Dimensional Stability of Lyocell Fibre Fabric during Processing on a Jigger

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1.0 Introduction

Lyocell fibre is a regenerated cellulose fibre made by dissolving pulp (bleached wood pulp). It was first manufactured in 1987 by Courtaulds Fibres, UK.

With the enhanced purchasing power and lifestyle of domestic consumers, a big business opportunity for these high-end-fibre fabrics can be visualised for the domestic (Indian) market. However, this opportunity has not been fully explored.

It is worth mentioning that chemical processing of lyocell is very critical and needs attention, due to the delicate yarn character, lower wet strength, fibrillation, high dye pick-up and residual shrinkage.

In the present study, chemical processing for lyocell fabrics was optimised on jigger.

Importance is given to setting up a chemical-processing technique for lyocell based fabrics in existing infrastructure and machinery available within the processing industry - in India in general, and in Surat in particular – which at present is mainly focused on the processing of polyester varieties only. When lyocell fabrics were processed on jigger machine, the dimensional stability in terms of % residual shrinkage was 2.5 and 1.3, warp and weft-wise, respectively.

2.0 Review of Literature

The aim of the present investigations is to find out whether it is possible to decrease the shrinkage of lyocell fabrics by proper selection of technology/machinery.

Different types of lyocell fibres are available in the market but all the different types are manufactured in the USA, Germany, Korea, Japan and Russia and are generally found in apparel, denim, crepes, etc. Studies on the temperature resistance of direct dyes in a high temperature dye bath, according to the dyeing ability of Tencel/polyester fibre, has been reported**1**. Lyocell fibres have a specific structure, with long crystals and a high degree of fibre crystallisation, high wet rigidity and a tendency towards fibrillation under the impact of mechanical processing and wet processing.

Two directions of finishing processes have been reported – enzymatic defibrillation, aimed at obtaining a peachskin look, and additional defibrillation, aimed at obtaining completely smooth surface**2**. However, both routes are through chemical finishing techniques.

Liquid-ammonia treatment of lyocell has been reported**3**. It is reported that the NH3 treatment of lyocell is not effective for improvement of 'hand'. The production of easy-care Tencel fabrics by liquid-ammonia treatment and silicone finishing has been discussed in one communication**4**. Udomkichdecha et al 5-10 report the relationship between the degree of fibrillation of modified rayon fibres and their physical properties, viz.

birefringency, viscosity and relative crystallinity. Lyocell fabrics have found a niche in the apparel market with indigo denim

3.0 Studies in Optimisation of Chemical Process for Lyocell Fabrics

3.1 Materials

Lyocell fabrics were procured from the market. The details of fabric specifications are as follows.

Fabric type:	Lyocell (100% - woven)
Material:	1/40s x 1/40s Lyocell
EPI:	96
PPI:	76
GSM:	118
Greige width:	52
GLM:	209.3
Weave:	Plain
Dimensional stability: 10%	

3.2 Methods

The dimensional stability/shrinkage/(boil test) of greige fabric was analysed by the IS-9 method.

Lyocell fabric was processed in the sequence mentioned below. After chemical finishing, fabric was again tested in a physical laboratory for potential shrinkage so that residual shrinkage could be adjusted on a sanforising machine. Laboratory-scale trials were conducted at MANTRA and pilotscale/ bulk-scale trials were conducted using a hydraulic pressurised jigger in a process houses in Surat, as described in **Table 1**.

Table 1: Methods and parameters/recipes used in processing of lyocell at pilot scale

	Process Route	Processing Condition	Jigger machine
1	Singeing	Speed 70 mpm two rounds.	Singeing
2	Desizing (if needed)	Desizing Enzyme: 1.5 gpl Wetting agent: 02 gpl Glauber salt: 03 gpl Batching time is 8-10 hrs.	Singeing machine + rotating station.
3	Washing	First a boil wash at 90°C. Sample check for desizing	Jigger
4	Caustic treatment	Caustic flakes - 90 gpl run at RT 2 passages	Jigger
5	Washing	First a boil wash at 90°C, 2 ends	Jigger
6	Scouring	Soda Ash-2 gpl Soap-2gpl Run at 80°C, for 2 ends	Jigger
7	Washing	Hot wash at 80°C, for 2 ends. Cold wash at 50°C, for 2 ends followed by Neutralising with 1 gpl acetic acid at 50°C for 2 ends.	Jigger
8	Bleaching/ Dyeing	Bleaching as A Dyeing as per B	Jigger

	(Piece dyeing)		
9	Drying	At 120°C	Stenter
10	Chemical finishing	Resin required – 50-60 gpl Softener as per requirement. Binder as per requirement. Acid – 0.5 gpl Dry at 120°C and cure at 170°C, contact time 40 sec.	Stenter
11	Sanforising	Belt pressure-2 kg Speed-13 mpm	Sanforising machine
A	Soda ash-0.6 gpl H2O2 – 2 gpl OBA – 0.6 gpl G.Salt – 1 gpl Stabilizer – 0.5 gpl		Jigger
B	Dyes as per the recipe G. Salt as per shade % Soda ash as per shade % Temp. as per dye class ant time as per shade depth		Jigger

4.0 Results and Discussion

Dimensional stability of lyocell fabric in terms of % residual shrinkage was 2.5 and 1.3 warp and weft-wise respectively. As regards tearing strength, results obtained were 11.3 N and 10.8 N warp and weft-wise respectively. The results are thoroughly tabulated in **Table 2**, which are well within the general norms.

Table 2: Dimensional and physical properties of lyocell fabric

Application	Jigger process (open width)				
Composition	Lyocell x Lyocell fabric				
Counts	1/40s x 1.40s (100% lyocell woven)				
Weave	Plain				
	Unit		**Fabric Norms**	**Actual**	**Method**
Greige EPI x PPI	--		± 3%	96 x 76	IS 1963-1981
Finished EPI x PPI	--		± 3%	108 x 86	IS 1963-1981
Greige GSM	Gm/m2		± 5%	118	ISO 3801-1977
Finished GSM	Gm/m2		± 5%	130	ISO 3801-1977
Greige width	cm		Actual	156	IS 1954-1990
Finished width	cm		Actual	144	IS 1954-1990
Tearing strength	Warp	N	8.8	11.3	IS 6489-1993
	Weft	N	8.8	10.8	
	Warp	%	3.5% ± 0.5%	2.5	IS 1299-1984

Dimensional stability	Weft	%	3.5% ± 0.5%	1.3	
Abrasion resistance					
(wt.loss after 2000 rev. at 9 kpa load) %			<2.5%	1.8	IS 12673-1989
Pilling	Rating		>4	4-5	IS 10971-1984
Fastness to wash			4 (for dk 3-4)	4	Is 764-1979
Change in shade/staining on cotton Rating				4-5 4	IS 766-1988
Fastness to Rubbing	Dry	Rating	2.5	NA	IS 1966-1975
	Wet				
Bursting strength Kg/cm2					
Warp mm			<6 mm	3.4	
Seam slippage					IS 3320-1970
Weft mm			<6 mm	3.2	
Prespiration fastness				4-5	AATCC – 15
					AATCC – 15

5.0 Conclusion and Recommendations

1. Fabric loading should be in warm water along with a good lubricating agent.
2. No cold wash should be given below 45°C.
3. Fabric should not be kept in a wet condition for long time as it reduces strength and leads to permanent crease formation.
4. Jet process is not recommended for lyocell fabric, as fabric swells to a greater extent.
5. A boiling-water shrinkage test prior to processing is a must. Width and overfeed setting on a stenter should be decided as per the result of test.
6. Hot brand (HE/ME) reactive dyestuffs are more suitable for achieving good dyeing in terms of levelness and fastness.
7. Due to high affinity for dyestuff, it is recommended to follow slow and controlled dosing of dyes, salt and alkali.
8. Sufficient lubricant should be added to avoid crease formation at every stage.
9. Drying should be below 130°C to avoid yellowness and shade alteration.

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