(昭和 45 年 4 月 8 日 受理)

WRINKLE-RESISTANT COTTON FABRIC BY STEAM-CURE FINISHING

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Abstract

Simultaneous drying and curing of a finishing agent on cotton fabric in superheated steam offers a method of producing wrinkle-resistant fabric with improved retention of strength and abrasion resistance and with improved smooth-drying characteristics after line drying. The process requires a methyrolamide finishing agent that gives an acid-resistant finish and a catalyst more active than those used in conventional dry-cure finishing. Examples of successful agent and catalyst are dimethylol dihydroxyethyleneurea and a mixture of a metal salt with a hydroxy-substituted carboxylic acid.

Introduction

In view of the current interest of Japanese research in obtaining wrinkle-resistant cotton fabrics by steam curing under pressure (1), it seems appropriate to describe some experience gained in related work leading to the development of a steam-cure process at the Southern Utilization Research and Development Division of the U.S. Department of Agriculture. This information may prove not only timely in avoiding duplication of effort, but may also lead to the development of a process that would produce commercially a durably-pressed (DP) cotton fabric by use of a pressure steamer.

Conventional procedures to impart durable-press properties to cotton fabric are dry-cure processes. A relatively brittle fiber with rather large losses of strength and abrasion resistance results from the dry-cure treatment. To obtain durable-press fabric with improved strength retention, an investigation of curing in steam was initiated in this laboratory. This note reports the initial exploratory work on steam curing of dimethylol urea on fabric after padding and drying. The results are similar to those reported by Shimo, Ishino, Ujigawa, and Shiota¹⁾. However, this work led to the development of a steam-cure process, at atmospheric pressure, that gives greater than usual strength retention in wrinkle-resistant cotton²⁾.

Experimental and Discussion

[I] **Curing of Dimethylol Urea on Fabric in Superheated Steam.** Printcloth was padded with 10% dimethylol urea and 0.5% zinc nitrate hexahydrate and was dried at 60°C for 10 mins. in a slightly stretched condition on pin frames. The samples were then steam cured: (a) at 145°C for 6 mins.; and (b) at 133°C for 10 mins. Re-curing of the steam-cured samples was performed in a hot air oven at 160°C for 3 mins. Textile testing data from these samples, and from samples finished conventionally for comparison, are reported in Table I.

It can be seen that steam curing did not raise wrinkle recovery to the level obtained by conventional finishing, probably because zinc nitrate is not an efficient catalyst in the presence of moisture. The improved strength retention is due mainly to lower levels of wrinkle-recovery improvement. Re-curing or

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Table I. Finishing of Printcloth with Dimethylol Urea

Fabric Cure	Wrinkle Recovery Angless (W+F)		Retention (warp) (% of original)	
	Conditioned (deg.)	Wet (deg.)	Stoll Flex Cycles	Tearing Strength
Conventional dry cured*	279	266	37	67
Steam cured at 145° (a)	238	249	62	72
Steam cured at 133° (b)	213	247	83	85
Re-curing of (a)	238	258	37	71
Re-curing of (b)	229	249	51	75

* Curing was in a hot air oven at 160°C for 3 min.

from dimethylol dihydroxyethyleneurea (DMDHEU) which are highly acid resistant, survive the hydrolytic effects of acid catalyst and moisture to a greater extent. In the work of Shimo, *et al.*, it is interesting that they have found DMDHEU-treated cloth to be relatively acid resistant during pressure steaming.

The conclusions drawn from the above work are that the metal salt catalysts alone are not suitable for crosslinking fabric with higher than usual water content and that an agent giving an acid-resistant finish, such as dimethylol dihydroxyethyleneurea, is best suited for steam curing.

[II] **The Steam-Cure Process.** In the development of a steam-cure process, an agent that gives an acid-resistant finish—such as dimethylol dihydroxyethyleneurea—was used with a catalyst that can promote crosslinking on wet, swollen cotton fiber in steam—such as the active catalyst from a mixture of a metal salt and a hydroxy—substituted carboxylic acid⁴). Also, to impart superior wet-recovery properties, drying was omitted before passing the padded fabric into a steamer for steam curing. The fabric, therefore, was dried and cured in one operation in superheated steam at atmospheric pressure. Thus, final curing occurs while the fabric still retains about 5% moisture. The results of this steam-cure process carried out on a pilot-plant scale flash ager with a 25 yd batch of 20 in. wide fabric are given in Table II.

It is possible to impart wrinkle-recovery improvements similar to those obtained in the conventional finishing and still retain more strength than usual. As expected, durable-press ratings after line drying are improved by steam curing. Moisture regain of the steam-cured fabric is 6.5% which is much higher than that observed in the conventionally finished fabric (4-4.5%).

The reason that steam curing gives higher strength at the same performance level is believed to be due to the formation of some reaction product in the wet cotton that is not formed in the conventional dry-cure process. This product seems to be formed when steam cure is the only cure or when a partial steam cure

Table II. Steam-cure Finishing of Printcloth with Dimethylol Dihydroxyethyleneurea

Formulation	Curing Conditions Steam-Cure (°C/min.sec.)	Wrinkle Recovery Angles		Accelerator Wt. Loss (%)	Retention (% of Original)				Durable-Press Rating	
		(deg. W+F)			Tearing Str.		Breaking Str.		Line Drying	Tumble Drying
		Cond.	Wet	(W)	(F)	(W)	(F)			
A	133°/7:45	289	277	3.8	59	46	63	48	4.4	3.8
	138°/6:10	297	278	4.4	49	43	60	50	3.7	3.7
	138°/6:50	302	264	6.6	45	43	57	45	3.9	3.9
B (Untreated, washed fabric)	Dry-cure*	303	272	7.3	35	36	36	38	3.3	3.8
		203	172	0.8	[1075g]	[750g]	[21kg]	[16.8kg]	1.1	1.0

Formulations used were:

[A] 20% DMDHEU, 1.25% equimolar mixture of citric acid and $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ 2% polyethylene, 0.1% wetting agent.

[B] 10% DMDHEU, 3% $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$, 2% polyethylene, 0.1% wetting agent.

* In pad-dry-cure treatments, drying was at 60°C for 6 min., and curing was at 160°C for 3 min.

continuing the cure in hot air did not significantly improve the wrinkle recovery. Probably the dimethylol urea was partially hydrolyzed during steam curing and was not available for subsequent curing.

These observations are comparable to those of Shimo, Ishino, Ujigawa, and Shirota¹⁾ from the steam curing of dimethylol ethyleneurea. It is recognized²⁾ that linkages such as those

is followed by a dry cure. This, therefore, allows a variation in procedural detail. This variation consists of a steam cure followed by a dry cure. The curing that is initiated but not completed in steam is then continued in subsequent dry curing. The textile properties of steam cure with a dry-cure process are also superior to those obtained in the conventional finishing²⁾.

By reference to Table II., it can be seen that it takes 7 minutes at 138°C to steam cure on printcloth. It is necessary to shorten the steam-cure time to a minute or so to make the process attractive for commercial exploitation. Shorter times of cure may be possible through the use of a pressure steamer with superheated steam. Higher temperatures may then be obtained with water contents similar to those obtained at atmospheric pressure because the equilibrium water content at a given temperature would be higher under pressure.

References

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(Received April 8, 1970)