Development of Anti-Shrink Treatment on Cellulosic Knits Part - III

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Evaluation Methodology

The chemically treated knitted fabric is tested for dimensional stability, spirality, bursting strength and formaldehyde content as per the standard test methods as mentioned below:

Dimensional Change after Washing

This test method is used to determine the dimensional changes in woven and knitted fabrics made of fibers other than wool when subjected to laundering procedures commonly used in commercial laundry. A range of laundering procedure from severe to mild is provided to allow simulation of the various types of launderings available. Five drying test procedures are established to cover the drying techniques used. These tests are not accelerated and must be repeated to determine dimensional changes after multiple launderings.

Procedure

To find out the dimensional stability of the fabric the following procedures has to be followed:

- Initially 40 X 40 cm specimen has to be cut.
- Each specimen with three 25 cm pairs of bench marks parallel to length of fabric and three 25 cm parallel to width of fabric has to be marked.
- Each bench mark must be at least 5 cm from all edges of test specimen.
- Pairs of bench marks in the same direction must be approximately 12 cm apart.
- IFB washing machine has to be programmed and 25 g of detergent should be added.
- Make up the weight to 2 kg with dummy white fabrics.
- More than 5 fabrics should not be used at a time.
- The machine should till finish.
- The fabric has to be line dried except denim to be flat dried.
- The shrinkage % in both directions has to be calculated.

The washing and drying procedure carried out for chemically treated fabric are:

Table 1: Washing, drying, and restoration procedure

Tests	Total time	Drying	Restoration
1	30 min	Line dry	none
2	45 min	Line dry	none
3	45 min	Line dry	none
4	60 min	Line dry	none
5	60 min	Line dry	none

The dimensional changes in the fabric after washing and drying are reported separately in the test results.

Technique for Measuring Spirality

- Because of the dimensional instability of knitted loop construction, knitted fabrics suffer from various forms of dimensional distortion. One such distortion arises from the use of yarn that is twist lively; arising in wale's that are not perpendicular to course; the phenomenon is called is called "spirality".
- Spirality of the fabric was measured in terms of angle after laundering. Initially the wale and course must be at 90 degree. Due to commercial laundering the angle between wale and course gets distorted. The distorted angle is measured by using the following method:

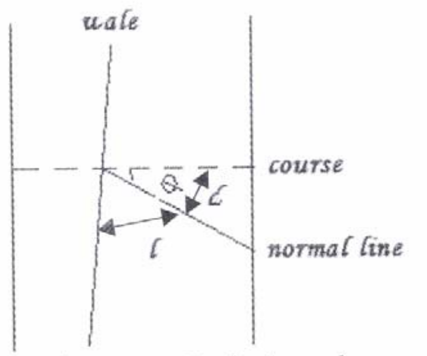

Figure 1 : Technique for measuring spirality

- A particular wale was taken and a line was drawn on course parallel to the tubular width of the fabric.
- A perpendicular line was drawn at the intersection of wale and course line.
- The displacement d of the course line from normal line to wale of the fabric was measured.
- Also the distance between d and identified wale line was measured i.e. l
- The magnitude of spirality was obtained by using the formula

$$\theta = \tan (d/l)$$

Where, d is displacement of the course from normal line to the wale of the fabric, l is distance from the identified wale line.

Bursting Strength

This method describes the measurement of the resistance of textile fabrics to bursting using the hydraulic diaphragm bursting strength tester. This test method is generally applicable to a wide range of textile products.

This test method may also be applicable for stretch woven industrial fabrics such as inflatable restraints.

Principle

Measurement of pressure required to burst the sample by applying load in all directions using fluid pressure.

Initial Adjustment

Before starting the experiment the following adjustments has to be made:

- The pointer on dial has to be set to zero.
- The level of dial with diaphragm should be checked.
- The handle must be reversed immediately after fabric bursting.

Procedure

The fabric whose bursting strength is to be measured is placed on the lower jaw and it is tightened with the upper jaw. The lower jaw has a diaphragm and it has glycerin inside. When the hand wheel is rotated, diaphragm comes out through the hole in the upper jaw and at an instant the fabric gets bursted. The movement of dial is noted when fabric bursting takes place.

Importance of bursting strength

It is a property of fabrics when they are applied to situation where they are subjected to forces in all direction such as filter cloth, parachute. In this situation tensile strength is of less importance.

Formaldehyde Test

This test method is applicable to textile fabrics that may evolve formaldehyde, particularly fabrics finished with chemicals containing formaldehyde. It provides accelerated storage conditions and an analytical means for determining the amount of formaldehyde released under the conditions of accelerated storage.

Principle

A weighed fabric specimen is suspended over water in a sealed jar. The jar is placed in an oven at a controlled temperature for a specified length of time. The amount of formaldehyde absorbed by the water is then determined colorimetrically.

Formaldehyde Release

Formaldehyde evolved from textiles under the accelerated storage conditions of this test, including that which is free from unreacted chemicals or from finish degradation as a result of this test.

Procedure

The amount of formaldehyde released from the fabric can be found out using the following procedure:

- Place 50 ml of distilled water in the bottom of each jar. Suspend one fabric specimen above the water in each jar, using wire mesh basket or other means. Seal the jars and place them in the oven at 49 degree Celsius.
- Remove and cool the jars for at least 30min.
- Remove the fabric and baskets or other support from the jars. Recap the jars and shake them to mix any condensation formed on the jar sides.
- Pipette 5 ml of Nash Reagent into a suitable number of test tubes, small. Erlenmeyer flasks or other suitable flask and pipette 5 ml of the reagent into at least one additional tube for a reagent blank. Add 5 ml aliquots from each of the sample incubation jars to the tubes and 5 ml of distilled water to the tube which is used as a reagent blank.
- Mix and place the tubes in a 58 degree Celsius water bath for 6min. remove and cool.

- Read the absorbance in the colorimeter or spectrophotometer against the reagent blank using a blue filter or a wave length of 412 nm.
- Caution: Exposure of the developed yellow color to direct sunlight for a period of time will cause some fading. If there is appreciable delay in reading the tubes after color development and strong solution is present, care should be exercised to protect the tubes such as by covering them with a card board or by similar means. Otherwise the color is stable for considerable time and reading may be delayed.
- Determine the micro grams/ml formaldehyde in the sample solutions using the prepared calibration curve.

Calculation

The amount of formaldehyde released for each specimen to the nearest micro gram/g can be calculated using the following equation:

F= (c) (50) / w

Where F = concentration of formaldehyde (micro *gig)*, c = concentration of formaldehyde in solutions as read from the calibration curve, w = weight of the test specimen g.

Test Results

Four different types of knitted fabrics were given finishing with RESIL CLS using Pad-dry-cure technique. The treated samples were also tested for dimensional stability, spirality, bursting strength and formaldehyde content as per standard test methods. The results of the test are as follows:

Dimensional Stability

Table 2: Dimensional stability before treatment

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	8.19	5	2
Dyed fabric	7.59	1	1
Interlock	8.72	2	3
Rib	9.02	5	5

Table 3: Dimensional stability after treatment for Recipe 1

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.25	3	1.3
Dyed fabric	6.59	0.5	0.9
Interlock	5.23	1	1.8
Rib	4.99	2.5	2

Table 4: Dimensional stability after treatment for Recipe 2

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.60	3.2	1.4
Dyed fabric	6.84	0.8	0
Interlock	5.85	1.2	1.7
Rib	3.79	3.2	3

Table 5: Dimensional stability after treatment for Recipe 3

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.92	4.2	1.5
Dyed fabric	6.52	1.5	2
Interlock	5.64	1.4	1.3
Rib	5.86	4.3	3.8

Table 6: Dimensional stability after 1st wash for Recipe 1

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.30	3.8	1 .1
Dyed fabric	6.37	0.5	1.6
Interlock	5.28	1.3	2.2
Rib	4.88	2.4	2

Table 7: Dimensional stability after 1st wash for Recipe 2

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.62	3.3	1.1
Dyed fabric	6.85	0.8	0
Interlock	5.88	1	1.2
Rib	3.82	3	2.8

Table 8: Dimensional stability after 1st wash for Recipe 3

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.33	4	1
Dyed fabric	6.34	1.5	2
Interlock	5.33	1	1
Rib	4.91	3.7	4

Table 9: Dimensional stability after 3rd wash for Recipe 1

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.30	3.5	1.3
Dyed fabric	6.37	0.5	1
Interlock	5.28	1	2
Rib	4.88	1.8	1.6

Table 10: Dimensional stability after 3rd wash for Recipe 2

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.62	3.3	1.1
Dyed fabric	6.85	0.8	0
Interlock	5.88	1	1
Rib	3.82	3	3

Table 11: Dimensional stability after 3rd wash for Recipe 3

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.35	4.2	1
Dyed fabric	6.44	1.5	2
Interlock	5.39	1	1
Rib	4.96	3.5	3.8

Table 12: Dimensional stability after 5th wash for Recipe 1

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.32	0.5	2.5
Dyed fabric	6.39	0.7	1
Interlock	5.30	1.2	2.3
Rib	4.90	1	2.8

Table 13: Dimensional stability after 5th wash for Recipe 2

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.66	1.1	3
Dyed fabric	6.88	1.3	1.2
Interlock	5.90	3.5	2.1
Rib	3.85	2.9	2.5

Table 14: Dimensional stability after 5th wash for Recipe 3

Fabric	Spirality (deg)	Shrinkage %	
		Length	Width
Yarn dyed Knitted fabric	5.33	4.4	1
Dyed fabric	6.46	1.6	2.3
Interlock	5.35	1.3	1.5
Rib	4.86	3.9	3.5

Bursting Strength

Table 15: Bursting Strength before treatment

Fabric	Bursting Strength
Yarn dyed Knitted fabric	93.4
Dyed fabric	65.80
Interlock	121.20
Rib	89

Table 16: Bursting Strength for Recipe 1

Fabric	Bursting Strength
Yarn dyed Knitted fabric	80.77
Dyed fabric	56.91
Interlock	104.83
Rib	76.98

Table 17: Bursting Strength for Recipe 2

Fabric	Bursting Strength
Yarn dyed Knitted fabric	79.88
Dyed fabric	61.43
Interlock	102.65
Rib	75.83

Table 18: Bursting Strength for Recipe 3

Fabric	Bursting Strength
Yarn dyed Knitted fabric	81.57
Dyed fabric	58.51
Interlock	107.33
Rib	74.58

The results obtained from dimensional stability, spirality, bursting strength and formaldehyde test are as follows:

Dimensional Stability

Four different types of chemically treated knitted fabrics at different conditions were tested for dimensional stability test using ISO 3759 method. A remarkable improvement of dimensional stability was noticed with Resil CLS treated fabrics, when compared to untreated fabric. Graph has been plotted between different concentrations of the finishing bath and shrinkage of the fabric both in length and width wise.

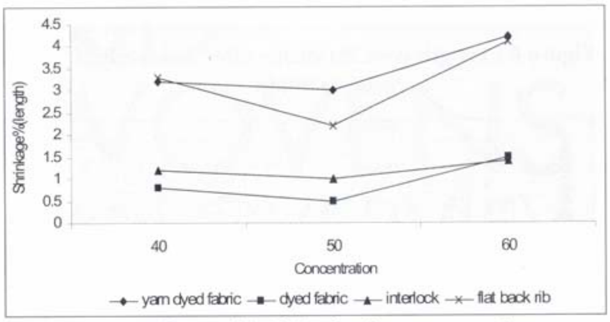

Figure 2 : Effect of finishing bath concentration on lengthwise shrinkage

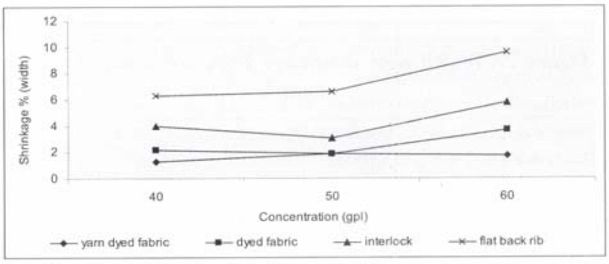

Figure 3 : Effect of finishing bath concentration on widthwise shrinkage

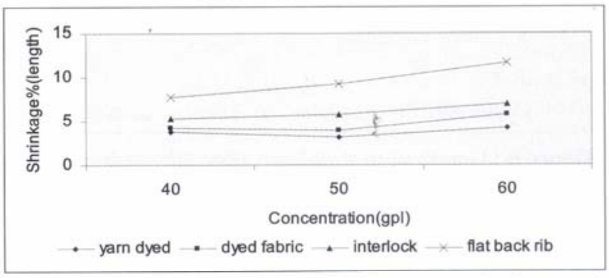

Figure 4 : Length wise shrinkage after 1st wash of treated sample

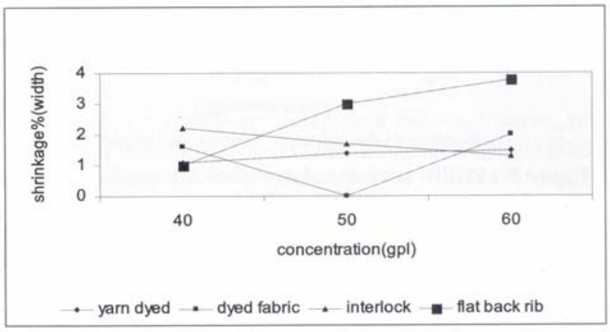

Figure 5 : Width wise shrinkage after1st wash of treated sample

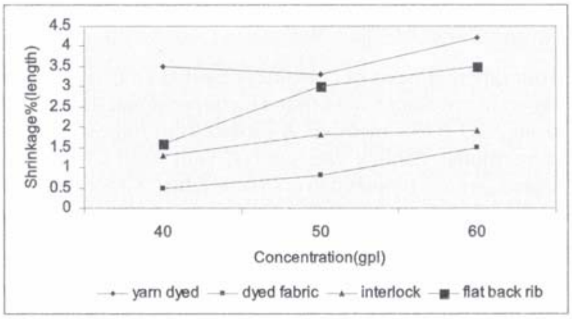

Figure 6 : Length wise shrinkage after 3rd wash of treated sample

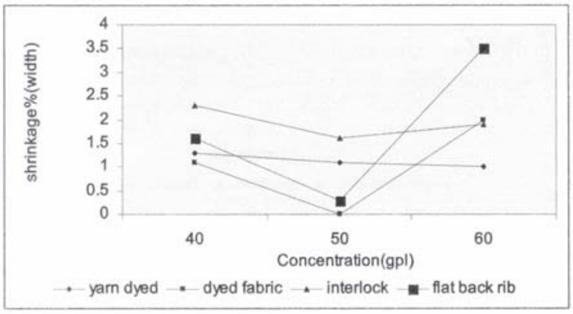

Figure 7 : Width wise shrinkage after 3rd wash of treated sample

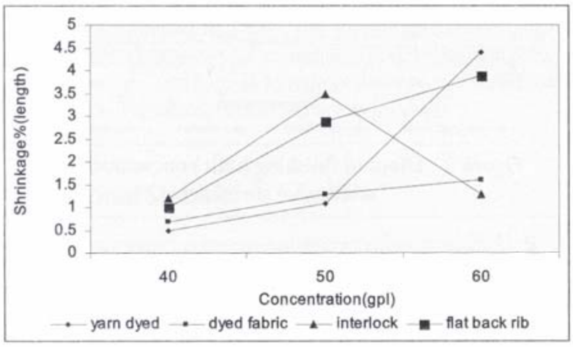

Figure 8 : Length wise shrinkage after 5th wash of treated sample

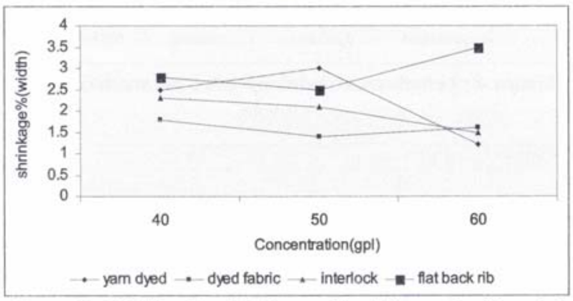

Figure 9 : Width wise shrinkage after 5th wash of treated sample

Spirality

The distorted angle between the wale and course was measured before and after treatment of the fabric. The angle of spirality was found to be less for Resil CLS treated fabric compared to that of untreated fabric. Effect of various finishing bath concentration on spirality has been shown graphically in fig4.

Bursting Strength

Resil CLS treatment resulted in a strength loss of 15.8 % when compared to untreated fabric. This is negligible and acceptable when compared to the DMDHEU's 30 to 35 % strength loss. The effect of various finish bath concentration on strength of the fabric has plotted (fig 5).

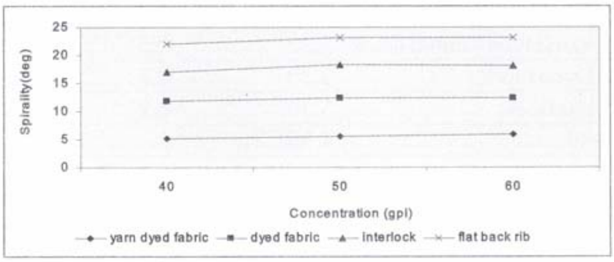

Figure 10 : Effect of finishing bath concentration on spirality

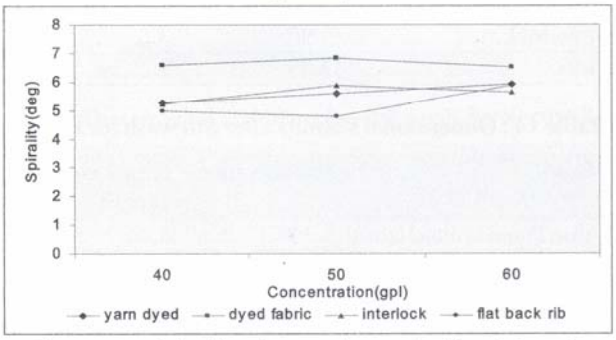

Figure 11 : Spirality of treated sample after 1st wash

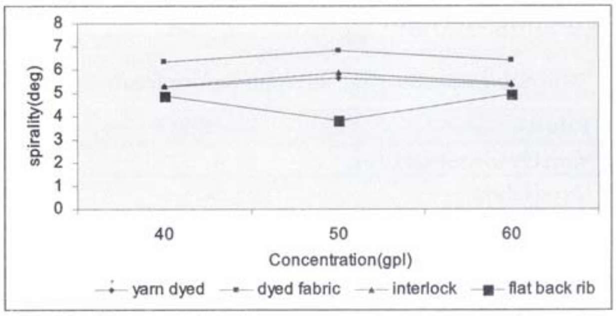

Figure 12 : Spirality of treated sample after 3rd wash

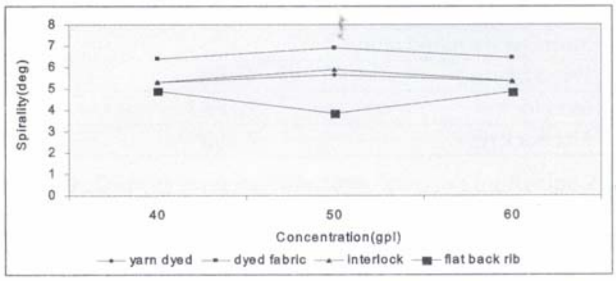

Figure 13 : Spirality of treated sample after 5th wash

Formaldehyde Content

Formaldehyde was found to be only 4.05 ppm on the Resil CLS treated sample. The acceptable formaldehyde content (which is a major limiting factor for conventional DMDHEU systems), as per the standards is as follows:

- For baby wear: 20 ppm
- For textiles in touch with skin: 75 ppm
- For textiles not in touch with skin: 300 ppm

The newly engineered, modified glyoxal Resil CLS can be tried on the cellulosic and cellulosic blended knits to overcome the problems of dimensional stability and spirality.

Remarkable improvement of dimensional stability and spirality was noticed with Resil CLS treated fabrics. Even though there is a loss of 15.8 % in strength compared to untreated sample, formaldehyde content was to be less on treated sample, as Resil CLS is a single component low formaldehyde glyoxal reactant system.

Hence Resil CLS is more advantageous compared to that of other cross linking resins. While using Resil CLS there is no need for any softener or catalyst as every thing is in built.

Thus Resil CLS is best suited for 100 % cellulosic fabric as it has the potential to overcome the problem of shrinkage and spirality. Also, it releases very low formaldehyde from the fabric which is carcinogenic in nature. Due to the controlled cross-linking technology of Resil CLS, the fibres do not become brittle and stiff; the

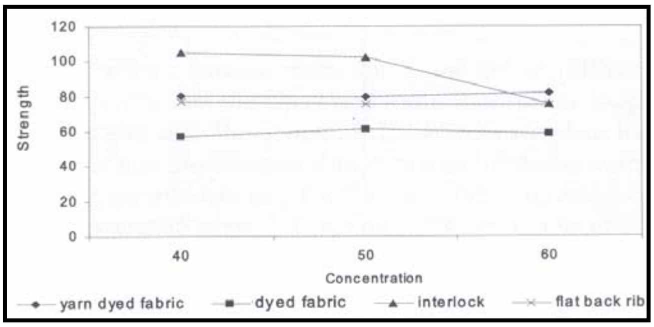

Fig. 14: Effect of finished bath concentration on strength of the fabric

abrasion resistance property remains unaffected and consequently, the life of fabric. Thus, it can be concluded that cellulosic fabrics can be treated with Resil CLS to overcome the problem of shrinkage.

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