International Institute for Cotton

Research Record No. 245

Report to Meritex on Data from the Mercerising Trial of May 1988

S. A. Heap

May 1988

Classification: Fabrics / Knitted / Processing

Keywords: Meritex, Single Jersey, Mercerizing, Omez

Electronic version April 2008

SUMMARY OF FINDINGS

1. There is a small influence of the speed of mercerising upon reference dimensions. As the speed is increased, the final Reference-State courses are reduced and the wales are increased. The reduction in courses is greater than the increase in wales with the result that the reference weight is also slightly reduced.
2. There is an influence of the strength of caustic soda upon reference dimensions. With the 30 Baumé liquor, the final reference courses are increased and the wales are reduced. The change in courses is greater than that for wales, so the reference weight is also increased.
3. These two trends are in opposite directions so the final result depends on the exact combination of conditions. The greatest differences are seen when comparing the high-speed / low-concentration with low-speed / high-concentration. In many cases the net difference is very small - within a couple of percentage points.
4. These differences in Reference-State values can potentially result in significant differences in yield and performance (shrinkage) when fabrics which have been mercerised under different conditions are delivered at the same weight and width.
5. The reason why little or no difference was found in the shrinkages of the trial fabrics was that they were delivered with significantly different course densities and weights.
6. The current STARFISH model for Dornier-mercerised fabrics is a very good fit for the average of the fabrics which were mercerised at 25 Baumé, but not for those mercerised at 30 Baumé. This conclusion rests on some assumptions about changes in tex and stitch length which should be checked.
7. The test data supplied by Meritex was a much more self-consistent set than that which relates to the Bovetti trial, although there were still a few obvious bad numbers.

Introduction

On May 24 1988 a fax message was received from Meritex informing us of the results of a mercerising trial carried out on their Omez tubular merceriser with 24g single jersey fabric, quality XM02, in which the major experimental variables had been the speed of processing and the strength of caustic soda.

Quality XM02 is normally made from 16.7 tex yarn at a stitch length of 0.265 cm on a 2256 needle machine. Processing speed down the merceriser had been 20, 25, or 30 m/min; caustic soda strength had been 25 or 30 deg Baumé. The mercerised fabrics had been further processed with Meritex's normal production route, namely Brazzoli dye, Airtex, Ferraro pad soften, Alea dry, and Ferraro calender.

Meritex had sampled the pieces both before and after the calender and had tested them both as received and after a five cycle relaxation procedure including tumble drying. The test results were included, with a request for our comments. The fax message ended with "we had expected a difference in shrinkage and yield" from which we deduce that they were surprised to find little or no difference in weight and shrinkage as a result of the different mercerising conditions.

A quick look at the test data revealed that, indeed, there was apparently not much variation in the shrinkage of the fully finished (after calender) fabrics although it seemed as though there were small but systematic effects upon the reference dimensions as a result of the different mercerising conditions.

This report sets out the Meritex test data and attempts to quantify the systematic effects as well as to judge their practical consequences. A comparison of the test data with the predictions of the current STARFISH model is also made.

Preliminary Considerations

In the past IIC has run several trials with different types of mercerisers but we have never undertaken an experiment similar to this one so our past experience can only be a rough guide.

The general effect of mercerising on reference dimensions is somewhat equivalent to knitting a tighter fabric with a heavier yarn and indeed one of the most obvious changes in the fabric is shrinkage of the yarn which does result in a shorter stitch length and a heavier tex. However the changes in the final Reference State are usually more than can be explained simply by these yarn changes i.e. there is also an accompanying change in the shape of the loop. The extent to which these changes occur depends upon the conditions of mercerising, especially the degree of swelling which is achieved and the amount of tension which is imposed on the fabric.

Increasing the speed of mercerising is likely to have (at least) three main consequences.

1. Reduced impregnation time.
2. Reduced dwell time before washing off.
3. Reduced washing efficiency.

25 Baumé is about 19% NaOH by weight which is close to the concentration at which maximum swelling takes place in loose fibres (but not necessarily in fabrics). 30 Baumé is about 24% NaOH which is about the optimum level for fabric mercerising. Increasing the concentration of caustic soda from 25 Baumé to 30 Baumé is likely to have two main consequences. There may be a slight increase in the degree of mercerising and extra demands may be placed on the efficiency of washing off.

Reduced impregnation time puts a premium on the rate of wetting and there is usually a reduction in the wet pick-up as speed increases. However, knitted fabrics are capable of absorbing large quantities of liquor fairly rapidly. If the increased speed reduces wet pick-up to much below 100% then a reduced degree of mercerising could result.

Reduced dwell time puts a premium on rate of swelling. It is usually reckoned that at least 60 seconds are required before the washing starts. If a speed of 30 m/min substantially erodes the dwell time then a lower degree of mercerising could occur.

Reduced washing efficiency should not result in significant consequences for the degree of mercerising though it can cause problems in further processing - especially in dyeing. Incidentally, if the six pieces of this trial were all dyed together, and if there has been any significant influence upon the degree of mercerising, then there will be differences in the final depth of shade between the pieces.

Increased tension in mercerising can cause differences in the final Reference State of the fabrics. However we have found in the past that tension differences have to be quite large in order to create significant effects. Three examples come to mind.

1. The use of open width mercerising, in which both the length and the width of the fabric are held under tension, causes a large increase in the final reference length and width as compared to tubular mercerising. This is the extreme case.
2. We have carried out trials with two types of Omez tubular merceriser. On the early models a stretcher frame was included but with later models this was replaced by an air balloon system. Fabrics processed on the older machine have a different reference width to those from the newer system.
3. We have carried out trials with a Dornier merceriser in which the width of the 'cigars' was varied. So long as the resulting tension was not excessive there was little or no change in the reference dimensions but at very high tensions the resulting fabric was longer (fewer courses) and narrower (more wales).

Provided that the tension control systems were operating correctly, we would not expect to see large tension differences as a result of the speed or concentration changes used in this trial. However, if the washing efficiency was borderline (as is often the case with knitgoods mercerisers) then fabrics which had been processed at relatively high speed and at high alkali concentration might not be adequately washed and could proceed to the next wet process with a level of caustic soda which might allow the tensions in that process to influence the reference dimensions.

Results

Table 1 shows the raw test data as reported by Meritex. The first thing to do is always to check the apparent reliability and the internal consistency of the data. This is done by comparing the measured test data with those which can be calculated using other items.

Table 2 shows the comparisons which have been made for the purposes of this report. They are as follows.

1. Weight

   Weight before wash was calculated from measured courses and wales before wash together with estimates of the tex and stitch length. These latter were deduced from the following assumptions.

   - Starting tex was 16.7;
   - Increase in tex due to processing was 4%;
   - Starting stitch length was 0.265 cm;
   - Shrinkage in yarn due to processing was 7%.

   Weight after wash was calculated from measured reference courses and wales together with the same estimates for tex and stitch length.

2. Wales

   Wales before wash were calculated from the measured width and the number of needles in the knitting machine.

3. Shrinkages

   Shrinkages were calculated from measured courses and wales as delivered and in the reference state.

Table 2 shows that the measured and calculated weights before wash are in good agreement apart from two samples. In each case it is the calculated value which seems to be out of line and so the finger of suspicion points at the course and/or wale measurements.

With sample 25/25.B the measured and calculated length shrinkages are in agreement but width shrinkages are not so the problem must be with the measured wales which indeed look suspiciously high. A value of 52 wales seems much more likely than the 54 actually recorded. This is more or less in line with the calculated wales before wash.

With sample 30/20.B it is the measured course value which looks suspicious. However the calculated width shrinkage also indicates a possible problem with the measured wales so it could be that the real source is a small error in both courses and wales

The measured and calculated reference weights are all in very good agreement.

Measured and calculated wales before wash are in good agreement with the exception of the same two samples mentioned above, and also sample 30/20.A where the suggestion is that too many wales have been counted. This ties in with the difference between measured and calculated weight and also width shrinkage.

Measured and calculated length shrinkages are generally in reasonable agreement. More latitude is allowed here as shrinkage is usually only reliable to within two percentage points.

Measured and calculated width shrinkages agree pretty well with the exception of the three samples already mentioned plus sample 30/25.B. There may be small and opposite errors in both courses and wales which have cancelled themselves out for the weight calculations.

All in all this is not a bad data set. Certainly it seems more reliable than that which came from the Bovetti trial.

Effect of the Mercerising Process

As-Delivered Fabrics

In this section we are merely attempting to see how the various fabrics have been delivered. Under the assumption that the same finishing targets were applied to all variants, any differences which emerge must be due to changes in the Reference State or to changes in the ‘ease of processing’. For example if two fabrics are delivered at the same width but are found to have different width shrinkages, then there must be a difference in their reference widths. Similarly for their weights and length shrinkages.

Table 3 shows the dimensions and shrinkages of the fully-finished fabrics after calendering. The data have also been averaged over mercerising speed within caustic strengths. A few points are immediately obvious.

1. There are apparently no significant differences in the length and width shrinkages across the whole range of mercerising conditions. This is especially true of the width although one might suspect that the 30 Bé fabrics have slightly less length shrinkage.
2. There are apparently no significant differences in the number of wales across mercerising conditions. Although one gets just a faint suspicion that the 30 Bé fabrics may have been delivered with a slightly greater width.
3. There are clear differences in the number of courses and the weight. These differences are most obvious when comparing the 25 Bé fabrics with the 30 Bé ones but there is also an indication of systematic differences within each group. In general the higher the speed of mercerising the fewer the number of courses and the lighter the weight, but the stronger the alkali the more courses and the heavier the weight.
4. The fact that the differences in the number of courses are not very well reflected in length shrinkage differences must indicate that there have been corresponding changes in the reference courses.

Reference State Fabrics

Table 4 summarises the data for the reference state. For this table the pairs of samples, before and after calendering, have been averaged as we do not expect to see (and indeed we do not see) significant differences between them.

So far as the number of courses and the weight are concerned, the same trends are apparent as were found in as-delivered fabrics. However in this case there also seems to be a systematic trend to the number of wales.

Although the differences are small, it seems that the faster the speed of mercerising the greater the number of wales, but the stronger the alkali the fewer wales.

Another way to look at these effects is to calculate various ratios as shown in *Table 5* and *Table 6.*

Table 5 looks at the speed effect by dividing each measurement within an alkali strength group by the value obtained at the lowest speed and then averaging over the two alkali strengths. In this way we see that the effect of going from 20 m/min to 30 m/min is about 5.7% on courses, 2.1% on wales, and 2.4% on weight.

Table 6 looks at the alkali strength effect by dividing each measurement at a given speed using 30 Bé caustic soda by the corresponding figure at 25 Bé. In this way we see that the average effect of increasing the alkali concentration is 4.9% on courses, 1.3% on wales, and 3.6% on weight.

Notice, by the way that, theoretically, the sum of the changes in courses and wales (taking proper account of the sign) should be equal to the change in weight. This is more or less the case so it lends some weight to the significance of the small changes in the wale values.

Practical Consequences

When fabrics having different reference dimensions are delivered with the same weight and width then there will be differences in their shrinkages. In the case of these fabrics, the differences in reference wales are small but would lead to an average difference between the 25 Bé and the 30 Bé fabrics of about 1 to 1.5 percentage points. This is less than the accuracy of the shrinkage test and might not be detected. In addition there was a hint that the 30 Bé fabrics had actually been delivered marginally wider which, if true, would have helped to obscure any difference. Likewise, although the 30 Bé fabrics have about 5% more courses in the reference state, they were actually delivered with over 6% more courses so, again, the potential difference was not expressed.

From the customer's point of view there was no real difference in performance but from the viewpoint of the producer, the 30 Bé fabrics were delivered about 5% heavier i.e. 5% more expensive! If the two average fabrics had been delivered at the same weight and width, then the length shrinkage of the 30 Bé fabrics would inevitably have been greater.

Putting these considerations into a hard example, we can look at the effect of taking the average 25 Bé fabric and the average 30 Bé fabric and delivering them to exactly the same weight and width, namely 130 gsm and 67 cm. In this case, the following would be the dimensions and shrinkages.

	Courses	**Wales**	**Length%**	**Width%**
25 Bé	45.8	42.8	9.8	12.7
30 Bé	45.8	42.8	14.1	11.4

In order to bring the length shrinkage of the 30 Bé fabric down to below 10% the weight would have to be increased to about 140 gsm.

This does not necessarily mean that 30 Bé fabrics would always be more expensive or less suitable overall. For example one might find that, if more strenuous efforts were made to get shrinkages down, then the 30 Bé fabrics could be more responsive i.e. it might be possible to push relatively more courses into these fabrics. There is an indication from the as delivered courses that this may in fact be the case.

Alternatively it might prove possible to redesign the fabric so that it has fewer courses to start with i.e. by increasing the stitch length. STARFISH might be able to help there.

In addition we have to consider the source of these differences. Are they due to a better degree of mercerising? If so then we might expect to find a slightly better colour yield in dyeing which could reduce costs. Furthermore there is just a chance that we might find a lower level of spirality which could add to the value of the product.

Comparison with STARFISH

The current STARFISH model does not contain a processing route which is exactly the same as that used by Meritex. The nearest route is Dornier mercerise and Gyrostock dye (medium shade). Nevertheless it is worth checking whether STARFISH would have predicted any of the results from this trial and so a comparison has been made with the average 25 Bé and the average 30 Bé fabrics.

Obviously the detailed differences caused by different mercerising speeds can not be predicted as STARFISH does not yet possess this level of sophistication. To make the prediction, the nominal yarn count of 16.7 tex and stitch length of 0.265 cm have again been assumed. Only the Reference State has been considered since if this is correctly predicted then predictions for as-delivered fabrics will also be correct. The important numbers are given below.

	Courses	**Wales**	**Weight**
25 Bé	50.8	49.0	167
30 Bé	53.3	48.3	173
STARFISH	50.9	49.0	164

The almost exact correspondence between STARFISH and the 25 Bé fabric must be fortuitous but it does indicate that useful predictions for this fabric are indeed possible.

On the assumption that the difference between the two trial fabrics could have been due to a difference in the level of yarn shrinkage, some further predictions were made using heavier starting yarns and shorter stitch lengths. It was found that the difference could only be partly explained by this assumption. A further increase in yarn tex of about 5% and a further yarn shrinkage of about 3% were required to produce a reasonable (though not exact) fit. It seems likely that not only (or not even) the yarn shrinkage but also a change in the loop shape must be implicated. This implies an increase in the degree of mercerising and is another pointer to the fact that it may be worthwhile to check on the colour yield in dyeing.

Table 1

RAW TEST DATA SUPPLIED BY MERITEX

	Before wash				Reference			Shrinkage	
	WID	WT	CPI	WPI	WT	CPI	WPI	LEN	WID
25 Baume									
25/20.B	56	152	45	51	171	52	49	13.1	2.8e
25/20.A	66.5	134	46	43	168	52	48	9.3	10.9
25/25.B	54.5	144	43	54	165	50	49	14.4	3.2e
25/25.A	66	128	46	43	164	50	49	9.7	11.3
25/30.B	55	146	43	52	167	50	50	13.7	3.4e
25/30.A	66	130	45	43	165	51	49	9.6	11.4
30 Baume									
30/20.B	57.5	154	48	51	176	55	48	11.9	2.6e
30/20.A	67	140	50	44	174	55	48	8.2	11.1
30/25.B	57	154	46	51	174	54	48	13.3	2.2e
30/25.A	67	138	49	42	172	53	48	8.6	11.0
30/30.B	55.5	155	46	51	174	52	49	13.1	3.0e
30/30.A	66	134	47	44	169	51	49	9.8	11.6

Note sample code = Baume/speed.Calender
eg 25/30.B = 25 Be, 30m/min, Before calender

Table 2

INTERNAL DATA CHECKS

	WEIGHT BW		REF WEIGHT		WALES		LEN SHR%		WID SHR%	
	Meas	Calc	Meas	Calc	Meas	Calc	Meas	Calc	Meas	Calc
25 Baume										
25/20.B	152	152	171	169	51	51.2	13.1	13.5	2.8e	4.1e
25/20.A	134	131	168	166	43	43.1	9.3	11.5	10.9	10.4
25/25.B	144	154	165	163	54	52.6	14.4	14.0	3.2e	10.2e
25/25.A	128	131	164	163	43	43.4	9.7	8.0	11.3	12.2
25/30.B	146	148	167	166	52	52.1	13.7	14.0	3.4e	4.0e
25/30.A	130	128	165	166	43	43.4	9.6	11.8	11.4	12.2
30 Baume										
30/20.B	154	162	176	175	51	49.8	11.9	12.7	2.6e	6.2e
30/20.A	140	146	174	175	44	42.7	8.2	9.1	11.1	8.3
30/25.B	154	156	174	172	51	51.3	13.3	14.8	2.2e	6.2e
30/25.A	138	136	172	169	42	42.8	8.6	7.5	11.0	12.5
30/30.B	155	156	174	169	51	51.6	13.1	11.5	3.0e	4.1e
30/30.A	134	137	169	166	44	43.4	9.8	7.8	11.6	10.2

Notes :

1) Weight calculated from measured courses & wales plus assumed tex & stitch length
2) Wales calculated from measured width and needles
3) Shrinkages calculated from measured courses & wales
4) Sample code same as table 1

Table 3

AS-DELIVERED DIMENSIONS

	COURSES	WALES	WEIGHT	WIDTH	LEN SHR%	WID SHR%
25 Baume						
25/20.A	46	43	134	66.5	9.3	10.9
25/25.A	46	43	128	66	9.7	11.3
25.30.A	45	43	130	66	9.6	11.4
30 Baume						
30/20.A	50	44	140	67	8.2	11.1
30/25.A	49	42	138	67	8.6	11.0
30/30.A	47	44	137	66	9.8	11.6
Mean 25Be	45.7	43.0	131	66.2	9.5	11.2
Mean 30Be	48.7	43.3	137	66.6	8.9	11.2
Ratio 30/25	1.066	1.007	1.046	1.006		

Table 4

AVERAGE REFERENCE STATE DIMENSIONS

	COURSES	WALES	WEIGHT
25 Baume			
25/20	52.0	48.5	170
25/25	50.0	49.0	165
25/30	50.5	49.5	166
30 Baume			
30/20	55.0	48.0	175
30/25	53.5	48.0	173
30/30	51.5	49.0	171
Mean 25Be	50.8	49.0	167
Mean 30Be	53.3	48.3	173
Ratio 30/25	1.049	0.986	1.036

Table 5

EFFECT OF MERCERISING SPEED

	COURSES	WALES	WEIGHT
20m/min	1.000	1.000	1.000
25m/min	0.964	1.015	0.980
30m/min	0.963	1.021	0.976

Each value within an alkali strength group is divided by the corresponding value obtained for a mercerising speed of 20m/min. The results are then averaged over the two alkali strengths.

Table 6

EFFECT OF ALKALI STRENGTH

	COURSES	WALES	WEIGHT
20m/min	1.058	0.990	1.029
25m/min	1.070	0.980	1.048
30m/min	1.020	0.990	1.030
Mean	1.049	0.987	1.036

Each measurement for the 30 Be series at a given speed is divided by the corresponding 24 Be measurement at the same speed.