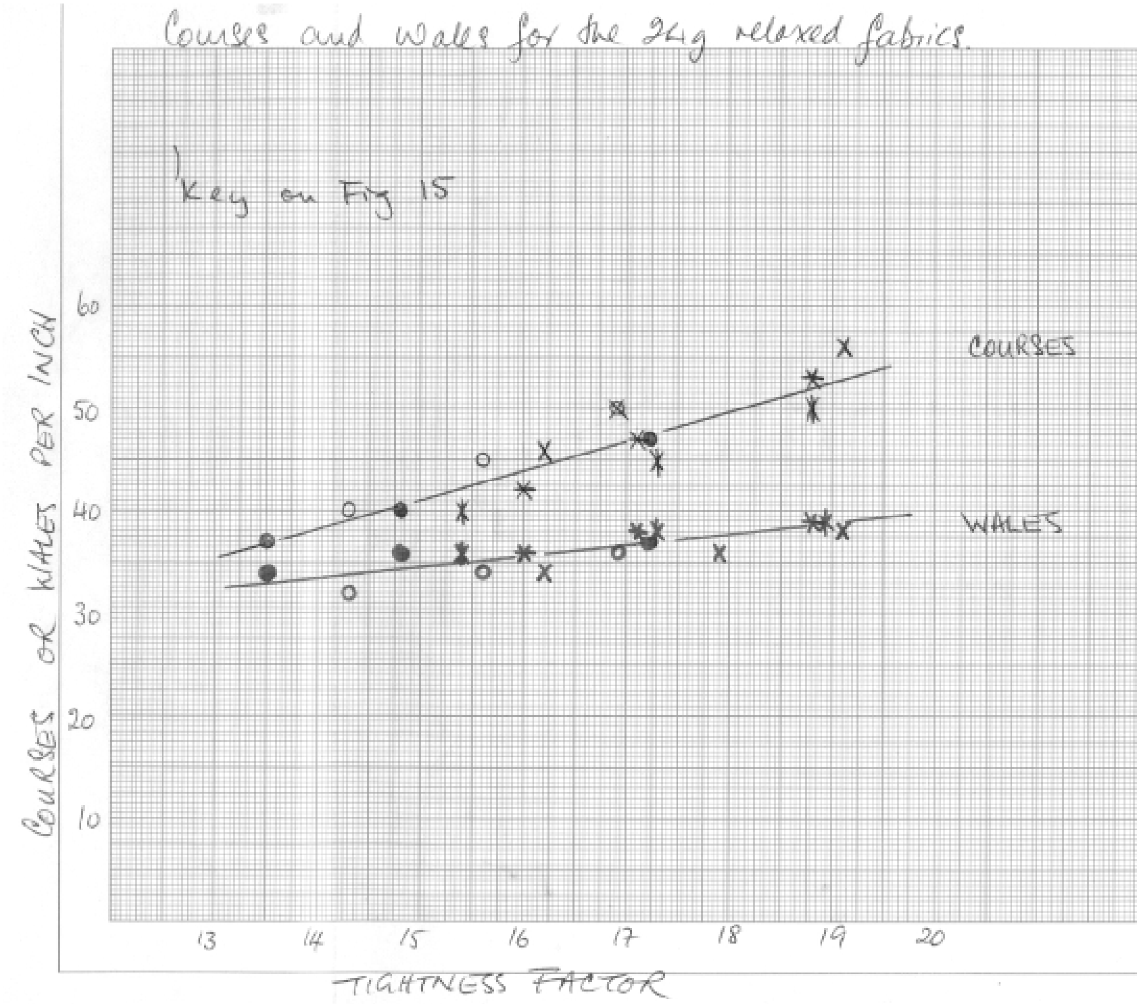

Courses and wales for 18g relaxed fabrics
Key on Fig 15
60
50
40
30
20
10
COURSES OR WALES PER INCH
COURSES
WALES
13
14
15
16
17
18
19
20
TIGHTNESS FACTOR.

Figure 18


Courses and wales for the 24g relaxed fabrics.
Key on Fig 15
COURSES
WALES
COURSES OR WALES PER INCH
10
20
30
40
50
60
13
14
15
16
17
18
19
20
TIGHTNESS FACTOR

Appendix 1: Knitting Details

Machine: Camber Velnit, 18 gauge, 26" diameter, 1500 needles.

Yarn: 1/20's cc, 29.5 Tex, Twist Factor 3.6 - Waxed on cones.

Fabric code	**CK 185**	**CK 186**	**CK 187**
Tightness factor (TF), K	13.5	15.0	16.5
Stitch length, inch	0.1584	0.1426	0.1296
Stitch length, cm	0.4023	0.3621	0.3292
Run-in, ft/10 revs	198	178.25	162
On-machine CPI	27	34	42
Width at take-up rollers, inch	34.5	34.5	35
CPI on doffed fabric roll	32	41	48
Doffed roll width	34	34	35
Dry-relaxed fabric weight, g/m^2	137	152	104
Roll length, yards	50	50	50

Machine: Monarch XL-JS, 24 gauge, 26" diameter, 1920 needles.

Yarn: 1/24's cc, 24.6 Tex, Twist Factor 3.5 - Waxed on cones.

Fabric code	**CK 182**	**CK 183**	**CK 184**
Tightness factor (TF), K	13.5	15.0	16.5
Stitch length, inch	0.1444	0.1303	0.1181
Stitch length, cm	0.3668	0.3310	0.3000
Run-in, ft/10 revs	231	208.4	189
On-machine CPI	28	35	44
Width at take-up rollers, inch	34.5	34.5	34.5
CPI on doffed fabric roll	33	40	49
Doffed roll width	34.5	34.5	34.5
Dry-relaxed fabric weight, g/m^2	116	139	149
Roll length, yards	30	30	30

APPENDIX 2

SHIRLEY INSTITUTE

THE COTTON SILK AND MAN-MADE FIBRES RESEARCH ASSOCIATION DIDSBURY MANCHESTER M20 8RX

Telephone: 061-445 8141
Telegrams: Explore, Manchester 20
Telex 668417 Shirley Mchr.

Ref. No: WTC/BM MS351K

Mr. J.T. Eaton
International Institute of Cotton,
Technical Research Division,
Kingston Road,
Didsbury, Manchester.

CONFIDENTIAL REPORT ON

TESTS ON EIGHT SETS OF YARN

Description: Eight sets of yarn were received for testing as follows:

5 Yarns 1/20 TNO, 1/24 TNO, 24's Grey, 24's Green, 24's Blue. Three cones of each. For Uster evenness and imperfection count Uster single thread strength and extension % at break, coefficient of friction against stainless steel.

3 Yarns 1/20 P761, 1/24 P761, 1/26 P761. Three cones of each. For Uster single thread strength and extension % at break, coefficient of friction against stainless steel.

Lab. Work: The test conditions were as follows:

Uster evenness
Yarn speed 25 yds/min.
Chart Speed 10 ins./min.
5 min. run on each package.
Imperfection settings.
Low 50%
Thick 3
Neps 3.

Uster Strength
Test length 50 cms
Time to break 20± 3 seconds
40 tests per package - cumulative - 120 tests per yarn.

Coefficient of friction:
Yarn speed 60 yds/min.
Stainless Steel object.
Means of 5 readings for each package.

The results are shown on the attached table. The Uster spectrographs and traces are enclosed for your inspection.

Signed: [signature]
Officer in charge of investigation
(Mrs.) O. Brien.

Signed: [signature]
Head of Member Service and Training Department
W.T. Cowhig

Ref: MS 351 K

Test USTER EVENNESS + IMPERFECTIONS / 1000 YDS
USTER SINGLE THREAD STRENGTH + EXT % AT BREAK

COEFFICIENT OF FRICTION AGAINST STAINLESS STEEL

Date: 2.4.76
Time:

Sample Description:

SAMPLE		U %	IMPERFECTIONS / 1000 YDS. LOW	THICK	NEPS		B. LOAD GMS.	CV [illegible]% (B.L.)	EXT %		COEFFICIENT OF FRICTION
1/20 TNO	1	10.6	8	NIL	8						0.224
	2	10.9	NIL	NIL	24						0.217
	3	10.9	8	NIL	48						0.119
	MEAN	10.8	5	NIL	27		472.1	7.7	7.7		0.187
1/24 TNO	1	11.1	NIL	NIL	56						0.[illegible]21
	2	12.5	40	24	64						0.123
	3	11.6	NIL	8	48						0.120
	MEAN	11.7	13	11	56		305.4	8.1	8.9		0.121
24s GREY	1	13.2	32	24	264						0.157
OPEN END	2	12.7	24	NIL	248						0.173
	3	12.2	24	8	240						0.169
	MEAN	12.7	27	11	251		278.4	9.4	8.4		0.166
24s GREEN	1	12.6	8	8	16						0.115
RINGSPUN	2	12.0	72	8	56						0.115
3.5	3	12.7	40	24	88						0.115
	MEAN	12.4	40	13	53		346.2	10.3	6.6		0.115
24s BLUE	1	12.2	8	24	72						0.115
RINGSPUN	2	11.9	8	24	24						0.112
4.2	3	12.1	8	24	8						0.116
	MEAN	12.1	8	24	35		434.4	7.7	7.7		0.114
1/24 P761	1										0.140
	2										0.145
	3										0.116
	MEAN						329.5	7.6	8.3		0.134
1/26 P761	1										0.126
	2										0.125
	3										0.124
	MEAN						311.4	8.8	4.2		0.125
1/20 P761	1										0.125
	2										0.125
	3										0.125
	MEAN						422.6	8.2	8.9		0.125