CHAPTER V

RESULTS AND DISCUSSION

In this research, acrylamide, dimethylol dihydroxy ethylene urea (Super finish EU) and their combination were studied. Cotton, cotton/polyester blend and polyester fabrics were used.

The results of this study have been described in three parts.

First, the comparison of the redox catalytic systems and the effect of different acrylamide applications on the Physical properties of the fabrics. Second, the influence of acrylamide finish in combination with DMDHEU and that of DMDHEU finish on the physical properties, their durability and appearance rating of fabrics. Third, the effect of acrylamide precondensate, DMDHEU and their combination on the physical properties of fabrics.

These various aspects of results are shown as follows:

Part I

5.1 Preliminary data of the fabrics.

5.2 The initial redox catalytic systems used, and their results.

5.3 Variation in the application stages of acrylamide finish and its effect on the physical properties of fabrics.

Part II

5.4 The effect of acrylamide (finish I), combination of finish I and III (finish II) and DMDHEU (finish III) at varying concentrations, on the physical properties of fabrics.

5.5 Analysis of finishes I, II and III for durability.

5.6 Appearance rating of finished fabrics.

Part III

5.7 The effect of acrylamide precondensate finish Ix and its combination with DMDHEU finish IIx on the physical properties of fabrics.

5.8 Analysis of finishes Ix and IIx for durability.

PART I

5.1 Preliminary data of the fabrics.

Three plain weave white fabrics, cotton, cotton/polyester blend and polyester were used in this study. These were of medium weight (85-117 grams per square metre) while thickness of the fabrics was similar (0.002-0.003 inch). The data has been given in Table 2.

5.2 The initial redox catalytic systems used, and their results.

Initially glyoxal and hydrogen peroxide system (a) formaldehyde and hydrogen peroxide system (b) were compared. Glyoxal and hydrogen peroxide catalytic system for acrylamide finish was studied by Jain[28] at 5% and 10% concentration on cotton and cotton/polyester fabrics. A similar catalytic system consisting of formaldehyde and hydrogen peroxide was expected to bring a reaction as formaldehyde and glyoxal have a similar chemical nature. In aminoplasts, both glyoxal and formaldehyde are in use, so the glyoxal and formaldehyde were compared.

The finish mixtures were padded on fabric-specimens, and air dried. The reaction was also expected in drying, as polymerization of acrylamide finish mixture with the two redox catalytic system, was obtained at room temperature in test tubes. The recipes used were as follows.

	5%	10%
a) Acrylamide ..	5 gm	10 gm
Glyoxal (40%) ..	2 ml	4 ml
Hydrogen Peroxide (20 vol) ..	2 ml	4 ml
Teepol (1 g/l) ..	96 ml	92 ml
	100 ml	100 ml

	5%	10%
b) Acrylamide ..	5 gm	10 gm
Formaldehyde (40%) ..	2 ml	4 ml
Hydrogen peroxide (20 vol) ..	2 ml	4 ml
Teepol (1 g/l) ..	96 ml	92 ml
	100 ml	100 ml

The results on wrinkle recovery and tensile strength of fabrics using two redox catalytic systems have been reported in Table 3 and 4 respectively.

TABLE 2

PRELIMINARY DATA OF THE FABRICS

Fabric code	Fibre content	Fabric count yarns/inch (yarns/cm) warp	weft	Weight per unit area Oz/sq.yd (gm/sqm)	Thickness in inch (in cm)
A	Cotton	125 (49)	65 (26)	3.33 (116.7)	0.003 (0.008)
B	Cotton/ polyester 30/70	107 (42)	85 (33)	2.43 (85.1)	0.002 (0.005)
C	Polyester	104 (41)	74 (29)	2.55 (89.3)	0.002 (0.005)

As seen from Graph 1, catalytic system a (glyoxal and hydrogen peroxide), showed an increase in wrinkle recovery while catalytic system b, (formaldehyde and hydrogen peroxide), showed a decrease in wrinkle recovery on the two fabrics.

Tensile strength data (Table 4) showed an increase in tensile strength on both fabrics with catalytic system b, (formaldehyde and hydrogen peroxide). This restores the tensile strength, therefore it has been used in this study. Glyoxal and hydrogen peroxide, catalytic system a as a part of a mixed redox system was further investigated by Modi[41] in her work.

It was observed that formaldehyde and hydrogen peroxide alone was not yet that sufficient with acrylamide; therefore addition of epichlorohydrin was thought of. Because epichlorohydrin by itself can react with cellulose and form a link between acrylamide and cellulose and bring about a reaction between the fibre and finish. This aspect is discussed in the next section.

TABLE 3

CHANGE IN WRINKLE RECOVERY OF FABRICS (WARP) AT VARYING CONCENTRATIONS USING TWO REDOX CATALYTIC SYSTEMS

a				b			
Fabric Code	Control (% change)	5% Finish (%change)	10% Finish (%change)	Fabric Code	Control (%change)	5% Finish (%change)	10% Finish (%change)
A'	83 (0)	93 (12)	117 (41)	A	68	69 (1.5)	61 (-10)
B'	131 (0)	135 (3)	140 (6.9)	B	120	108 (-10)	115 (-4.2)

A', A = 100% Cotton;

B' = 33/67 cotton/polyester

B = 30/70 cotton/polyester

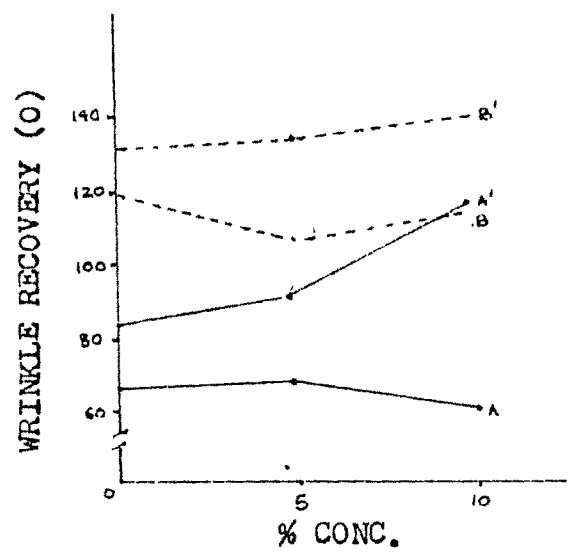
a = acrylamide with glyoxal and hydrogen peroxide

b = acrylamide with formaldehyde and hydrogen peroxide

Note : a = data from Jain's [28] work
b = data of this study

EFFECT OF ACRYLAMIDE FINISH WITH TWO REDOX CATALYTIC SYSTEMS ON WRINKLE RECOVERY OF FABRICS

GRAPH 1



_____ Cotton Fabric - A, A'

- - - - - - Cotton/Polyester Fabric - B, B'

A', B' For Catalytic System - a

A, B For Catalytic System - b

(PAD AND AIR DRIED)

TABLE 4

CHANGE IN TENSILE STRENGTH OF FABRICS (WARP) AT VARYING CONCENTRATIONS USING TWO REDOX CATALYTIC SYSTEMS

a				b			
Fabric Code	Control (% change)	5% Finish (%change)	10% Finish (%change)	Fabric Code	Control (%change)	5% Finish (%change)	10% Finish (%change)
A'	34 (0)	26 (-23.5)	31 (-8.8)	A	42 (0)	41 (-2.4)	46 (9.5)
B'	36.5 (0)	37 (1.4)	39 (6.8)	B	33 (0)	39.5 (19.7)	41 (24.2)

A', A = 100% Cotton;

B' = 33/67 cotton/polyester

B = 30/70 cotton/polyester

a = acrylamide with glyoxal and hydrogen peroxide

b = acrylamide with formaldehyde and hydrogen peroxide

Note : a = data from Jain's [28] work
b = data of this study

5.3 Variation in the application stages of acrylamide finish and its effect on the physical properties of fabrics.

As mentioned above, the application of the finish was required to be varied to bring about a reaction between the fibre and finish. Epichlorohydrin was added to the finish recipe. The finish on penetration into the fibre interior would influence the wrinkle recovery by possible crosslinking reaction. The reaction was judged by the change in the physical properties with these variations in application.

To, untreated i.e. control

	1st Step	2nd Step
t_1	acrylamide, ephichlorohydrin and simple redox	-
t_2	acrylamide, ephichlorohydrin and formaldehyde	alkaline hydrogen peroxide
t_{3a}	epichlorohydrin and formaldehyde	acrylamide with simple redox (pH 8)
t_{3b}	epichlorohydrin and formaldehyde	acrylamide with mixed redox (pH 3)
t_{3c}	epichlorohydrin and formaldehyde	acrylamide with simple redox and acetic acid (pH 6)
t_{3d}	epichlorohydrin and formaldehyde	acrylamide with simple redox and ammonia (pH 10)

Simple redox : formaldehyde and hydrogen peroxide

Mixed redox : formaldehyde, hydrogen peroxide and ammonium persulphate

5.3.1 The data on the physical properties with To, t_1, t_2 and t_3 has been reported in Table 5,6 and 7.

From Table 5 it was observed that t_1 does not seem to influence the wrinkle recovery due to introduction of rigidity, which increases the tensile strength (for fabrics A and B).

Hence the application of finish was varied to a two step (t_2) process. By using alkaline hydrogen peroxide in the second step the reaction was expected to accelerate. It was observed from Table 6 that the influence of t_2 on the wrinkle recovery of fabrics was different than that noted with t_1. On polyester fabirc an increase in wrinkle recovery at 5% concentration of finish with a decrease in stiffness could be a result of accelerating the reaction. The pitting tendency in presence of alkaline hydrogen peroxide need to be observed further.

The data on physical properties of fabrics treated with t_3 has been reported in Table 7, 7a, 7b and 7c. On an overall observation t_{3b} seemed effective for cotton and cotton/polyester fabrics. An increase in wrinkle recovery in the fabrics could be explained due to the finish reacting with the fibre and therefore some penetration of the finish inside the fibre.

Table 5

PHYSICAL PROPERTIES OF FABRICS (WARP) TREATED WITH ACRYLAMIDE FINISH (APPLICATION : SINGLE STEP)

Physical properties	Finish	% Conc.	A	B	C
Wrinkle recovery (0)	To	0	68	120	159
	t_1	5	60	114	154
	t_1	10	72	122	159
Stiffness (cms)	To	0	4.4	3.8	3.0
	t_1	5	4.3	4.8	2.2
	t_1	10	3.8	4.1	2.1
Tensile strength (lbs)	To	0	42	33	41
	t_1	5	44	40	36
	t_1	10	44	39	37
% Elongation	To	0	25	13	41
	t_1	5	24	16	22
	t_1	10	23	14	24

To = Control
t_1 = Acrylamide, epichlorohydrin with simple redox
A = 100% cotton
B = 30/70 cotton/polyester
C = 100% polyester

Table 6

PHYSICAL PROPERTIES OF FABRICS (WARP) TREATED WITH ACRYLAMIDE FINISH (APPLICATION : TWO STEP)

Physical properties	Finish	% Conc.	A	B	C
Wrinkle recovery (0)	To	0	68	120	159
	t_1	5	63	124	173
	t_1	10	69	112	142
Stiffness (cms)	To	0	4.4	3.8	3.0
	t_1	5	4.3	4.6	2.1
	t_1	10	3.8	4.6	2.6
Tensile strength (lbs)	To	0	42	33	41
	t_1	5	41	36	38
	t_1	10	41	31	33
% Elongation	To	0	25	13	41
	t_1	5	22	17	25
	t_1	10	20	13	20

To = Control
t_2 = 1st step = acrylamide, epichlorohydrin and formaldehyde
2nd step = alkaline hydrogen peroxide
A = 100% cotton
B = 30/70 cotton/polyester
C = 100% polyester

Table 7

PHYSICAL PROPERTIES OF FABRICS (WARP) TREATED WITH ACRYLAMIDE FINISH (APPLICATION : TWO STEP)

Physical properties	Finish	% Conc.	A	B	C
Wrinkle recovery (0)	To	0	68	120	159
	t_{3a}	5	45	114	156
	t_{3a}	10	49	116	168
	t_{3b}	5	73	111	153
	t_{3b}	10	81	127	154
	t_{3c}	5	46	105	160
	t_{3c}	10	72	124	163
	t_{3d}	5	50	101	152
	t_{3d}	10	71	117	156

To = Control

1st step = pretreatment with epichlorohydrin and formaldehyde

2nd step = acrylamide finish with redox catalytic system

t_{3a} = pH8 (simple redox)

t_{3b} = pH3 (mixed redox)

t_{3c} = pH6 (simple redox)

t_{3d} = pH10 (simple redox)

A = 100% cotton

B = 30/70 cotton/polyester

C = 100% polyester

Table 7a

PHYSICAL PROPERTIES OF FABRICS (WARP) TREATED WITH ACRYLAMIDE FINISH (APPLICATION : TWO STEP)

Physical properties	Finish	% Conc.	A	B	C
Stiffness (cms)	To	0	4.4	3.8	3.0
	t_{3a}	5	4.5	4.4	3.9
	t_{3a}	10	4.1	4.2	2.4
	t_{3b}	5	4.1	4.6	3.4
	t_{3b}	10	4.0	4.4	2.3
	t_{3c}	5	4.0	4.1	4.1
	t_{3c}	10	2.8	4.1	2.5
	t_{3d}	5	3.9	4.6	4.4
	t_{3d}	10	3.2	3.6	2.3

To = Control

1st step = pretreatment with epichlorohydrin and formaldehyde

2nd step = acrylamide finish with redox catalytic system

t_{3a} = pH8 (simple redox)

t_{3b} = pH3 (mixed redox)

t_{3c} = pH6 (simple redox)

t_{3d} = pH10 (simple redox)

A = 100% cotton

B = 30/70 cotton/polyester

C = 100% polyester

Table 7b

PHYSICAL PROPERTIES OF FABRICS (WARP) TREATED WITH ACRYLAMIDE FINISH (APPLICATION : TWO STEP)

Physical properties	Finish	% Conc.	A	B	C
Tensile strength (lbs)	To	0	42	33	41
	t_{3a}	5	34	31	43
	t_{3a}	10	38	33	39
	t_{3b}	5	32	29	42
	t_{3b}	10	33	30	39
	t_{3c}	5	31	30	41
	t_{3c}	10	45	40	38
	t_{3d}	5	42	32	44
	t_{3d}	10	44	39	38

To = Control

1st step = pretreatment with epichlorohydrin and formaldehyde

2nd step = acrylamide finish with redox catalytic system

t_{3a} = pH8 (simple redox)

t_{3b} = pH3 (mixed redox)

t_{3c} = pH6 (simple redox)

t_{3d} = pH10 (simple redox)

A = 100% cotton

B = 30/70 cotton/polyester

C = 100% polyester

Table 7c

PHYSICAL PROPERTIES OF FABRICS (WARP) TREATED WITH ACRYLAMIDE FINISH (APPLICATION : TWO STEP)

Physical properties	Finish	% Conc.	A	B	C
% Elongation	To	0	25	13	41
	t_{3a}	5	22	13	43
	t_{3a}	10	24	12	23
	t_{3b}	5	19	11	33
	t_{3b}	10	16	13	22
	t_{3c}	5	21	11	39
	t_{3c}	10	23	10	20
	t_{3d}	5	28	13	44
	t_{3d}	10	23	15	24

To = Control

1st step = pretreatment with epichlorohydrin and formaldehyde

2nd step = acrylamide finish with redox catalytic system

t_{3a} = pH8 (simple redox)

t_{3b} = pH3 (mixed redox)

t_{3c} = pH6 (simple redox)

t_{3d} = pH10 (simple redox)

A = 100% cotton

B = 30/70 cotton/polyester

C = 100% polyester

It was observed that by changing the pH to 6 and 10, as in t_{3c} and t_{3d} respectively, not much of an influence on the properties was observed. t_{3a} showed little influence also.

It was observed that ammonium persulphate was required along with formaldehyde and hydrogen peroxide to bring about the reaction with the fibre. A pretreatment of epichlorohydrin and formaldehyde was given as both have the ability to react with cellulose. Skeists[65] has explained that a monoepoxy compound such as epichlorohydrin ($O.CH_2-CH-CH_2Cl$) is formed by the reaction of sodium hydroxide on dichloropropanol. In the case of epoxy compounds, the reaction with cellulose requires a stronger catalyst such as zinc fluroborate while epichlorohydrin can react with cotton in a swollen state in presence of a basic catalyst (sodium hydroxide). The reaction between epichlorohydrin and cellulose is shown.

$$Cell\ (OH)+CH_2-CH-CH_2Cl \longrightarrow Cell-O-CH_2-CH-CH_2Cl+H_2O$$

In this study a reaction was possible as acrylamide itself is basic in nature and hence will influence a reaction of epichlorohydrin and cellulose. Resin finishing originated from the action of formaldehyde with cellulose.

The reaction between formaldehyde and cellulose has been reviewed by Marsh[35] and Walker[72] is as follows :

$$Cell\ (OH)+HCHO+(OH)\ Cell \xrightarrow{acid} Cell-O-CH_2-O-Cell+H_2O$$

By changing the pH to 6 and 10 in treatments t_{3c} and t_{3d} a decrease in wrinkle recovry was observed at 5% concentration on all the three fabrics. The increase at 10% was marginal as compared to the control, To. The change in pH to 6 and 10 does not provide any specific reaction between the fibre and finish.

From the varied applications of acrylamide finish the maximum increase in wrinkle recovery was obtained from t_{3b}. On an overall observation it could be concluded that t_{3b} (pretreatment with epichlorohydrin and formaldehyde and second step consisting of acrylamide finish with mixed redox catalytic system) was suitable for application on fabrics. Ammonium persulphate, an additional oxidising agent was required as hydrogen peroxide alone was not sufficient. Therefore t_{3b} was continued in this study.

PART II

As mentioned in Part I (above) the finishing treatment consisting of a pretreatment with epichlorohydrin and formaldehyde and a second step consisting of acrylamide finish with mixed redox system (t_{3b}), was more suitable as compared to others. Hence, it was used as a part of the combination finish with DMDHEU.

From Part II onwards t_{3b} is referred to as finish I. The combination finish consisting of this acrylamide finish (finish

I) and DMDHEU (finish III) is referred to as finish II and DMDHEU as finish III.

Basis to study combination

Combination of commercial acrylic emulsion (Tx-50) and DMDHEU has been used by Phadke[51] in her work. It was observed that on combining acrylic emulsion (Tx-50) with DMDHEU, the loss in tensile strength due to DMDHEU was minimized, that is, the loss in strength was less with greater or equal proportions of acrylic emulsion to DMDHEU finish. Finish II, the combination of acrylamide (finish I) with DMDHEU (finish III), was therefore studied to see for its similar effect on the physical properties.

The effectiveness of the reaction was good on acidic pH (the pH of finish I was 3); it was used as such. Sheokand[64] in her study on wool with acrylamide and similar redox system in presence of trichloroacetic acid has also noted the preference of acidic pH for these reactions.

5.4 The effect of acrylamide (finish I) combination of finish I and III (finish II) and DMDHEU (finish III), at varying concentrations on the physical properties of fabrics.

5.4.1 Effect on wrinkle recovery

5.4.2 Effect on stiffness

5.4.3 Effect on tensile strength

5.4.4 Effect on percent elongation

5.4.1. The effect of finish I,II and III (its percent add-on) on the wrinkle recovery of the treated fabrics has been given in Tables 8 and 8a and illustrated in Graphs 2-4 and 2a-4a.

Add-on on cotton fabric A was more than add-on on cotton/polyester fabric B and polyester fabric C. (This was due to the pick up of cotton fabric being more than the other two fabrics).

Increasing add-on of the finishes on fabrics generally, increased the wrinkle recovery. However the combination finish II and DMDHEU finish III showed little effect on polyester (Graphs 3 and 4). DMDHEU finish III showed high wrinkle recovery at lower add-on of finish. (DMDHEU finish seemed more effective at lower concentration). With acrylamide finish I increaasing add-on increased the wrinkle recovery (Graph 2). On curing acrylamide finish further increased the wrinkle recovery on increasing add-on of finish (Graph 2a). Finish II and III on cotton/polyester and polyester fabrics showed little change when samples were cured at 130° C (Graphs 3a and 4a).

TABLE 8

WRINKLE RECOVERY OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES (AIR DRIED)

			% Add-on and Wrinkle Recovery (0)					
Fabric Code	Soln. Conc. %	Control To WR	Finish I add-on	WR	Finish II add-on	WR	Finish III add-on	WR
A	5	68	7.0	73	8.5	105	5.3	110
	10	68	14.6	81	9.8	123	6.4	116
B	5	120	3.9	111	4.4	146	3.6	139
	10	120	11.9	127	7.9	149	6.3	138
C	5	159	3.1	153	5.0	157	3.0	153
	10	159	11.7	154	8.1	158	6.0	158

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

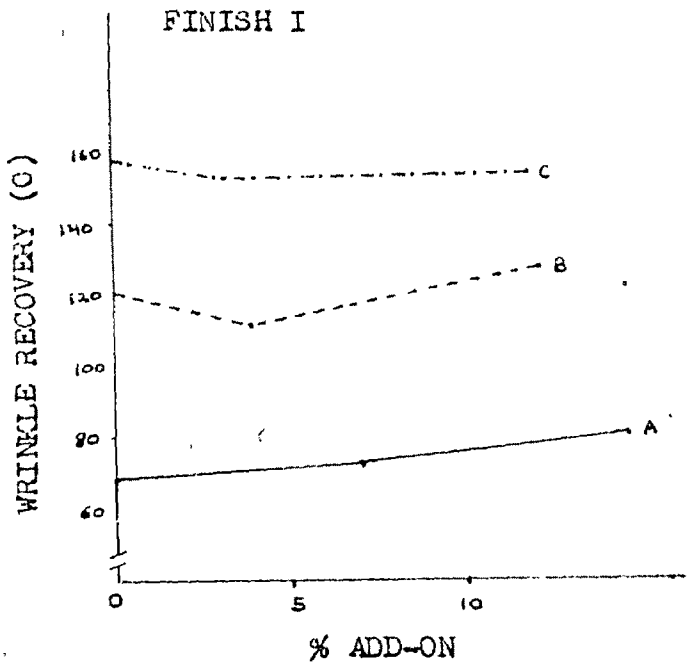
Finish II = Ist step : Pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

Finish III = DMDHEU finish

EFFECT OF ADD-ON OF FINISH I, II and III ON WRINKLE RECOVERY OF FABRICS. (AIR DRIED)

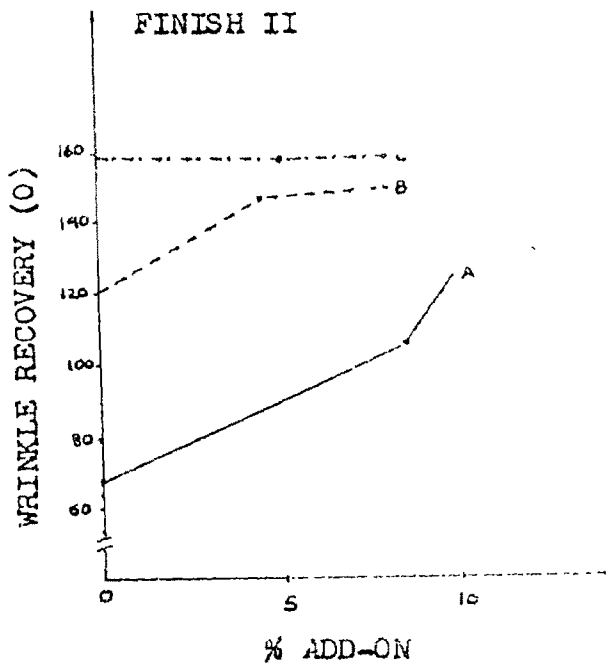
GRAPH 2

FINISH I



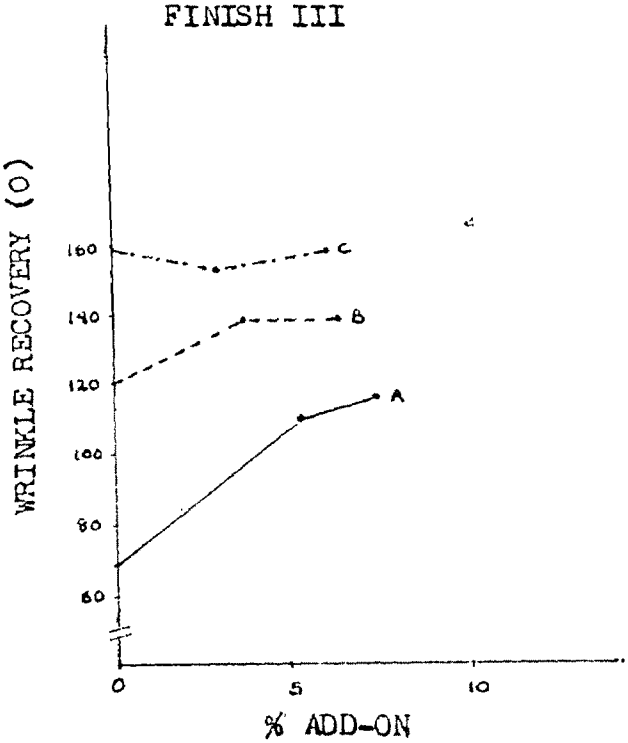
GRAPH 3

FINISH II



GRAPH 4

FINISH III



——— Cotton Fabric - A

– – – Cotton/Polyester Fabric - B

—•— Polyester Fabric - C

FINISH I Arrylamide Finish

FINISH II Combination Finish

FINISH III DMDHEU Finish

TABLE 8a

WRINKLE RECOVERY OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE AND THEIR COMBINATION FINISHES (CURED AT 130° C)

Fabric Code	Soln. Conc. %	Control To WR	% Add-on and Wrinkle Recovery (o) Finish I add-on	Finish I WR	Finish II add-on	Finish II WR	Finish III add-on	Finish III WR
A	5	68	7.0	79	8.5	109	5.3	112
	10	68	14.6	111	9.8	128	6.4	119
B	5	120	3.9	112	4.4	146	3.6	143
	10	120	11.9	126	7.9	149	6.3	141
C	5	159	3.1	160	5.0	156	3.0	156
	10	159	11.7	160	8.1	153	6.0	150

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

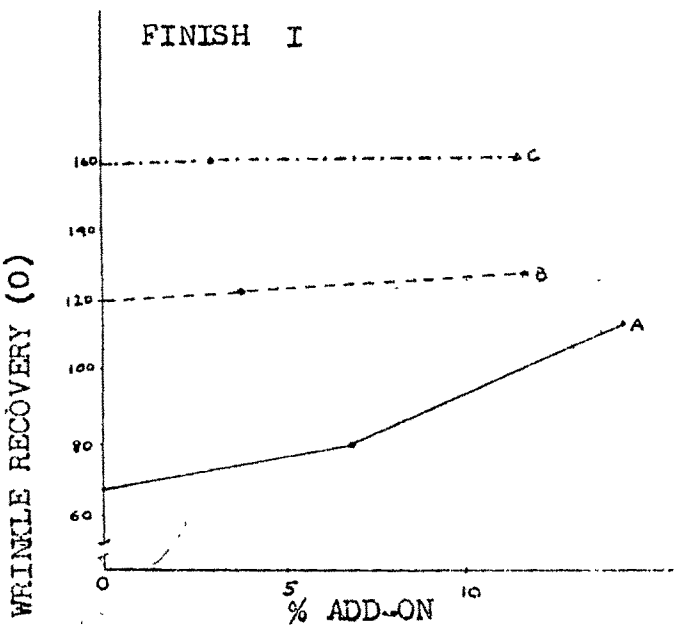
Finish II = Ist step : Pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

Finish III = DMDHEU finish

THE EFFECT OF ADD-ON OF FINISH I, II and III ON WRINKLE RECOVERY OF FABRICS (Cured at 130°C)

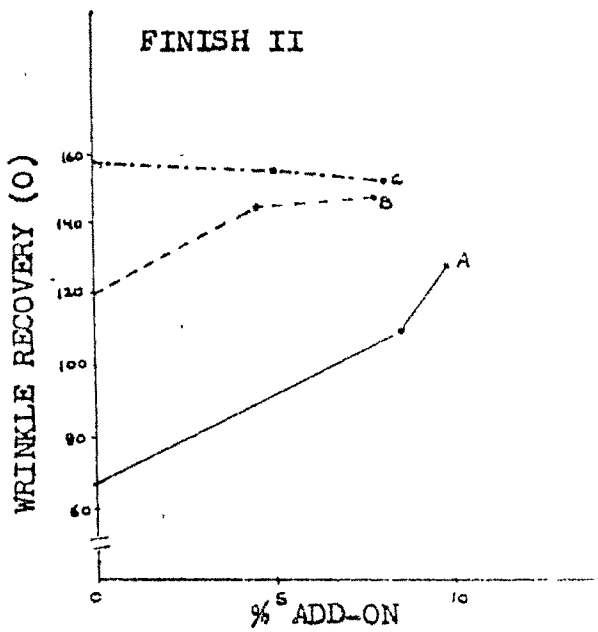
GRAPH 2a

FINISH I



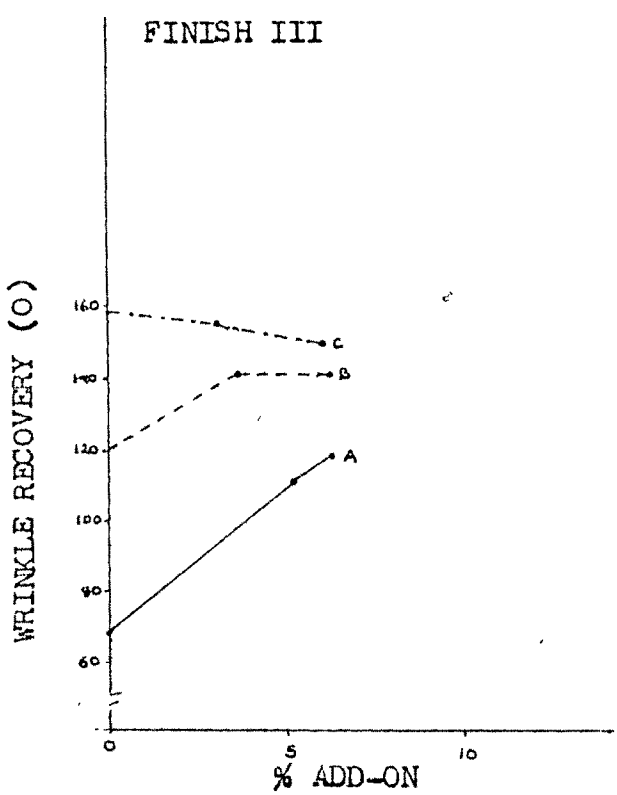
GRAPH 3a

FINISH II



GRAPH 4a

FINISH III



——— Cotton Fabric - A

– – – – Cotton/Polyester Fabric - B

—o— Polyester Fabric - C

FINISH I = Acrylamide Finish

FINISH II = Combination Finish

FINISH III = DMDHEU Finish

It was stated by Frick and Harper[20] in their study that acrylamide products were crosslinking agents that were as effective as the dihydroxydimethilimeolazolinone and less effective than DMDHEU. It was also noted that acrylamide products and the other formaldehyde free agents reacted with the fibre to a lesser extent than the DMDHEU. With a lesser extent of reaction lower wrinkle recovery angles and durable press rating were obtained.

With acrylamide finish I, the wrinkle recovery of polyester fabirc was reduced marginally, therefore the finish could be applied on polyester as well to get other desirable properties such as moisture regain and low static electricity. Maity, Kartha and Srivastsava[32] in their study used a mixture of acrylamide and diallydimethyl ammonium chloride which was compolymerized on the surface of polyester fabric in presence of a catalytic system, comprising of ammonium persulphate and sodium dithionite. The finish was found to impart durable antistatic and hydrophillic properties to the fabric without any deterioration of its basic properties.

5.4.2 The effect of finish I, II and III (its percent add-on) on the stiffness of the treated fabrics has been given in Table 9 and 9a and illustrated in Graphs 5-7 and 5a - 7a.

The stiffness was reduced generally on cotton fabric with all finishes. With combination finish II and DMDHEU finish III,

increase in stiffness with increasing add-on on cotton/polyester and polyester fabrics was noted (Graphs 6 and 7). Combination finish II and DMDHEU finish III showed more reaction with cotton content of fabrics. With the polyester content, increase in stiffness was observed.

On curing stiffness was marginally reduced on fabrics with finish I (Graph 5a). Finish II on curing showed an increase in stiffness on cotton/polyester and polyester fabrics (Graph 6a). Finish III on curing did not show much change in stiffness of fabrics (Graph 7a). Increase in stiffness on curing is due to the layer of the finish binding the fibres and causing rigidity.

5.4.3. The effect of finish I, II and III (its percent add-on) on the tensile strength of the treated fabrics has been given in Tables 10 and 10a and illustrated in Graphs 8-10 and 8a-10a.

Tensile strength decreased in cotton with all the finishes. However at higher add-on of acrylamide finish I and combination finish II the tensile strength was restored. With DMDHEU finish higher add-on decreased the tensile strength (Graph 8,9,10). Strength loss with combination finish II was less due to acrylamide finish I present in the combination (Graph 9) than that of DMDHEU finish III (Graph 10). Acrylamide finish helped to reduce strength loss. There was some strength loss on cotton/polyester and polyester fabrics with all finishes. On curing tensile strength decreased marginally on all fabrics with the finishes (Graph 8a, 9a and 10a).

TABLE 9

STIFFNESS OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES (AIR DRIED)

% Add-on and Stiffness (cms)

Fabric Code	Soln. Conc.	Control To S	Finish I add-on	Finish I S	Finish II add-on	Finish II S	Finish III add-on	Finish III S
A	5	4.4	7.0	4.1	8.5	3.6	5.3	3.7
	10	4.4	14.6	4.0	9.8	3.9	6.4	4.0
B	5	3.8	3.9	4.6	4.4	4.2	3.6	4.1
	10	3.8	11.9	4.4	7.9	5.0	6.3	5.1
C	5	3.0	3.1	3.4	5.1	4.5	3.0	3.8
	10	3.0	11.7	2.3	8.1	5.5	6.0	3.5

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

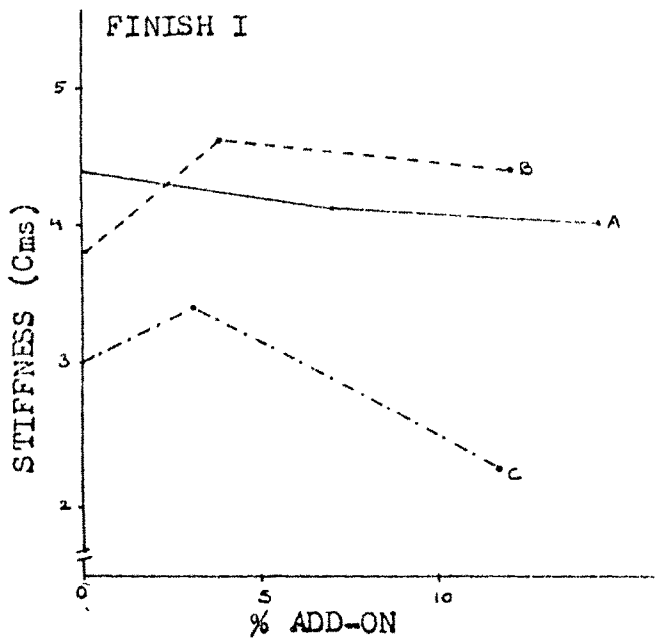
Finish II = Ist step : Pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

Finish III = DMDHEU finish

EFFECT OF ADD-ON OF FINISH I, II, and III ~~on~~
ON STIFFNESS OF FABRICS (AIR DRIED)

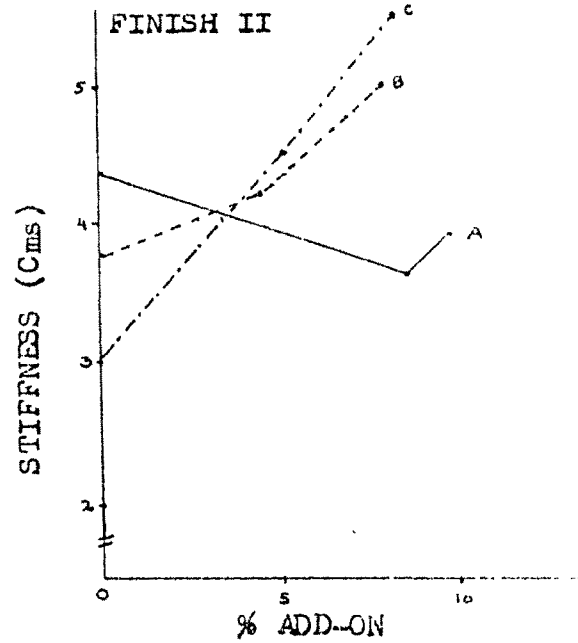
GRAPH 5

FINISH I



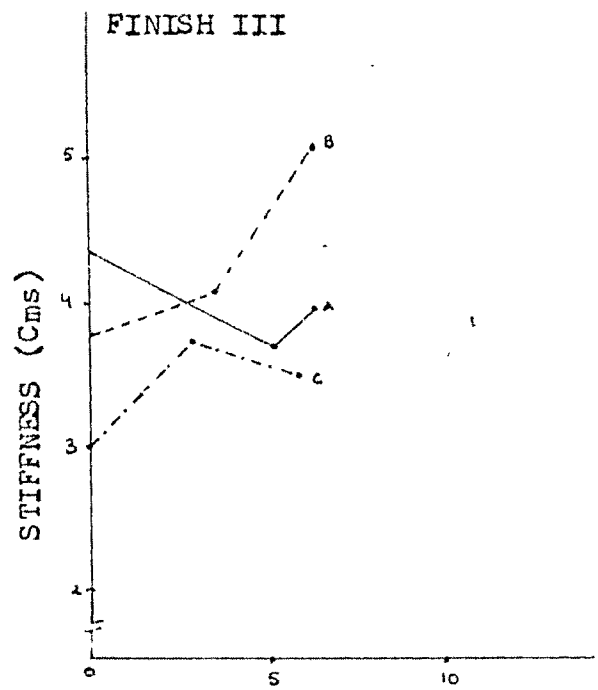
GRAPH 6

FINISH II



GRAPH 7

FINISH III



——— Cotton Fabric - A
---- Cotton/Polyester Fabric - B
--•-- Polyester Fabric - C

FINISH I Acrylamide Finish
FINISH II Combination Finish
FINISH III DMDHEU Finish

TABLE 9a

STIFFNESS OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES (CURED AT 130°C)

% Add-on and Stiffness (cms)

Fabric Code	Soln. Conc.	Control To S	Finish I add-on	Finish I S	Finish II add-on	Finish II S	Finish III add-on	Finish III S
A	5	4.4	7.0	4.0	8.5	3.5	5.3	3.7
	10	4.4	14.6	3.7	9.8	3.6	6.4	3.7
B	5	3.8	3.9	4.6	4.4	4.5	3.6	4.6
	10	3.8	11.9	4.3	7.9	5.2	6.3	5.1
C	5	3.0	3.1	3.5	5.0	6.2	3.0	3.8
	10	3.0	11.7	2.1	8.1	5.6	6.0	3.5

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

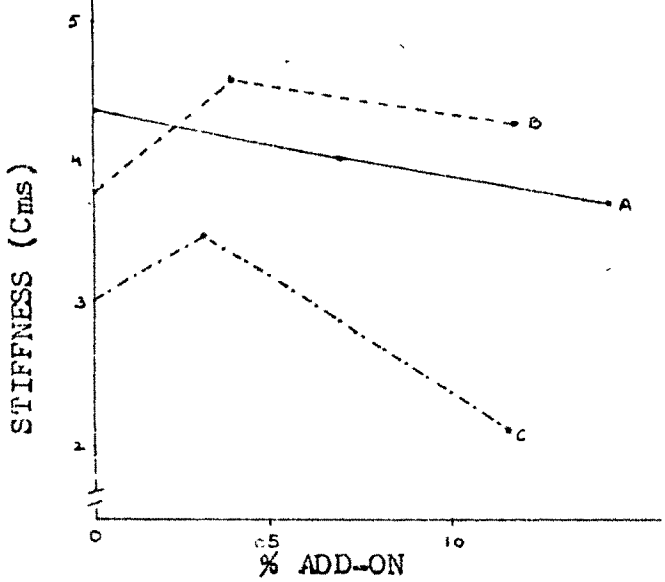
Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : Pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

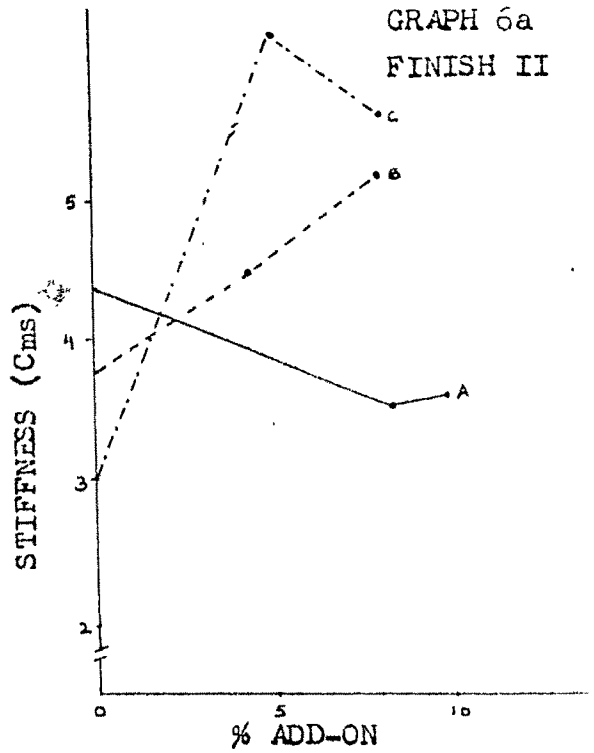
Finish III = DMDHEU finish

EFFECT OF ADD-ON FINISH I, II and III ON STIFFNESS OF FABRICS (CURED AT 130°C)

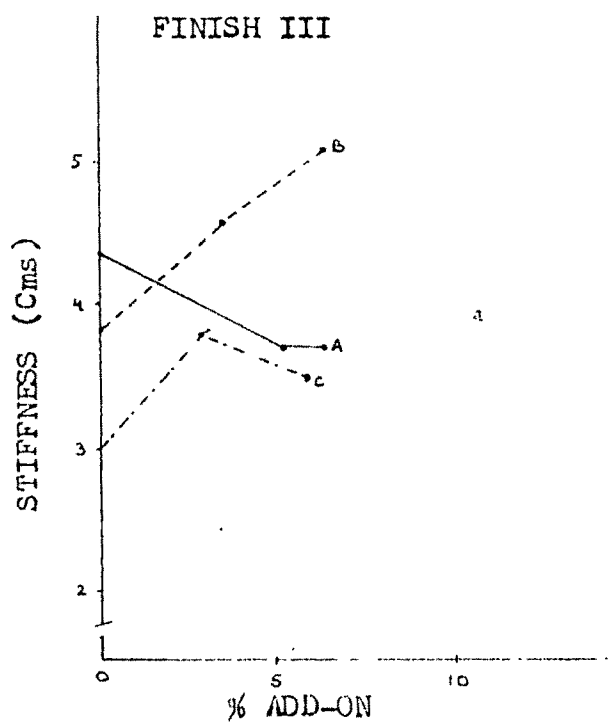
GRAPH 5a
FINISH I



GRAPH 6a
FINISH II



GRAPH 7a
FINISH III



——— Cotton Fabric - A
- - - - Cotton/Polyester Fabric - B
—•— Polyester Fabric - C

FINISH I Acrylamide Finish
FINISH II Combination Finish
FINISH III DMDHEU Finish

TABLE 10

TENSILE STRENGTH FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES (AIR DRIED)

% Add-on and Tensile Strength (lbs)

Fabric Code	Soln. Conc. %	Control To TS	Finish I add-on	Finish I TS	Finish II add-on	Finish II TS	Finish III add-on	Finish III TS
A	5	42	7.0	32	8.5	31	5.3	38
	10	42	14.6	33	9.8	33	6.4	27
B	5	33	3.9	29	4.4	30	3.6	32
	10	33	11.9	30	7.9	29	6.3	31
C	5	41	3.1	42	5.0	39	3.0	39
	10	41	11.7	39	8.1	40	6.0	39

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

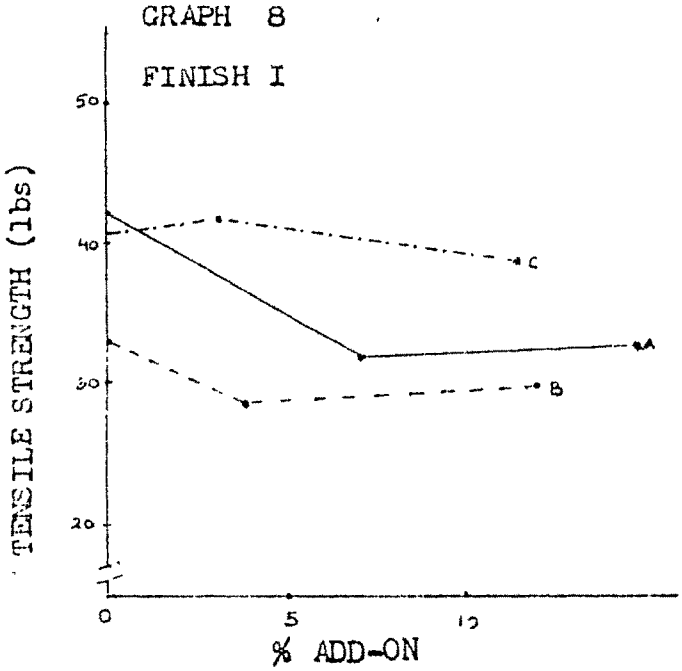
Finish II = Ist step : Pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

Finish III = DMDHEU finish

EFFECT OF ADD-ON OF FINISH I, II AND III ON TENSILE STRENGTH OF FABRICS (AIR DRIED)

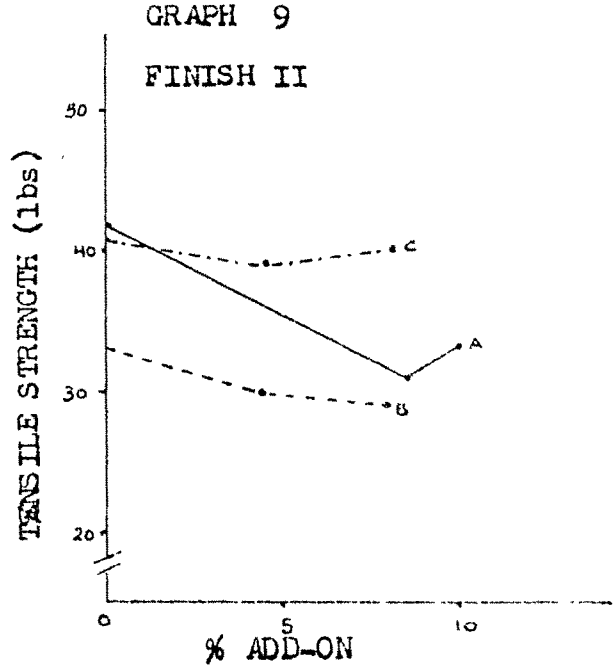
GRAPH 8

FINISH I



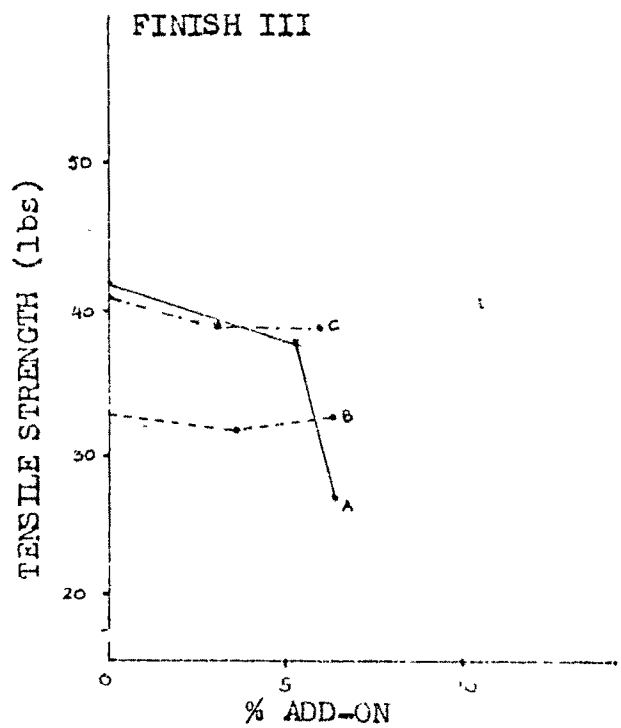
GRAPH 9

FINISH II



GRAPH 10

FINISH III



____ Cotton Fabric - A

_ _ _ _ Cotton/Polyester Fabric - B

--o-- Polyester Fabric - C

FINISH I Acrylamide Finish

FINISH II Combination Finish

FINISH III DMDHEU Finish

TABLE 10a

TENSILE STRENGTH OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES (CURED AT 130°C)

% Add-on and Tensile Strength (lbs)

Fabric Code	Soln. Conc. %	Control To TS	Finish I add-on	Finish I TS	Finish II add-on	Finish II TS	Finish III add-on	Finish III TS
A	5	42	7.0	30	8.5	29	5.2	35
	10	42	14.6	30	9.8	30	6.4	25
B	5	33	3.9	25	4.4	30	3.6	31
	10	33	11.9	26	7.9	29	6.3	30
C	5	41	3.1	41	5.0	38	3.0	38
	10	41	11.7	39	8.1	38	6.0	38

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

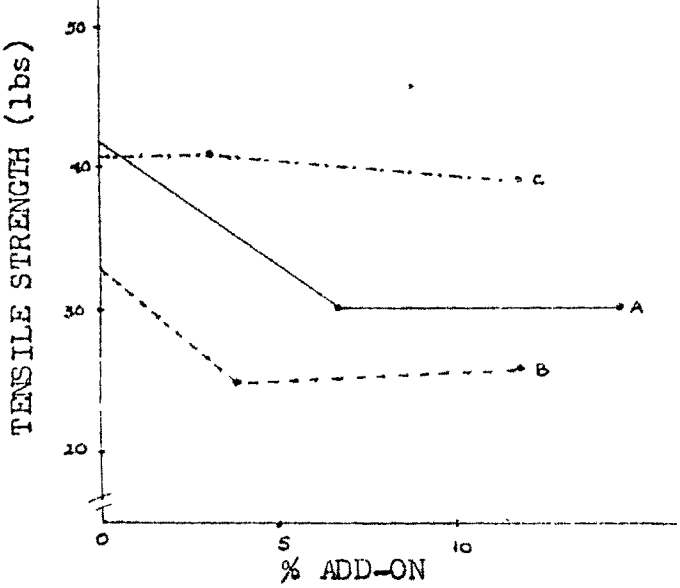
Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

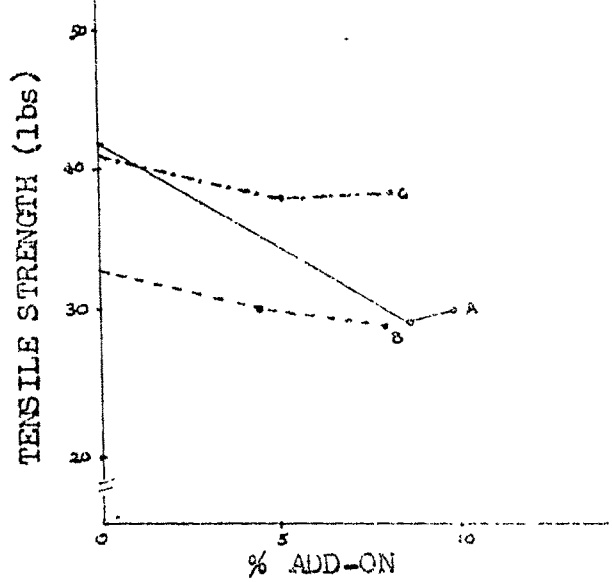
Finish III = DMDHEU finish

EFFECT OF ADD-ON OF FINISH I, II, AND III ON TENSILE STRENGTH OF FABRICS (Cured at 130°C)

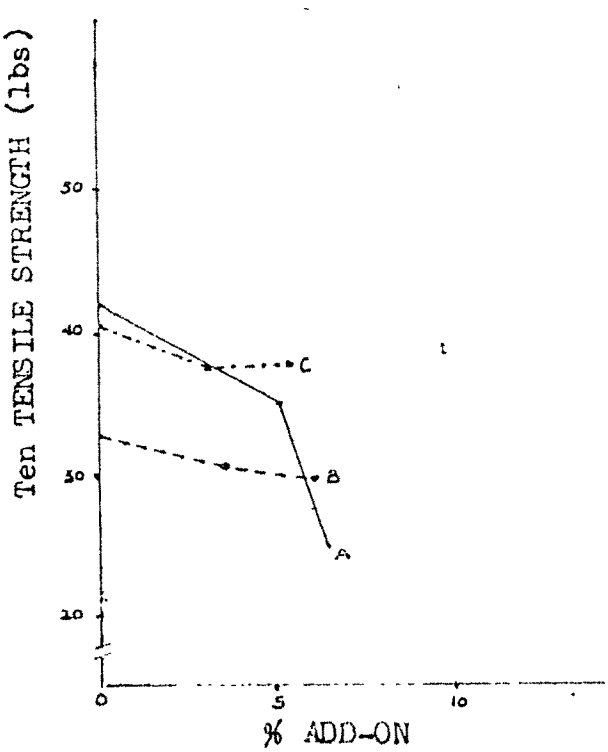
GRAPH 8a
FINISH I



GRAPH 9a
FINISH II



GRAPH 10a
FINISH III



Cotton Fabric - A
Cotton/Polyester Fabric - B
Polyester Fabric - C

FINISH I Acrylamide Finish
FINISH II Combination Finish
FINISH III DMDHEU Finish

TABLE 11

PERCENT ELONGATION OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES (AIR DRIED)

			% Add-on and Percent Elongation					
Fabric Code	Soln. Conc. %	Control To E	Finish I add-on	E	Finish II add-on	E	Finish III add-on	E
A	5	25	7.0	19	8.5	20	5.3	19
	10	25	14.6	16	9.8	18	6.4	15
B	5	13	3.9	11	4.4	11	3.6	12
	10	13	11.9	13	7.9	12	6.3	10
C	5	41	3.1	33	5.0	24	3.0	24
	10	41	11.7	22	8.1	22	6.0	25

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

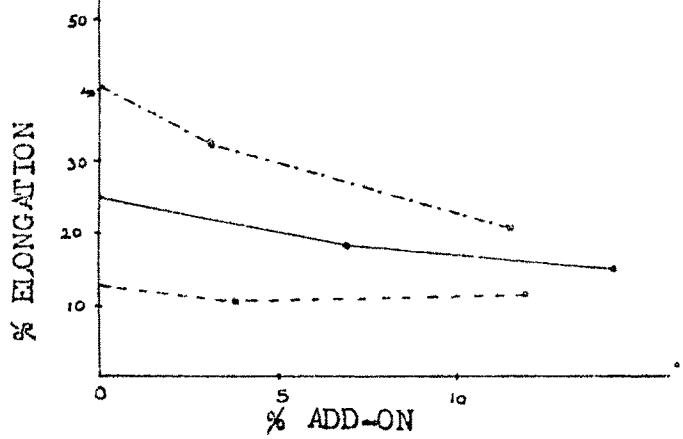
Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : Pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

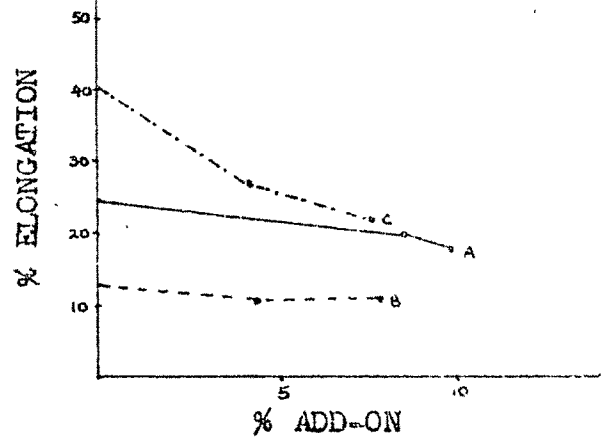
Finish III = DMDHEU finish

EFFECT OF ADD-ON OF FINISH I, II AND III ON PER -CENT ELONGATION OF FABRICS (AIR DRIED)

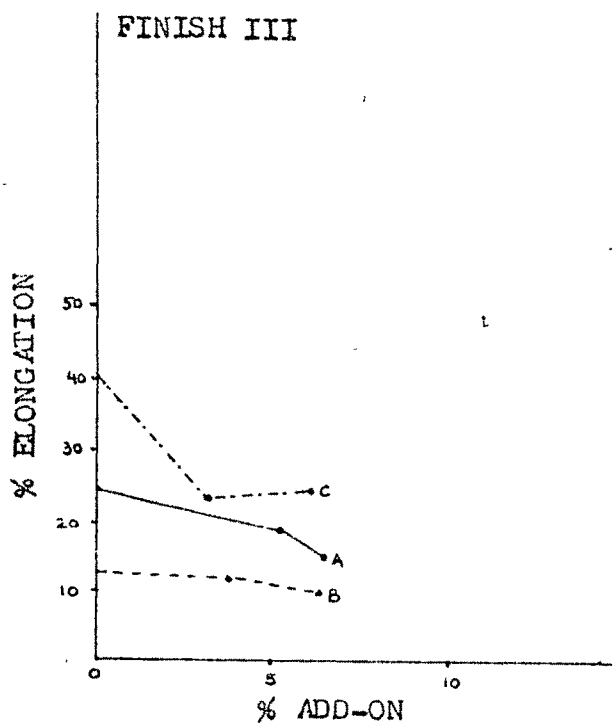
GRAPH 11
FINISH I



GRAPH 12
FINISH II



GRAPH 13
FINISH III



——— Cotton Fabric - A
– – – – Cotton/Polyester Fabric - B
—o— Polyester Fabric - C

FINISH I Acrylamide Finish
FINISH II Combination Finish
FINISH III DMDHEU Finish

TABLE 11a

PERCENT ELONGATION OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES (CURED AT 130° C)

Fabric Code	Soln. Conc. %	Control To E	% Add-on and Percent Elongation Finish I add-on	E	Finish II add-on	E	Finish III add-on	E
A	5	25	70	18	8.5	17	5.3	18
	10	25	14.6	15	9.8	14	6.4	13
B	5	13	3.9	12	4.4	11	3.6	10
	10	13	11.9	13	7.9	11	6.3	10
C	5	41	3.1	23	5.0	23	3.0	23
	10	41	11.7	20	8.1	20	6.0	23

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

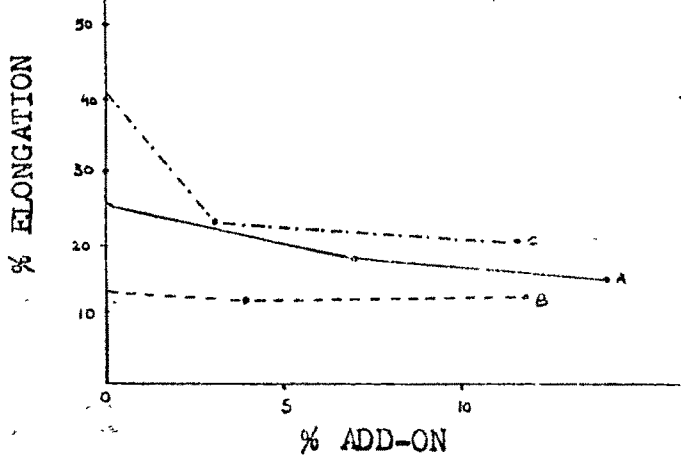
Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : Pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU (I and III)

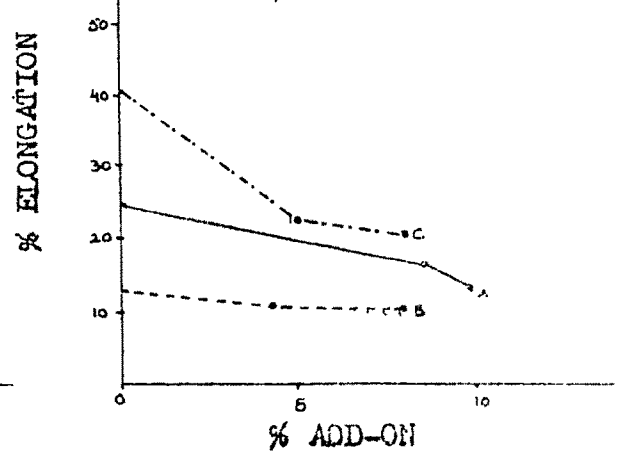
Finish III = DMDHEU finish

EFFECT OF ADD-ON OF FINISH I, II AND III ON PERCENT ELONGATION (Cured at 130°C)

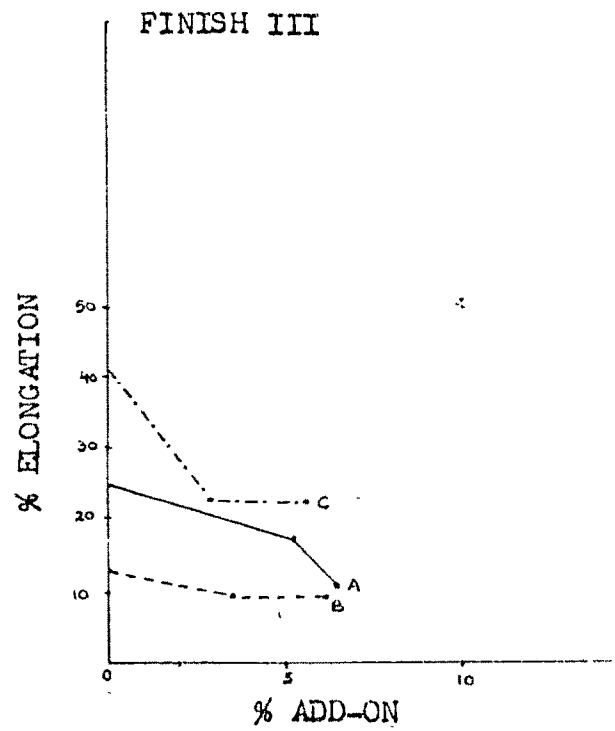
GRAPH 11a
FINISH I



GRAPH 12a
FINISH II



GRAPH 13a
FINISH III



——— Cotton Fabric - A
– – – – – Cotton/Polyester Fabric - B
—o— Polyester Fabric - C

FINISH I Acrylamide Finish
FINISH II Combination Finish
FINISH III DMDHEU Finish

5.4.4 The effect of finish I, II and III (its percent add-on), on the percent elongation of the treated fabrics has been given in Table 11 and 11a and illustrated in Graphs 11-13 and 11a-13a.

Percent elongation of fabrics, in general, decreased with all finishes and on curing no noticeable changes from the air dried one to cured one were observed.

5.5 Analysis of finishes I, II and III for durability

The finishes on the fabrics were analysed for durability; percent add-on, wrinkle recovery and stiffness were determined before and after washing.

5.5.1 Percent add-on and its retention after washing have been given in Table 12 and 12a for finish I, II and III.

On washing the percent add-on the finished fabrics reduced to a great extent (retention being approximately half or less). So, when the reaction was allowed at room temperaturue the finishes were not so durable.

Jain[28] in her work on acrylamide finish has stated that lower concentration of the finish showed some durability which was achieved by use of trichloroacetic acid and glyoxal in the first stage and acrylamide and hydrogen peroxide in the second. Epichlorohydrin (of this work) seems to be less effective than trichloroacetic acid (of Jain's[28] work).

From results in Table 12a, it was seen that on curing of samples for 5 minutes at 130 C, an improvement in the durability was observed, the percent retention of finish on fabrics was found to be improved.

It is to be seen whether this improvement in retention of finish is enough or not for influencing the wrinkle recovery and appearance of fabrics, after wash.

5.5.2 Wrinkle recovery of fabrics, before and after washing has been given in Table 13 and 13a.

In general wrinkle recovery loss was observed when fabrics were washed (Table 13), that is, with the loss of finish the wrinkle recovery decreased. The reaction of finish with the fibre was not sufficient by air drying.

On curing, the wrinkle recovery of finished fabrics was improved (Table 13a). On washing these values were reduced but were still above as compared to those of control and air dried fabrics.

5.5.3. Stiffness of fabrics, before and after washing has been given in Table 14 and 14a.

There was a loss in stiffness when finished fabrics were washed (Table 14, 14a). Removal of surface finish was thus reflected.

5.5.4 Relation between these properties and the finish content as add-on.

TABLE 12

FINISH CONTENT, AS PERCENT ADD-ON AT VARYING CONCENTRATIONS (AIR DRIED)

% Add-on and % Retention

Finish and Conc.	A X	A Y (% R)	B X	B Y (% R)	C X	C Y (% R)
Control	0	0	0	0	0	0
I 5%	7.0	3.3 (47.0)	3.9	2.3 (58.9)	3.4	2.0 (64.5)
I 10%	14.6	1.5 (10.2)	11.9	2.6 (21.8)	11.7	1.9 (16.2)
II 5%	8.5	2.0 (23.5)	4.4	2.2 (50.0)	5.0	1.9 (38.0)
II 10%	9.8	3.5 (35.7)	7.9	3.9 (49.3)	8.1	3.9 (48.1)
III 5%	5.3	1.2 (22.6)	3.6	0.9 (25.0)	3.0	1.0 (33.3)
III 10%	6.4	2.5 (39.0)	6.3	2.3 (36.5)	6.0	1.0 (16.6)

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% Polyester

X = before washing

Y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : Preteatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

TABLE 12a

FINISH CONTENT, AS PERCENT ADD-ON AT VARYING CONCENTRATIONS (CURED AT 130° C)

% Add-on and % Retention

Finish and Conc.	A X	A Y (% R)	B X	B Y (% R)	C X	C Y (% R)
Control	0	0	0	0	0	0
I 5%	7.0	4.5 (64.2)	3.9	3.2 (82.0)	3.1	2.2 (70.9)
I 10%	14.6	9.8 (65.0)	11.9	8.5 (71.4)	11.7	7.6 (64.9)
II 5%	8.5	3.2 (37.6)	4.4	3.07 (69.7)	5.0	2.5 (50.0)
II 10%	9.8	6.0 (61.2)	7.9	4.60 (58.2)	8.1	4.4 (54.3)
III 5%	5.3	1.4 (26.4)	3.6	1.1 (30.5)	3.0	1.0 (33.3)
III 10%	6.4	2.9 (45.3)	6.3	2.8 (44.4)	6.0	2.3 (38.3)

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

TABLE 13

WRINKLE RECOVERY OF FINISHED FABRICS (AIR DRIED)

Finish and Conc.		A		B		C	
		X	Y	X	Y	X	Y
Control		68	68	120	120	159	159
I	5%	7	74	111	126	153	160
	10%	81	69	127	123	154	170
II	5%	105	88	146	130	157	158
	10%	123	95	149	134	158	165
III	5%	110	77	139	122	153	157
	10%	116	90	138	120	158	156

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

TABLE 13a

WRINKLE RECOVERY OF FINISHED FABRICS (CURED AT 130°C)

Finish and Conc.		A		B		C	
		X	Y	X	Y	X	Y
Control		68	68	120	120	159	159
I	5%	79	85	122	121	160	165
	10%	111	92	126	122	166	169
II	5%	109	98	146	148	156	163
	10%	128	102	149	137	153	157
III	5%	112	108	143	135	156	159
	10%	119	121	141	139	150	160

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

TABLE 14

STIFFNESS OF FINISHED FABRICS (AIR DRIED)

Finish and Conc.		A		B		C	
		X	Y	X	Y	X	Y
Control		4.4	4.4	3.8	3.8	3.0	3.0
I	5%	4.1	3.7	4.6	4.1	3.4	3.0
	10%	4.0	3.6	4.4	4.1	2.3	2.4
II	5%	3.6	3.5	4.2	3.9	4.5	3.3
	10%	3.9	3.4	5.0	4.0	5.5	3.5
III	5%	3.7	3.5	4.1	3.7	3.8	2.8
	10%	4.0	3.4	5.1	3.8	3.5	3.1

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

TABLE 14a

STIFFNESS OF FINISHED FABRICS (CURED AT 130°C)

Finish and Conc.		A		B		C	
		X	Y	X	Y	X	Y
Control		4.4	4.4	3.8	3.8	3.0	3.0
I	5%	4.0	3.9	4.6	4.5	3.5	2.9
	10%	3.7	3.4	4.3	4.2	2.1	2.1
II	5%	3.5	3.3	4.5	4.1	6.2	4.0
	10%	3.6	3.5	5.2	4.0	5.6	3.6
III	5%	3.7	3.4	4.6	3.6	3.8	3.0
	10%	3.7	3.4	5.1	4.3	3.5	3.6

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

The relationship between percent add-on and wrinkle recovery of fabrics has been illustrated in Graphs 14-16 and 14a-16a (Data has been earlier given in Tables 12-13 and 12a-13a).

From these it has been indicated that residual (i.e. retained) add-on has some and positive influence on wrinkle recovery, the influence being higher in cotton fabric and less in cotton/polyester fabirc. The polyester fabric was least influenced by finish.

The relationship between percent add-on and stiffness has been illustrated in Graphs 17-19 and 17a-19a. (Data has been earlier given in Tables 12-14 and 12a-14a).

The influence of stiffness was similar, namely loss of stiffness with the loss in percent add-on.

How the smooth appearance of finished fabrics has been influenced by finish is discussed in the next section (5.6).

5.6 Appearance rating of fabrics after wrinkling and ironing.

The appearance of each finished fabric after wrinkling and recovery was evaluuated according to AATCC 128-1969. To judge wash and wear property a mild ironing (at nylon setting) was introduuced to aid recovery. The wrinkled surface of the sample was observed under an overhead fluorescent lighting system, photographs of three dimensional replicas were used as standards for comparison. The data on appearance rating has been presented in Table 15-17 and illustrated in Graphs 20-31. The data on

RELATIONSHIP BETWEEN WRINKLE RECOVERY AND PERCENT ADD-ON ON FABRICS BEFORE AND AFTER WASHING (AIR DRIED)

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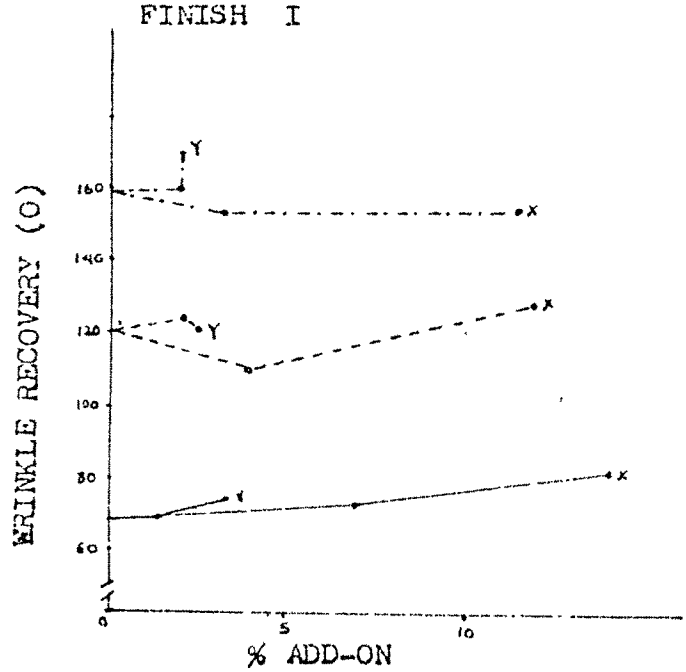
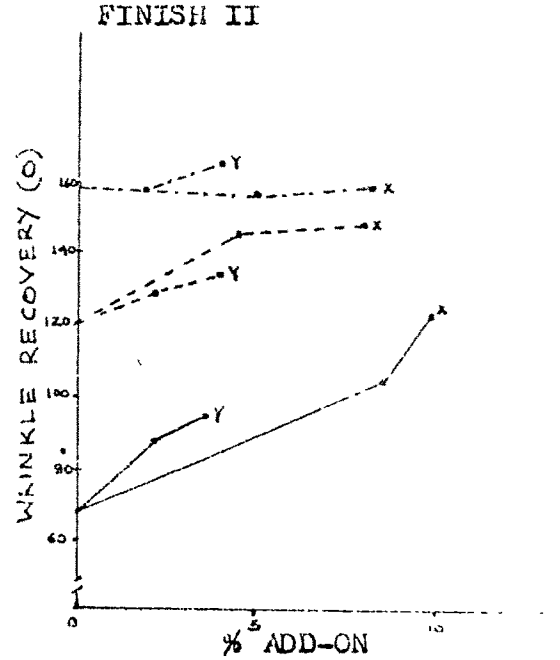
GRAPH 14

FINISH I



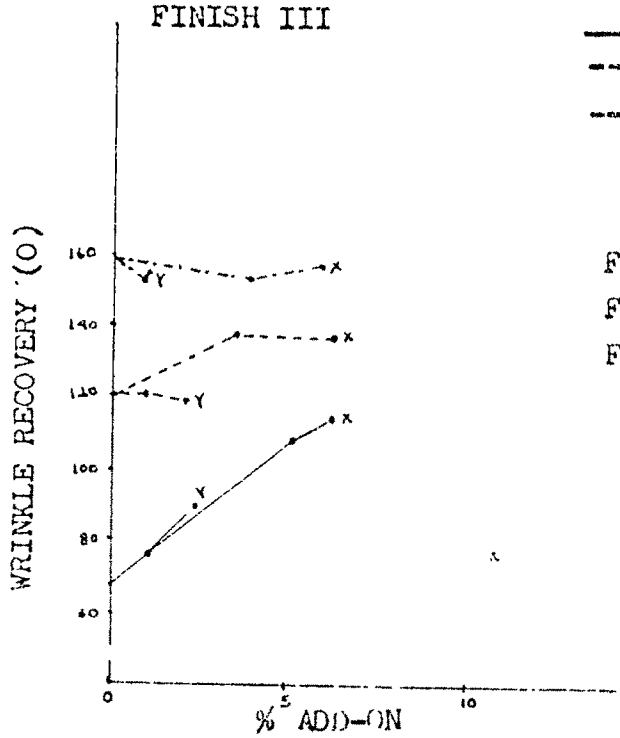
GRAPH 15

FINISH II



GRAPH 16

FINISH III



——— Cotton Fabric - A

– – – – Cotton/Polyester Fabric - B

—o— Polyester Fabric - C

x = before washing

y = after washing

FINISH I Acrylamide Finish

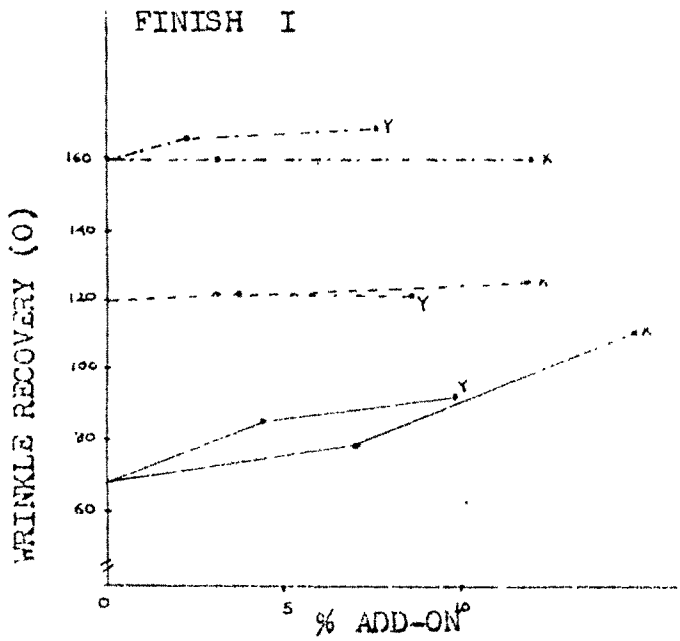
FINISH II Combination Finish

FINISH III DMDHEU Finish

RELATIONSHIP BETWEEN WRINKLE RECOVERY AND PERCENT ADD-ON ON FABRICS BEFORE AND AFTER WASHING (Cured at 130°C)

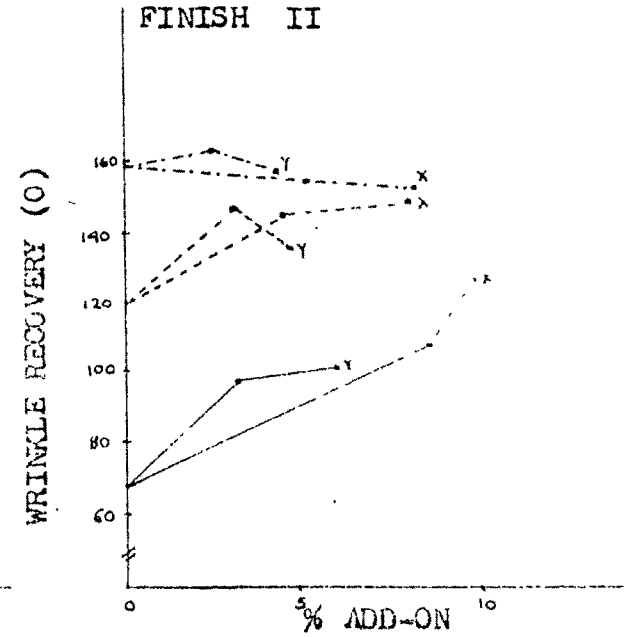
GRAPH 14a

FINISH I



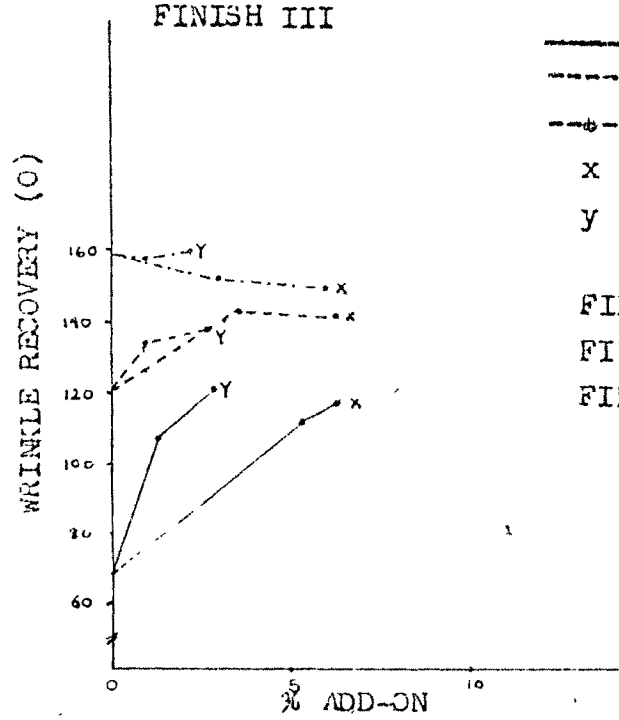
GRAPH 15a

FINISH II



GRAPH 16a

FINISH III



——— Cotton Fabric - A

– – – – – Cotton/Polyester Fabric - B

—•— Polyester Fabric - C

x = before washing

y = after washing

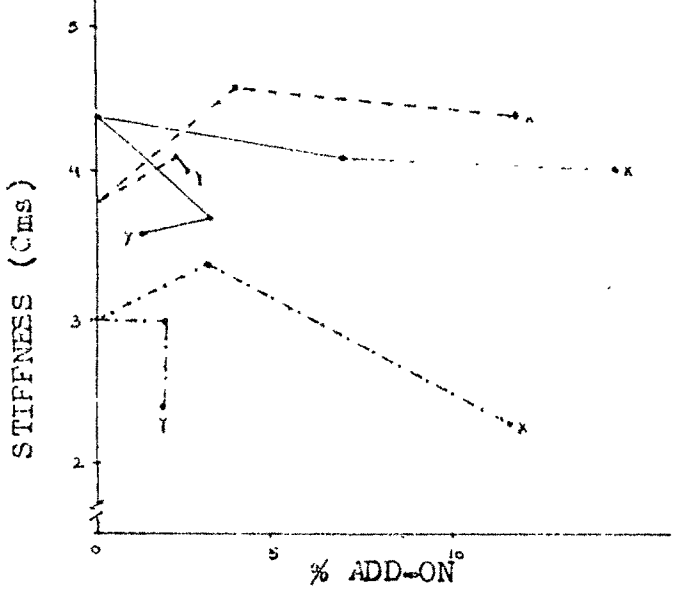
FINISH I : Acrylamide Finish

FINISH II : Combination Finish

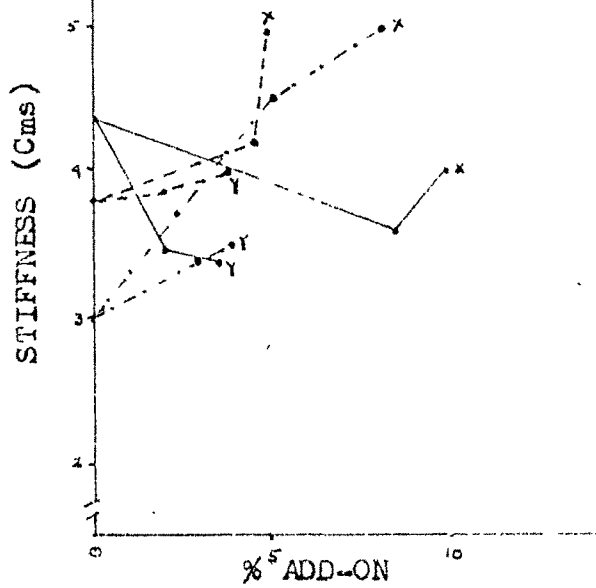
FINISH III : DMDHEU Finish

RELATIONSHIP BETWEEN STIFFNESS AND PERCENT ADD-ON ON FABRICS BEFORE AND AFTER WASHING (AIR DRIED)

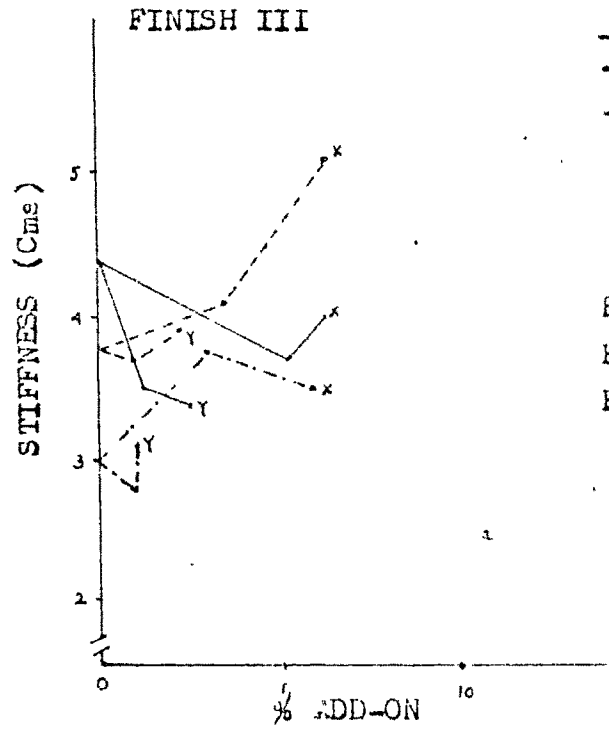
GRAPH 17
FINISH I



GRAPH 18
FINISH II



GRAPH 19
FINISH III



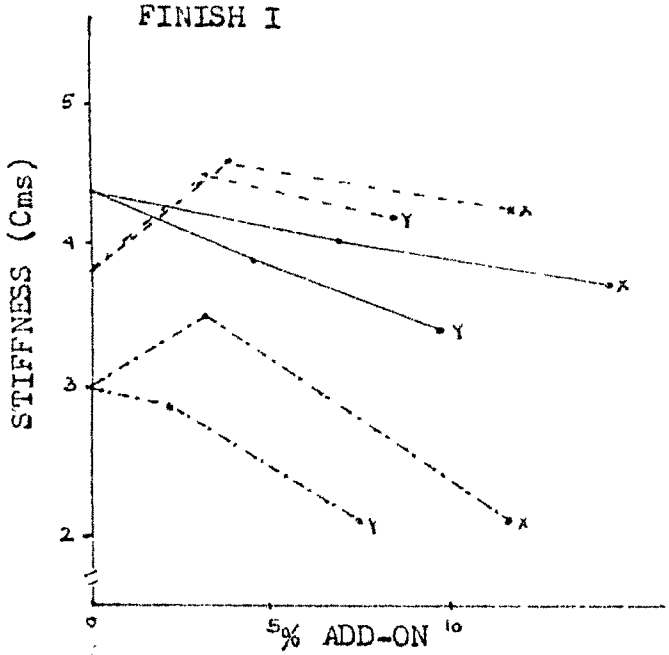
_____ Cotton Fabric - A
------ Cotton/Polyester Fabric - B
--o-- Polyester Fabric - C

x = before washing
y = after washing

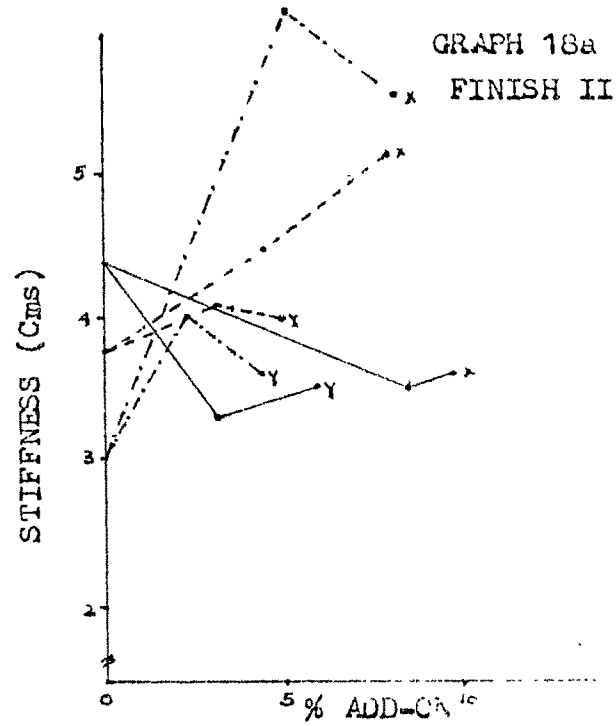
FINISH I : Acrylamide Finish
FINISH II : Combination Finish
FINISH III : DMDHEU Finish

RELATIONSHIP BETWEEN STIFFNESS AND PERCENT ADD-ON ON FABRICS BEFORE AND AFTER WASHING (Cured at 130°C)

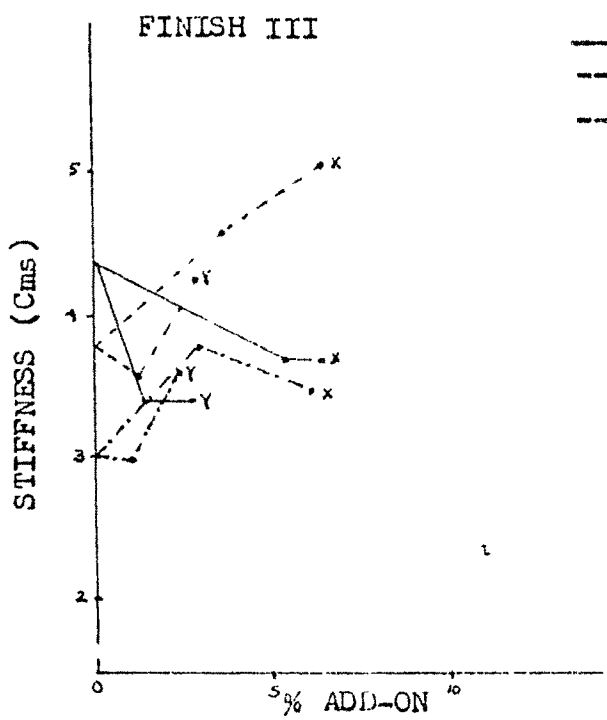
GRAPH 17a
FINISH I



GRAPH 18a
FINISH II



GRAPH 19a
FINISH III



——— Cotton Fabric - A
----- Cotton/Polyester Fabric - B
---o--- Polyester Fabric - C
x = before washing
y = after washing

FINISH I : Acrylamide Finish
FINISH II : Combination Finish
FINISH III : DMDHEU Finish

appearance rating showed improvement only when the fabrics were ironed at nylon setting.

From Graph 20 and 22, the influence of finish on cotton fabric was observed but this was reduced on washing (Graphs 21 and 23). As seen earlier in this chapter that durability of the finish was also less on washing. On cotton/polyester the reduction in appearance rating was also observed when the fabrics were washed (Graphs 24-27). However it was noted that the influence of the finish on cotton fabric was more than cotton/polyester fabric. On polyester fabric the finishes did not seem to have any influence, however after washing and ironing a marginal improvement in appearance rating was observed (Graphs 28-31).

It was noticed that appearance rating of cotton and cotton/polyester blend was improved with the combination and DMDHEU finishes.

As compared to the increase in wrinkle recovery on cotton fabric with acrylamide finish the appearance rating was better. Acrylamide finish being thermoplastic in nature could have introduuced thermoplasticity to the fabric which gave better appearance rating on ironing. However this appearance was lost on washing.

As seen from the results, it was observed that combination of acrylamide and DMDHEU and DMDHEU gave a good appearance rating to the fabrics. This appearance could be further improved by curing, the way durability was improved on curing.

TABLE 15

APPEARANCE RATING FOR COTTON FABRIC (A)

Finish and Conc.	A Ratings a	b	c	d	B Ratings a	b	c	d
Control To	1.0	1.0	1.0	1.5	1.0	1.0	1.0	1.5
I 5%	1.5	1.5	1.5	2.5	1.5	1.5	1.5	2.5
I 10%	1.5	1.5	1.5	3.0	1.0	1.5	1.5	1.5
II 5%	2.0	2.0	2.5	4.0	1.5	2.0	2.0	3.0
II 10%	2.0	2.0	2.5	4.5	2.0	2.0	2.0	3.5
III 5%	2.0	3.0	3.0	4.0	1.5	1.5	1.5	2.5
III 10%	2.0	3.0	3.0	4.0	1.5	1.5	1.5	3.0

a = after wrinkling

b = after twenty four hours (recovery time)

c = after ironing with cold iron

d = after ironing with warm iron

To = control

x = before washing

y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

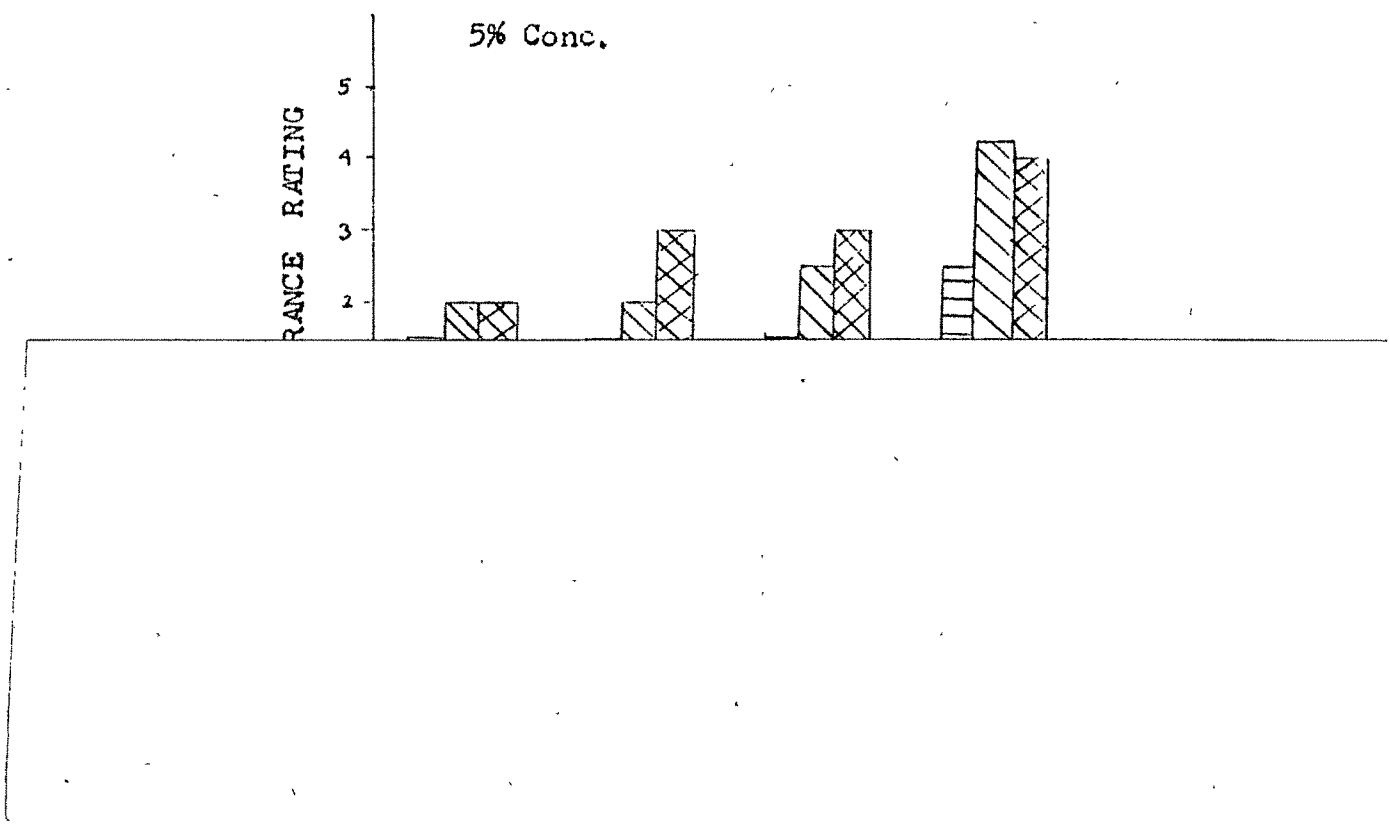
EFFECT OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES ON APPEARANCE RATING (COTTON FABRIC - A)

	% ADD-ON (x)	(y)
CONTROL	(o)	(o)
FINISH I	(7.0)	(3.3)
FINISH II	(8.5)	(2.0)
FINISH III	(5.3)	(1.2)

a. AFTER WRINKLING
b. TWENTY FOUR Hrs. AFTER WRINKLING
c. AFTER IRONING WITH COLD IRON
d. AFTER IRONING AT NYLON SETTING

GRAPH 20

BEFORE WASHING (x)



EFFECT OF ACRYLAMIDE DMDHEU AND THEIR COMBINATION FINISHES ON APPEARANCE RATING (COTTON FABRIC - A)

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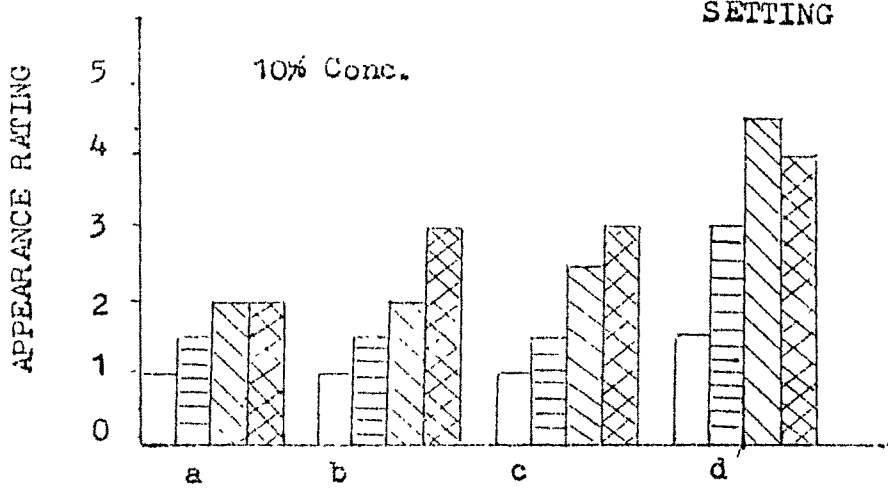
	% ADD-ON X (%)	Y (%)
CONTROL		
FINISH I	(14.6)	(1.5)
FINISH II	(9.8)	(3.5)
FINISH III	(6.4)	(3.5)

a, AFTER WRINKLING
b. TWENTY FOUR HRS. AFTER WRINKLING
c. AFTER IRONING WITH COLD IRON
d. AFTER IRONING AT NYLON SETTING

GRAPH 22

BEFORE WASHING (x)



GRAPH 23

AFTER WASHING (y)

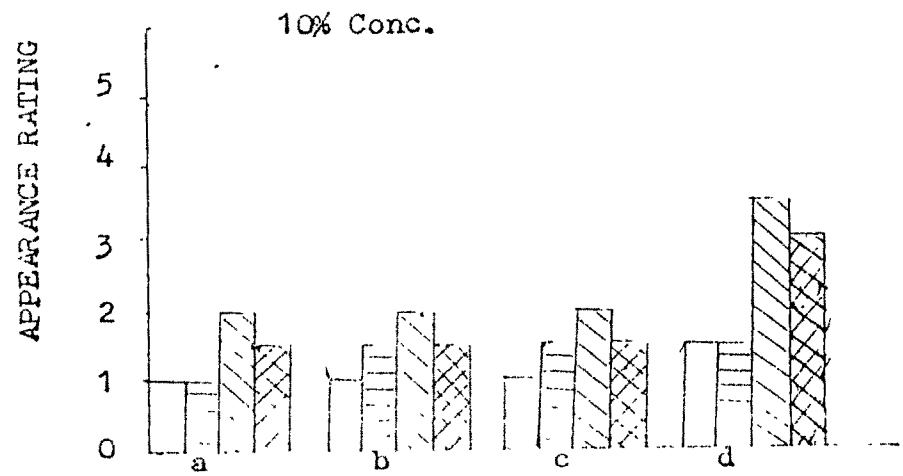


TABLE 16

APPEARANCE RATING FOR COTTON/POLYESTER FABRIC (A)

Finish and Conc.		X Ratings a	b	c	d	Y Ratings a	b	c	d
Control To		1.5	2.5	2.5	3.0	1.5	2.5	2.5	3.0
I	5%	2.0	3.0	3.0	3.5	2.0	3.0	3.0	3.5
	10%	2.0	3.0	3.0	4.0	2.0	3.0	3.0	3.5
II	5%	2.0	3.0	3.0	5.0	2.0	3.0	3.0	3.5
	10%	2.0	3.5	3.5	5.0	2.0	3.0	3.0	3.5
III	5%	2.0	3.0	3.0	4.5	1.5	2.5	2.5	3.0
	10%	2.0	3.0	3.0	4.5	1.5	2.5	2.5	3.0

a = after wrinkling

b = after twenty four hours (recovery time)

c = after ironing with cold iron

d = after ironing with warm iron

To = control

x = before washing

y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

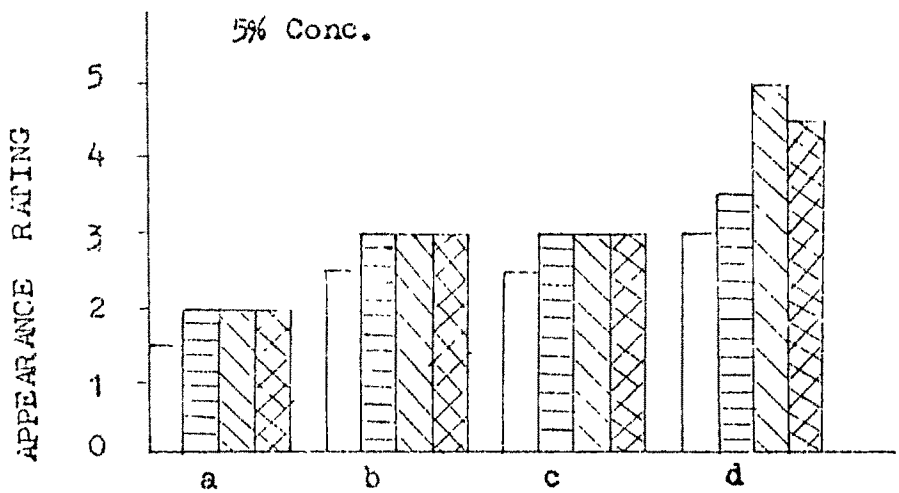
EFFECT OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES ON APPEARANCE RATING(COTTON/POLYESTER - B)

	% ADD-ON x (o)	y (o)
CONTROL		
FINISH I	(3.9)	(2.3)
FINISH II	(4.4)	(2.2)
FINISH III	(3.6)	(0.9)

a. AFTER WRINKLING
b. TWENTY FOUR Hrs. AFTER WRINKLING
c. AFTER IRONING WITH COLD IRON
d. AFTER IRONING AT NYLON SETTING

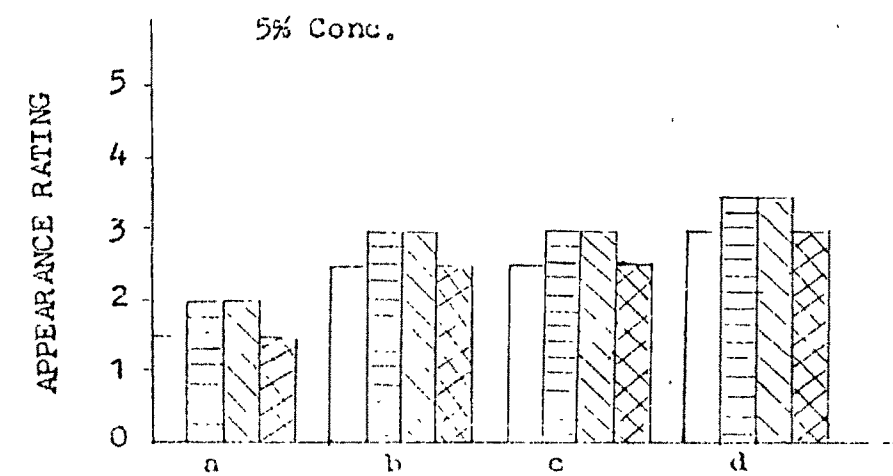
GRAPH 24

BEFORE WASHING (x)



GRAPH 25

AFTER WASHING (y)

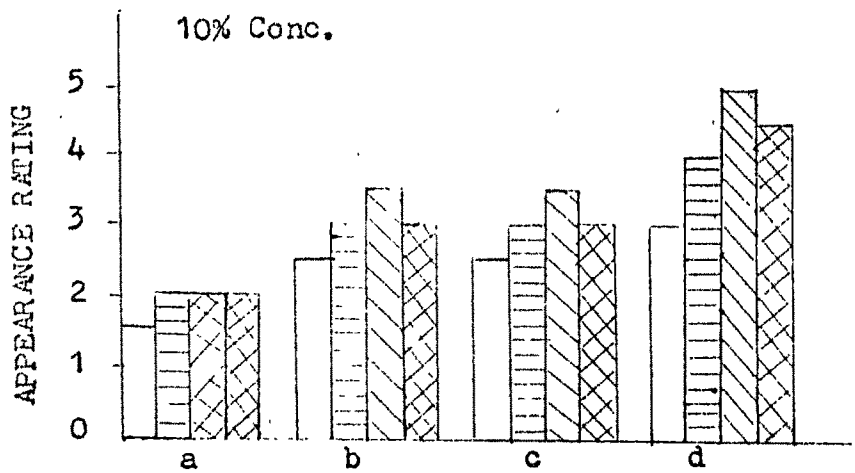


EFFECT OF ACRYLAMIDE DMDHEU AND THEIR COMBINATION FINISHES ON APPEARANCE RATING (COTTON/POLYESTER-B)

	% ADD-ON X	y
CONTROL	(o)	(o)
FINISH I	(11.9)	(2.6)
FINISH II	(7.9)	(3.9)
FINISH III	(3.6)	(0.9)

a. AFTER WRINKLING
b. TWENTY FOUR Hrs. AFTER WRINKLING
c. AFTER IRONING WITH COLD IRON
d. AFTER IRONING AT NYLON SETTING

GRAPH 26
BEFORE WASHING (x)



GRAPH 27
AFTER WASHING (y)

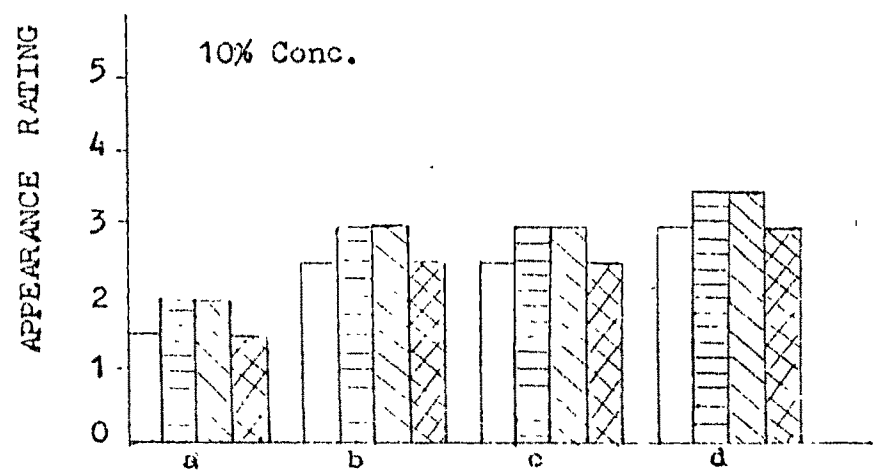


TABLE 17

APPEARANCE RATING FOR POLYESTER FABRIC (C)

Finish and Conc.		X Ratings a	b	c	d	Y Ratings a	b	c	d
Control To		2.5	3.0	3.5	4.0	2.5	3.0	3.5	4.0
I	5%	2.5	3.0	3.0	4.0	2.5	3.5	3.5	5.0
	10%	2.5	3.0	3.0	4.0	2.5	4.0	4.0	5.0
II	5%	2.0	3.0	3.0	4.0	2.0	3.0	3.5	4.0
	10%	2.0	3.0	3.0	4.0	2.0	3.5	3.5	5.0
III	5%	2.5	3.0	3.0	4.0	2.5	3.5	3.5	4.0
	10%	2.0	3.0	3.0	3.0	2.5	3.5	3.5	4.0

a = after wrinkling

b = after twenty four hours (recovery time)

c = after ironing with cold iron

d = after ironing with warm iron

To = control

x = before washing

y = after washing

Finish I = Ist step : pretreatment with epicholohydrin and formaldehyde
2nd step : acrylamide with mixed redox system

Finish II = Ist step : pretreatment with epichlorohydrin and formaldehyde
2nd step : combination of acrylamide and DMDHEU finish

Finish III = DMDHEU finish

EFFECT OF ACRYLAMIDE DMDHEU AND THEIR COMBINATION FINISHES ON APPEARANCE RATING (POLYESTER FABRIC-C)

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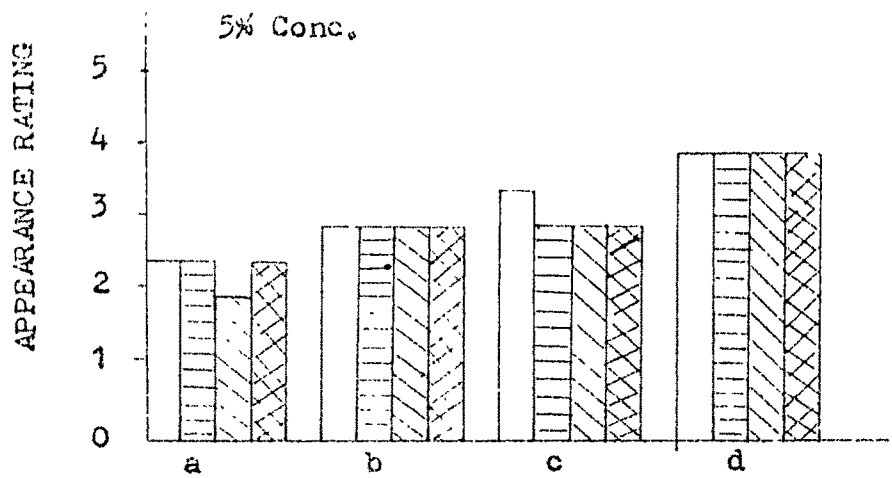
	% ADD-ON (x)	(y)
CONTROL	(o)	(o)
FINISH I	(3.1)	(2.0)
FINISH II	(5.0)	(1.9)
FINISH III	(3.0)	(1.0)

a. AFTER WRINKLING
b. TWENTY FOUR Hrs. AFTER WRINKLING
c. AFTER IRONING WITH COLD IRON
d. AFTER IRONING AT NYLON SETTING

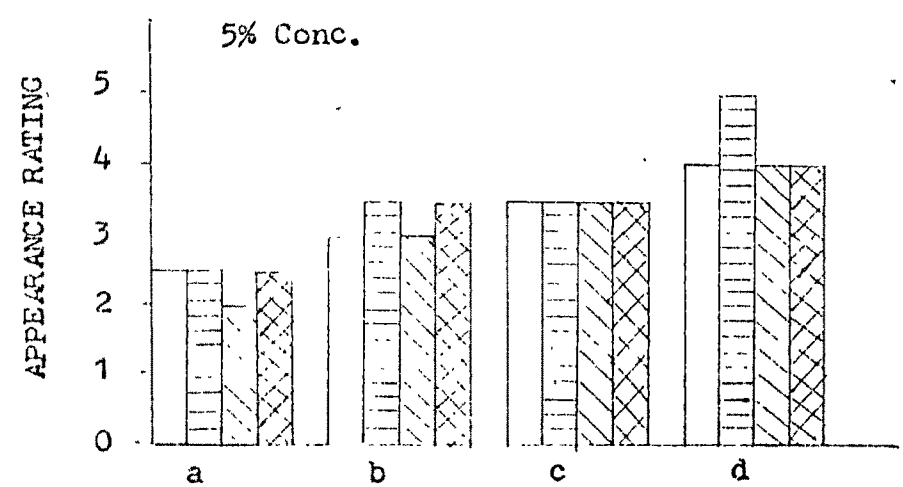
GRAPH 28

BEFORE WASHING(x)



GRAPH 29

AFTER WASHING (y)



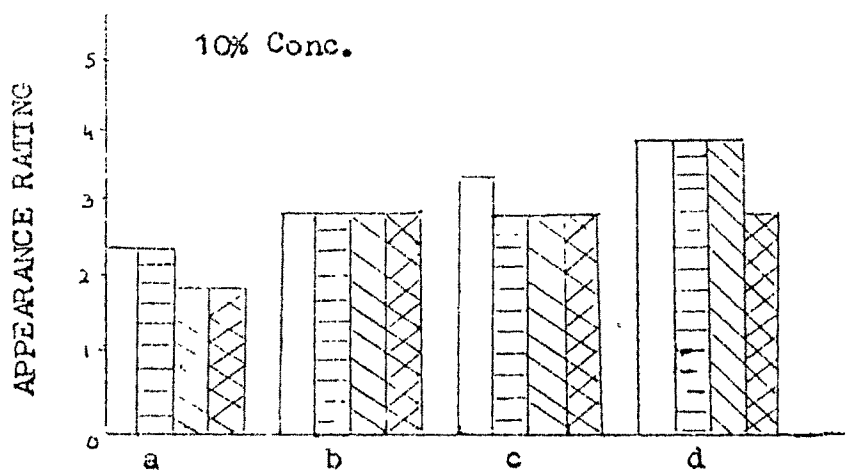
EFFECT OF ACRYLAMIDE, DMDHEU AND THEIR COMBINATION FINISHES ON APPEARANCE RATING (POLYESTER FABRIC-C)

	% ADD-ON (x)	(y)
CONTROL	(o)	(o)
FINISH I	(11.7)	(1.9)
FINISH II	(8.1)	(3.9)
FINISH III	(6.0)	(1.0)

a. AFTER WRINKLING
b. TWENTY FOUR Hrs. AFTER WRINKLING
c. AFTER IRONING WITH COLD IRON
d. AFTER IRONING AT NYLON SETTING

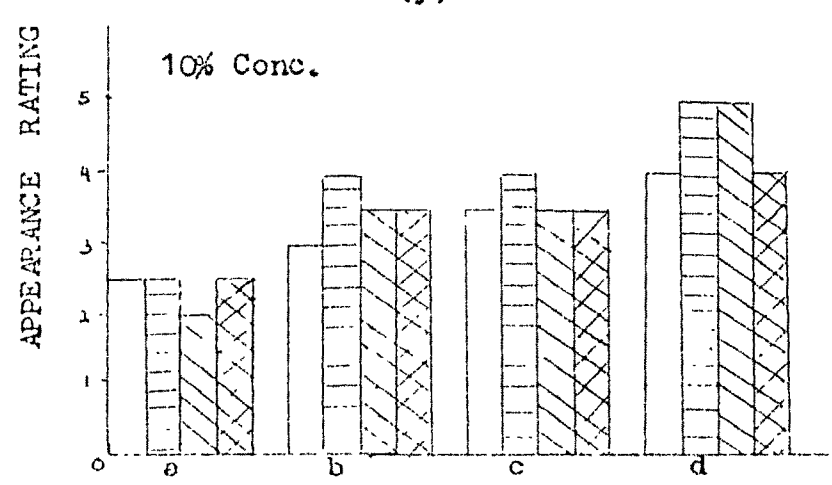
GRAPH 30.

BEFORE WASHING (x)



GRAPH 31

AFTER WASHING (y)



The durability of acrylamide and combination finishes was more than DMDHEU finish. On curing and washing higher wrinkle recovery angles were achieved with 5% acrylamide finish. With 10% acrylamide finish and the other two finishes the wrinkle recovery angles were reduced on washing.

As observed acrylamide finish I, did not sufficiently penetrate and react inside the fibre. The reaction could be enhanced by padding a precondensate to the fabric. Therefore an experiment was performed to see the difference in the reaction.

PART III

5.7 The effect of acrylamide precondensate (IX) at varying concentrations and its combination with DMDHEU III on the physical properties of fabrics.

Acrylamide precondensate (termed as finish Ix) was prepared to see its effect in comparison with acrylamide monomer (finish I). This was thus to verify that combination of acrylamide finish I and DMDHEU (III) assist to increase the wrinkle recovery (pg. 78) with less loss in tensile strength, as compared to the DMDHEU finish (III).

A precondensate of acrylamide, epichlorohydrin and formaldehyde was prepared by mixing them in 1 g/l teepol made to pH 8 (by ammonia) and left to stand at room temperature for 48

hours. (The pH was maintained at 8 throughout). The clear solution turned milky after 48 hours. (No precipitate was found on centrifuging the solution at 3000 rpm for 5 minutes). The precondensate was mixed with the mixed redox catalytic system containing ammonium persulphate and was used for padding the fabric samples. The finish on samples was allowed to react at room temperature or cured at 130° C for 5 minutes.

Composition of finish Ix and IIx of 5% and 10% concentration has been given below :

Composition		5%	10%
Finish Ix			
1. Acrylamide	..	5 gm	10 gm
2. Epichlorohydrin	..	2 ml	4 ml
3. Formaldehyde (40%)	..	2 ml	4 ml
4. Teepol (1 g/l)	..	92 ml	84 ml
5. Ammonia (25% as needed to get pH 8)	..	<1 ml	<1 ml
6. Formaldehyde (40%)	..	2 ml	4 ml
7. Hydrogen peroxide (20 vol)	..	2 ml	4 ml
8. Ammonium persulphate	..	1 gm	2 gm
Total	..	100 ml	100 ml

1 to 5 were mixed first, 6, 7, and 8 were added just before padding (formaldehyde was added in two parts as above).

Composition		5%	10%
Finish IIx			
1. Acrylamide	..	2.5 gm	5 gm
2. Epichlorohydrin	..	1 ml	2 ml
3. Formaldehyde (40%)	..	1 ml	2 ml
4. Teepol (1 g/l)	..	46 ml	42 ml
5. Ammonia (25% as needed to get pH 8)	..	<1 ml	<1 ml
6. Formaldehyde (40%)	..	1 ml	2 ml
7. Hydrogen peroxide (20 vol)	..	1 ml	2 ml
8. DMDHEU (50%)	..	2.5 ml	5 ml
9. Ammonium persulphate	..	1 gm	2 gm
10. Teepol (1 g/l)	..	47.5 ml	45 ml
Total	..	100 ml	100 ml

1 to 5 were mixed first, 6, 7, 8, 9 and 10 were added just before padding (formaldehyde and teepol were added in two parts as above).

The data on the physical properties of fabrics treated with acrylamide precondensate (finish Ix) and its combination with DMDHEU (finish IIx) has been discussed as follows :

5.7.1 Effect on wrinkle recovery

5.7.2 Effect on Stiffness

5.7.3 Effect on tensile strength

5.7.4 Effect on percent elongation

5.7.1 The effect of finish Ix and IIx, (as % add-on) on the wrinkle recovery of the treated fabrics has been given in Tables 18 and 18a and illustrated in Graphs 32-33 and 32a-33a.

TABLE 18

WRINKLE RECOVERY OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (AIR DRIED)

			% Add-on and Wrinkle Recovery			
Fabric Code	Soln. Conc. %	Control To WR	Finish Ix add-on	WR	Finish IIx add-on	WR
A	5	68	9.3	92	5.0	90
	10	68	15.7	113	9.0	113
B	5	120	6.9	130	4.0	121
	10	120	15.0	141	7.9	142
C	5	159	7.4	154	4.3	150
	10	159	14.9	148	8.2	160

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

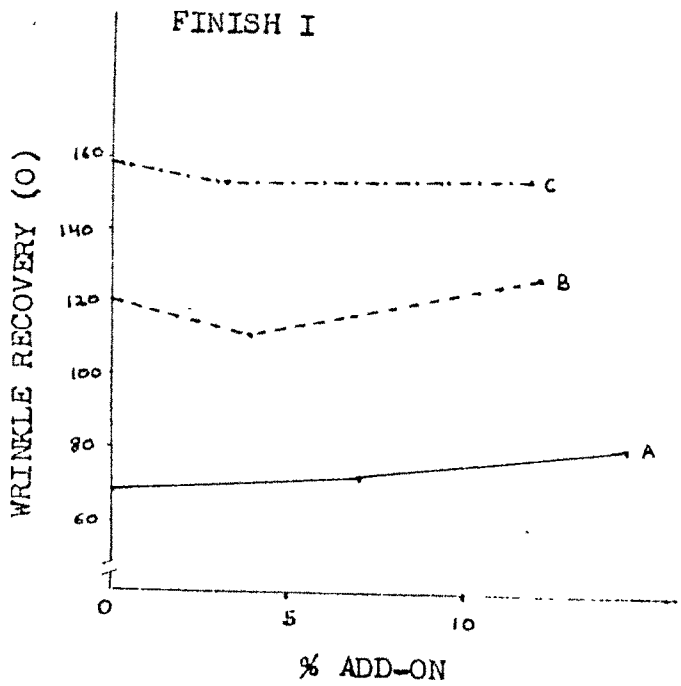
Ix = acrylamide precondensate finish

IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD-ON OF FINISH I AND FINISH II ON WRINKLE RECOVERY OF FABRICS (AIR DRIED)

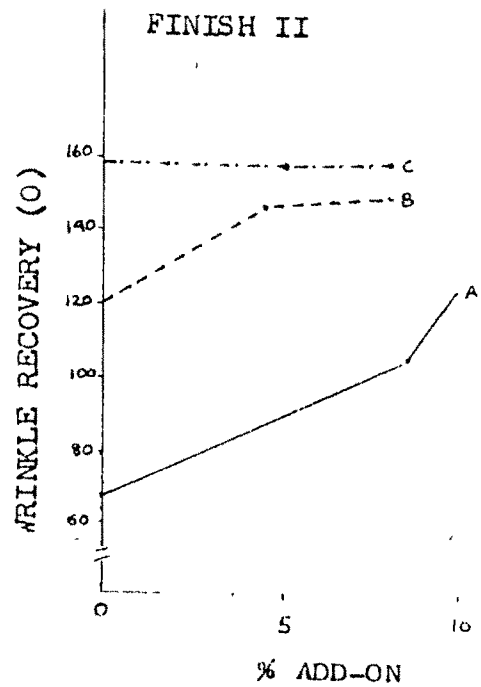
GRAPH 2

FINISH I



GRAPH 3

FINISH II



—— Cotton Fabric - A

– – – Cotton/Polyester Fabric - B

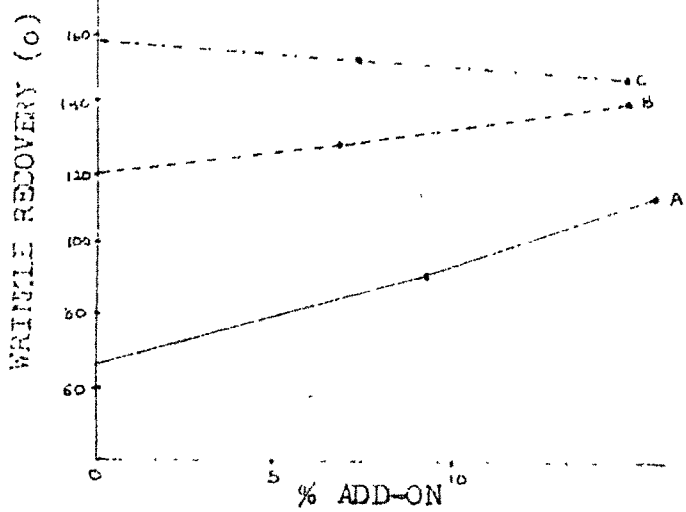
--●-- Polyester Fabric - C

Finish I Acrylamide Finish

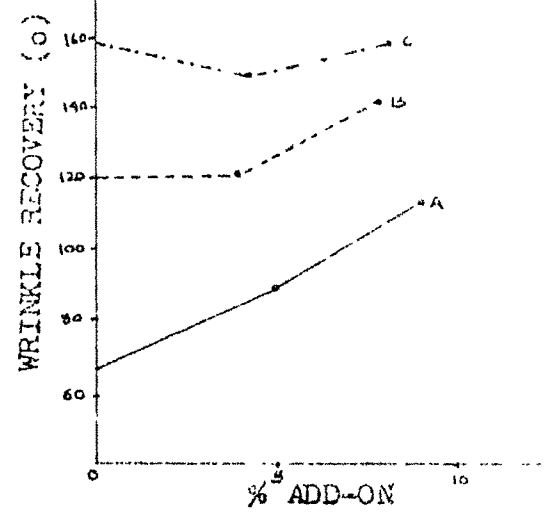
Finish II Combination Finish (I and DMDHEU Finish I

EFFECT OF ADD-ON OF FINISH Ix AND IIx ON
WRINKLE RECOVERY OF FABRICS (AIR DRIED)

GRAPH 32
FINISH Ix



GRAPH 33
FINISH IIx



——— Cotton Fabric - A
- - - - - Cotton/Polyester Fabric - B
--o-- Polyester Fabric - C

FINISH Ix = Acrylamide Precondensate Finish
FINISH IIx = Combination of (Ix) and DMDHEU

TABLE 18a

WRINKLE RECOVERY OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (CURED AT 130° C)

			% Add-on and Wrinkle Recovery (0)			
Fabric Code	Soln. Conc. %	Control To WR	Finish Ix add-on	WR	Finish IIx add-on	WR
A	5	68	9.3	119	5.0	110
	10	68	15.7	111	9.0	129
B	5	120	6.9	139	4.0	136
	10	120	15.0	145	7.9	144
C	5	159	7.4	160	4.3	157
	10	159	14.9	160	8.2	148

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

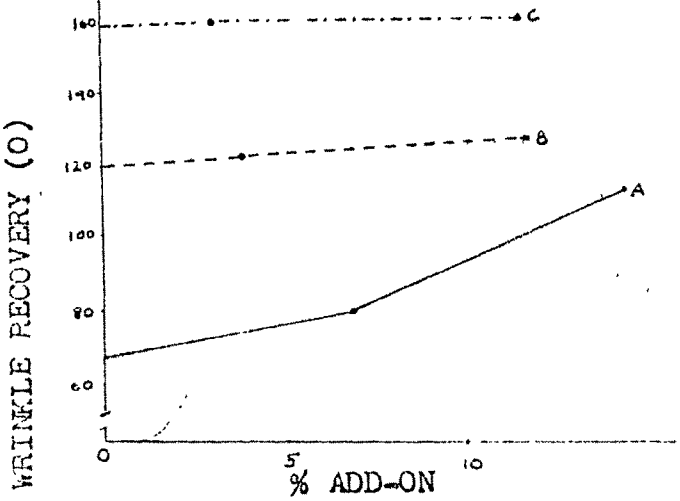
Ix = acrylamide precondensate finish

IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD-ON OF FINISH I AND FINISH II ON THE WRINKLE RECOVERY OF FABRICS (CURED AT 130° C)

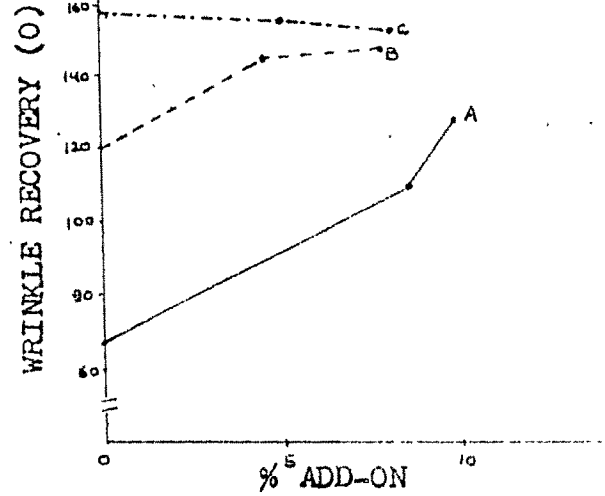
GRAPH 2a

FINISH I



GRAPH 3a

FINISH II



——— Cotton Fabric - A

– – – – Cotton/Polyester Fabric - B

—•— Polyester Fabric - C

Finish I Acrylamide Finish

Finish II Combination Finish (I and DMDHEU Finish III)

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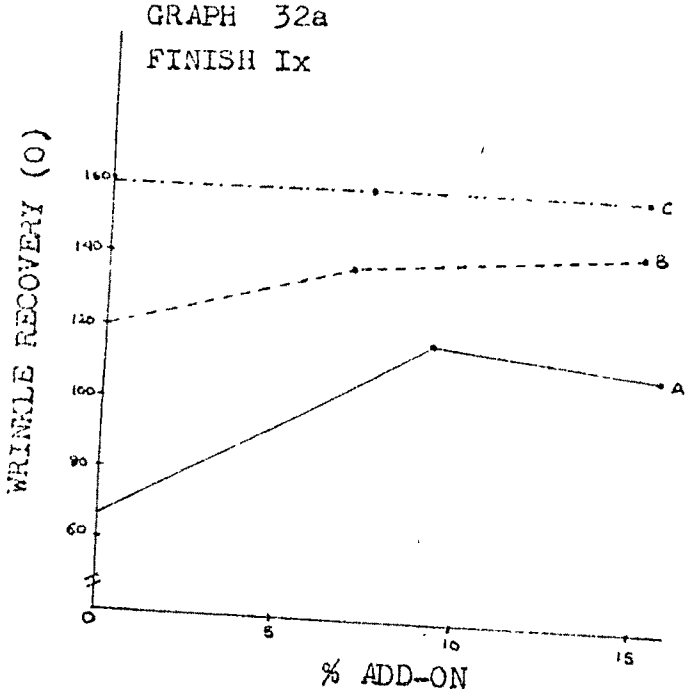
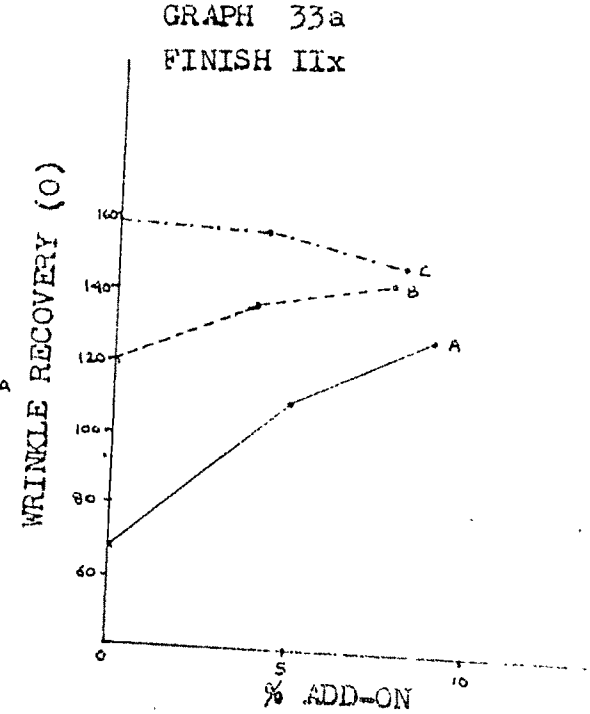
EFFECT OF ADD-ON OF FINISH Ix AND IIx ON WRINKLE RECOVERY OF FABRICS (Cured at 130°)

GRAPH 32a
FINISH Ix



GRAPH 33a
FINISH IIx



FINISH Ix = Acrylamide Precondensate Finish
FINISH IIx = Combination of Ix and DMDHEU

— Cotton Fabric - A
--- Cotton/Polyester Fabric - B
-·- Polyester Fabric - C.

Increasing add-on of finish Ix and IIx showed an increase in wrinkle recovery for cotton fabric A and cotton/polyester fabric B, little change was observed for polyester fabric C, under air dry and cure (130°C) conditions.

The increase in wrinkle recovery and so the effect of increasing add-on of finish Ix was noted to be above that was observed earlier with finish I both under air dry and cure conditions (Graphs 2,2a and 32, 32a). Finish IIx and finish II however showed similar results for wrinkle recovery (Graphs 3, 3a and 33, 33a).

5.7.2 The effect of finish Ix and IIx (as % add-on) on the stiffness of the treated fabrics has been given in Tables 19 and 19a and illustrated in Graphs 34-35 and 34a-35a.

From Graphs 34-35 it was observed that precondensate (finish Ix and IIx) decreased the stiffness of cotton fabric A whereas it increased only initially the stiffness of cotton/polyester B and polyester C fabrics. This was similar to the earlier observation with finish I and finish II (Graphs 5 and 6).

Difference was noted on curing namely that on curing, stiffness increased with add-on for cotton fabric A whereas it decreased for cotton/polyester (B) and polyester (C) fabrics with finish Ix. The more reaction of precondensate with cotton fibre as compare to non-precondensate was thus seen. In other fabrics,

TABLE 19

STIFFNESS OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (AIR DRIED)

			% Add-on and Stiffness (cms)			
Fabric Code	Soln. Conc. %	Control To S	Finish Ix add-on	S	Finish IIx add-on	S
A	5	4.4	9.3	3.8	5.0	3.7
	10	4.4	15.7	3.4	9.0	3.4
B	5	3.8	6.9	5.7	4.0	5.7
	10	3.8	15.0	5.3	7.9	5.5
C	5	3.0	7.4	4.7	4.3	4.9
	10	3.0	14.9	4.6	8.2	5.0

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

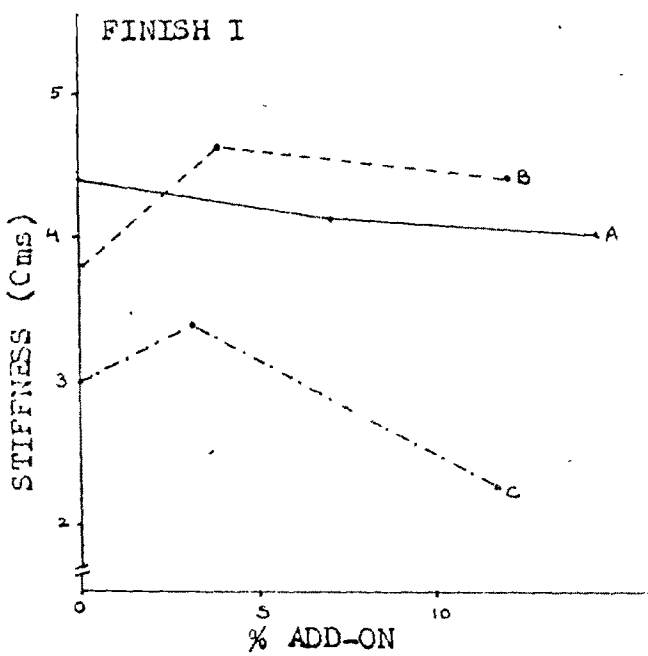
Ix = acrylamide precondensate finish

IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD ON OF FINISH I AND FINISH II ON THE STIFFNESS OF FABRICS (AIR DRIED)

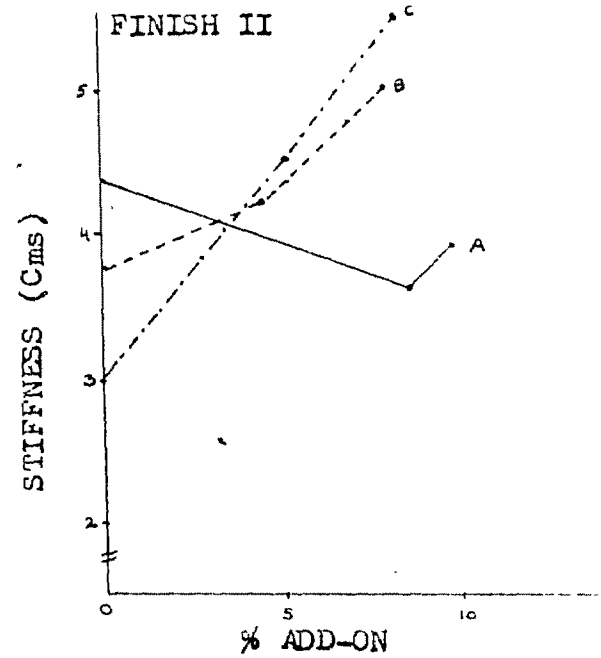
GRAPH 5

FINISH I



GRAPH 6

FINISH II



——— Cotton Fabric - A

– – – – Cotton/Polyester Fabric - B

—•— Polyester Fabric - C

Finish I Acrylamide Finish

Finish II Combination Finish
(I and DMDHEU Finish III)

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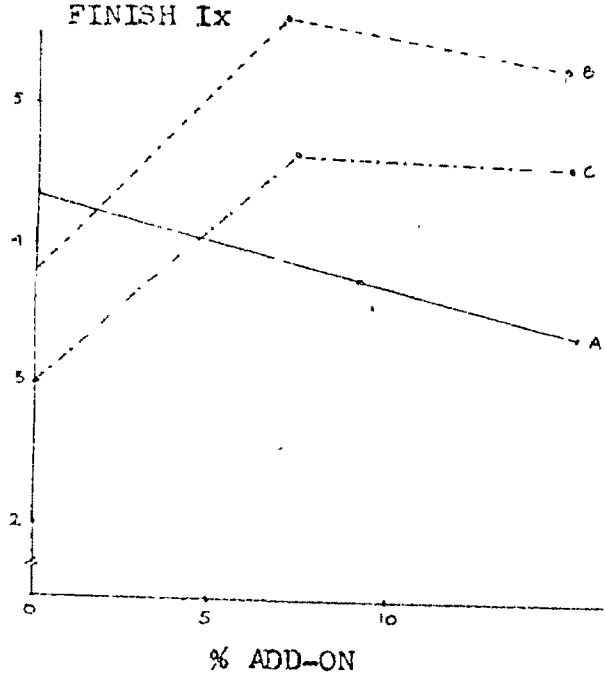
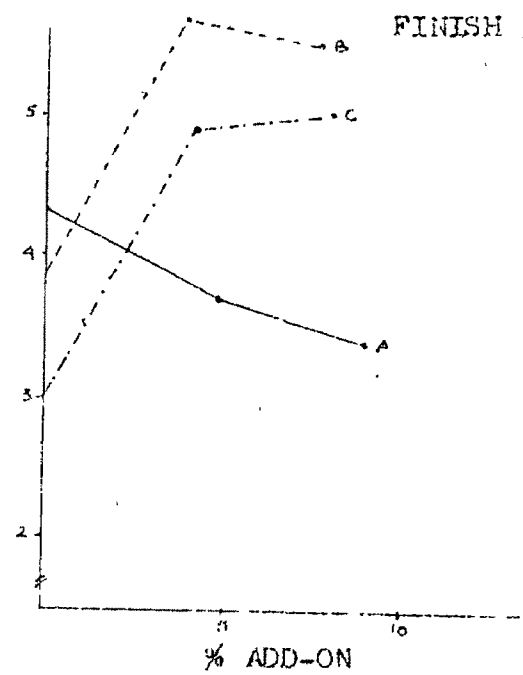
EFFECT OF ADD-ON OF FINISH Ix AND IIx ON STIFFNESS OF FABRICS (AIR DRIED)

GRAPH 34
FINISH Ix



% ADD-ON

GRAPH 35
FINISH IIx



% ADD-ON

FINISH Ix = Acrylamide Precondensate Finish

FINISH IIx = Combination of Ix and DMDHEU.

—— Cotton Fabric - A
--- Cotton / Polyester Fabric - B
-.- Polyester Fabric - C.

TABLE 19a

STIFFNESS OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (CURED AT 130°C)

		% Add-on and Stiffness (cms)			
Fabric Code	Soln. Conc. %	Control To S	Finish Ix add-on	S	Finish IIx add-on	S
A	5	4.4	9.3	4.2	5.0	3.6
	10	4.4	15.7	5.2	9.0	3.7
B	5	3.8	6.9	5.0	4.0	3.7
	10	3.8	15.0	4.5	7.9	4.2
C	5	3.0	7.4	4.1	4.3	2.9
	10	3.0	14.9	3.0	8.2	4.1

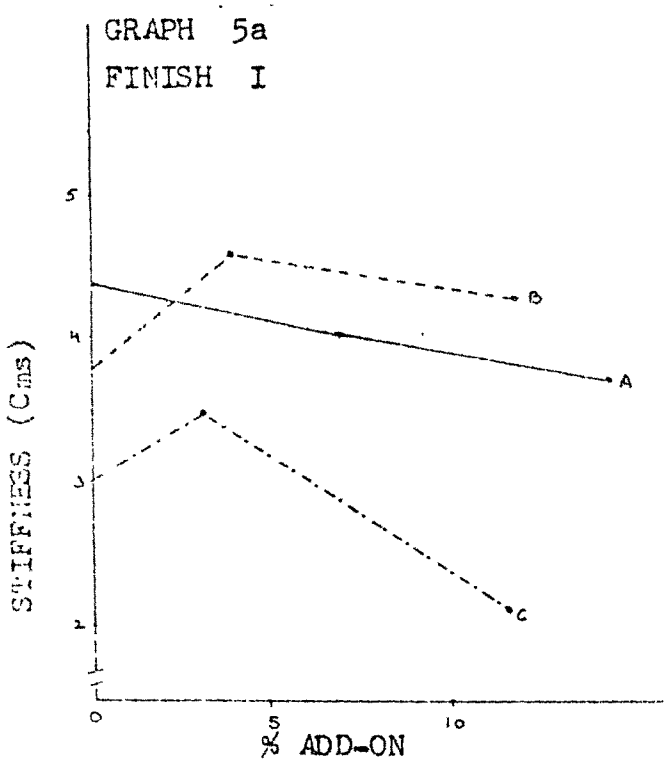
A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

Ix = acrylamide precondensate finish

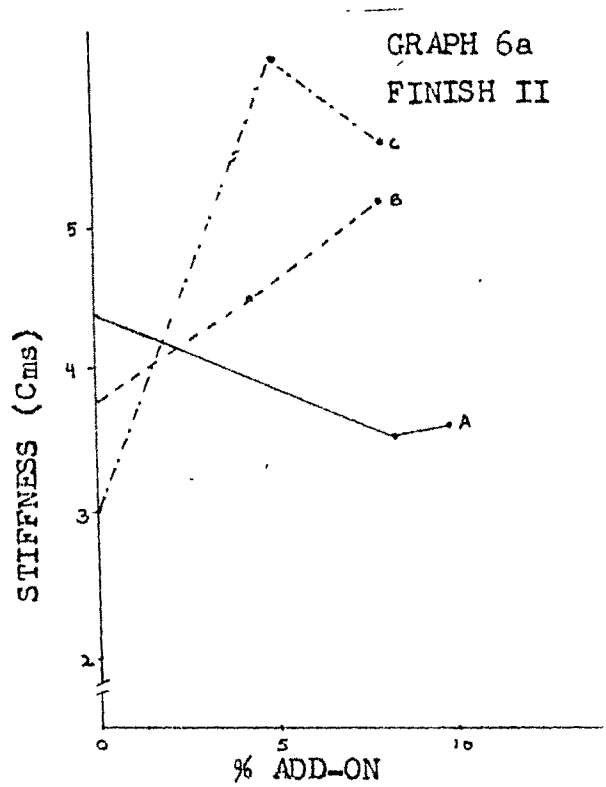
IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD ON OF FINISH I AND FINISH II ON THE STIFFNESS OF FABRICS (CURED AT 130°C)

GRAPH 5a
FINISH I



GRAPH 6a
FINISH II



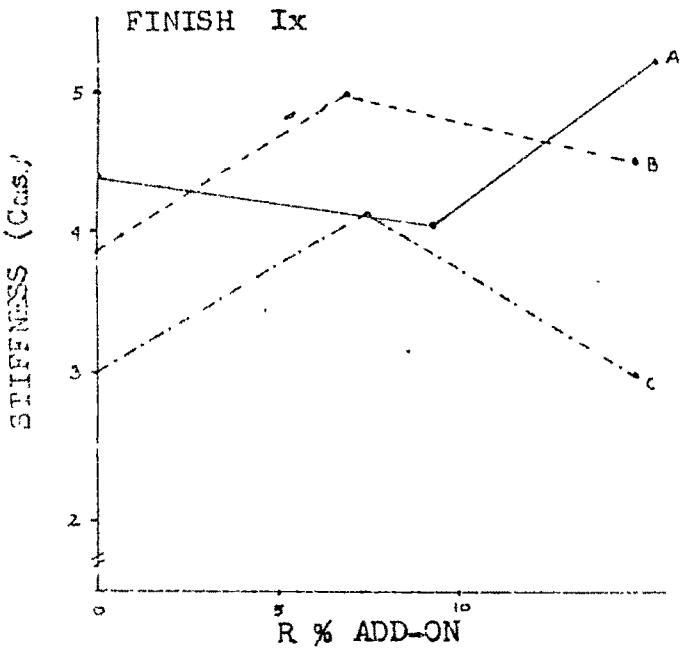
——— Cotton Fabric - A
- - - - Cotton/Polyester Fabric - B
—•— Polyester Fabric - C

Finish I Acrylamide Finish

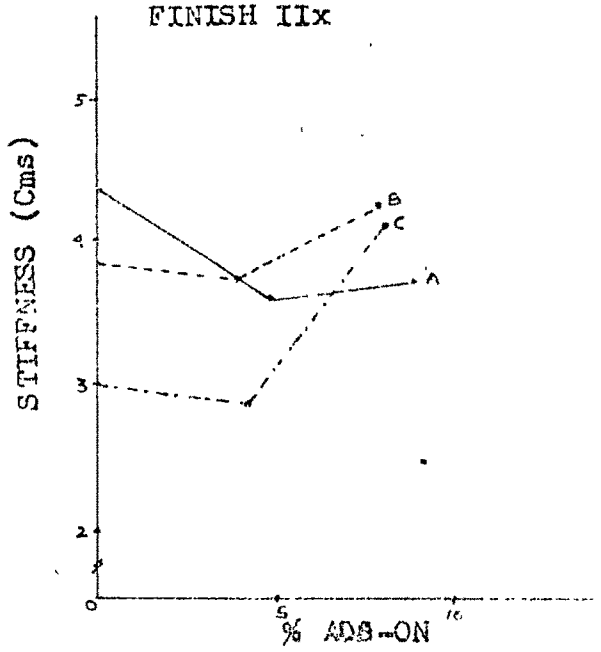
Finish II Combination Finish
(I and DMDHEU Finish III

EFFECT OF ADD-ON OF FINISH Ix AND IIx ON STIFFNESS OF FABRICS (Cured at 130°C)

GRAPH 34a
FINISH Ix



GRAPH 35a
FINISH IIx



FINISH Ix = Acrylamide Precondensate Finish

FINISH IIx = Combination of Ix and DMDHEU.

—— Cotton Fabric - A
--- Cotton / Polyester Fabric - B
-.- Polyester Fabric - C.

B and C, the thermoplastic nature of acrylamide finish could be the cause of resiliency of finish and its migration on curing.

5.7.3 The effect of finish Ix and IIx (as % add-on) on tensile strength of the treated fabrics has been given in Tables 20 and 20a and illuustrated in Graphs 36-37 and 36a-37a.

Tensile strength decreased for all fabrics with finish Ix (Graph 36). The loss in tensile strength with Ix was however less than that observed with finish I (Graph 8).

The combination of finishes in IIx tend to restore the loss in strength (Graph 37), an observation similar to combination finish II (Graph 9). The reaction of IIx being more to that of finish II was noted from further loss in strength on curing (Graph 37a).

5.7.4. The effect of finish Ix and IIx (as % add-on) on percent elongation of the treated fabrics has been given in Tables 21 and 21a and illustrated in Graphs 38-39 and 38a-39a.

Percent elongation decreased for all fabrics with finish Ix and IIx. The tendency of finish binding/reacting with fibre giving loss in elongation and then of finish binding with itself (with add-on) helping to allow elongation has been noted.

TABLE 20

TENSILE STRENGTH OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (AIR DRIED)

			% Add-on and Tensile Strength (lbs)			
Fabric Code	Soln. Conc. %	Control To TS	Finish Ix add-on	TS	Finish IIx add-on	TS
A	5	42	9.3	36	5.0	34
	10	42	15.7	34	9.0	38
B	5	33	6.9	31	4.0	36
	10	33	15.0	27	7.9	30
C	5	41	7.4	38	4.3	37
	10	41	14.9	38	8.2	40

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

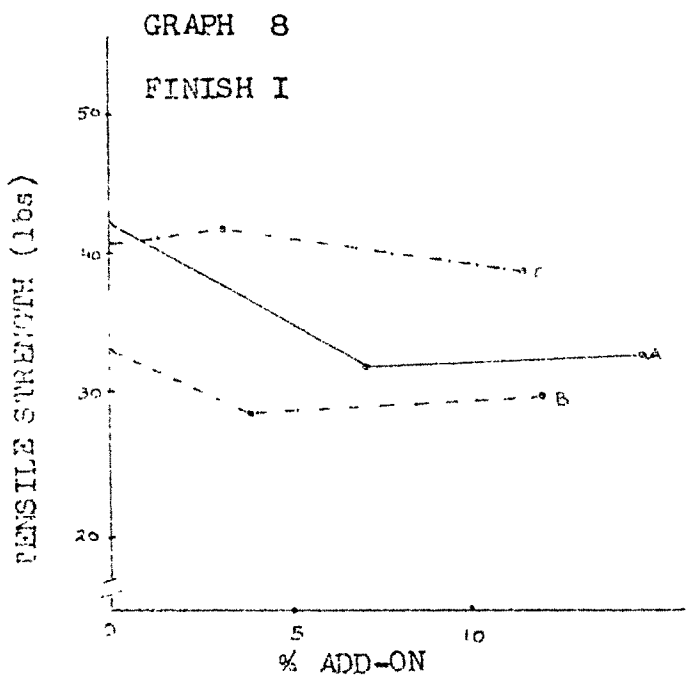
Ix = acrylamide precondensate finish

IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD-ON OF FINISH I AND FINISH II ON TENSILE STRENGTH OF FABRICS (AIR DRIED)

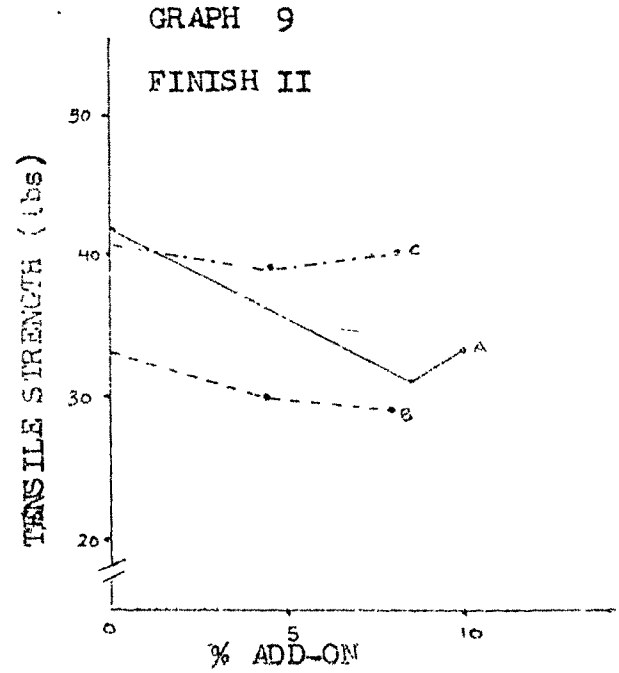
GRAPH 8

FINISH I



GRAPH 9

FINISH II



Cotton Fabric - A

Cotton/Polyester Fabric - B

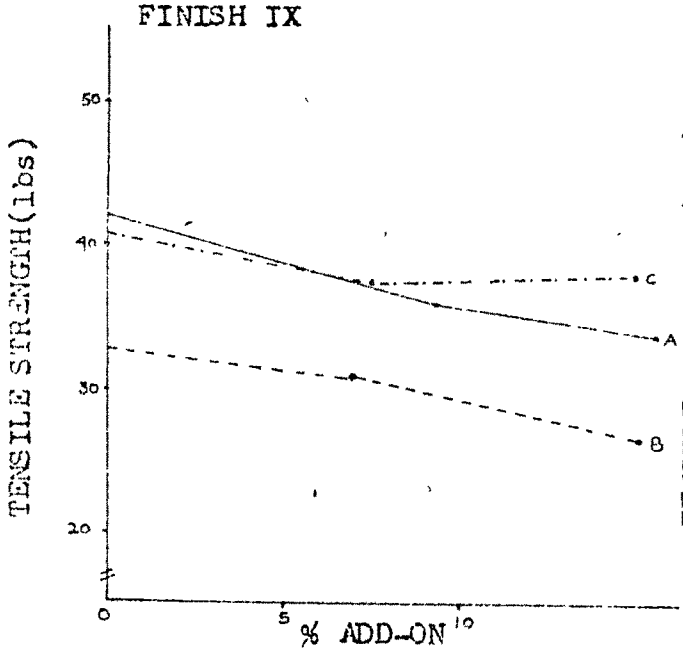
Polyester Fabric - C

FINISH I = Acrylamide Finish

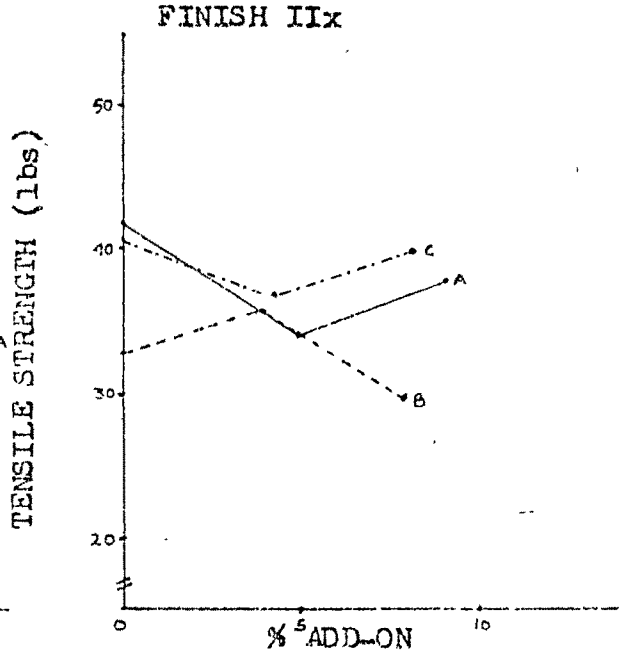
FINISH II = Combination Finish (I + DMDHEU III)

EFFECT OF ADD-ON OF FINISH Ix AND IIx
ON TENSILE STRENGTH OF FABRIC(AIR DRIED)

GRAPH 36
FINISH IX



GRAPH 37
FINISH IIx



_____ Cotton Fabric - A
---- Cotton/Polyester Fabric - B
--o-- Polyester Fabric - C

FINISH Ix = Acrylamide precondensate Fabric
FINISH IIx = Combination of Ix and DMDHEU

TABLE 20a

TENSILE STRENGTH OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (CURED AT 130° C)

% Add-on and Tensile Strength (lbs)

Fabric Code	Soln. Conc. %	Control To TS	Finish Ix add-on	Finish Ix TS	Finish IIx add-on	Finish IIx TS
A	5	42	9.3	29	5.0	35
	10	42	15.7	31	9.0	32
B	5	33	6.9	29	4.0	29
	10	33	15.0	28	7.9	29
C	5	41	7.4	38	4.3	36
	10	41	14.9	37	8.2	41

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

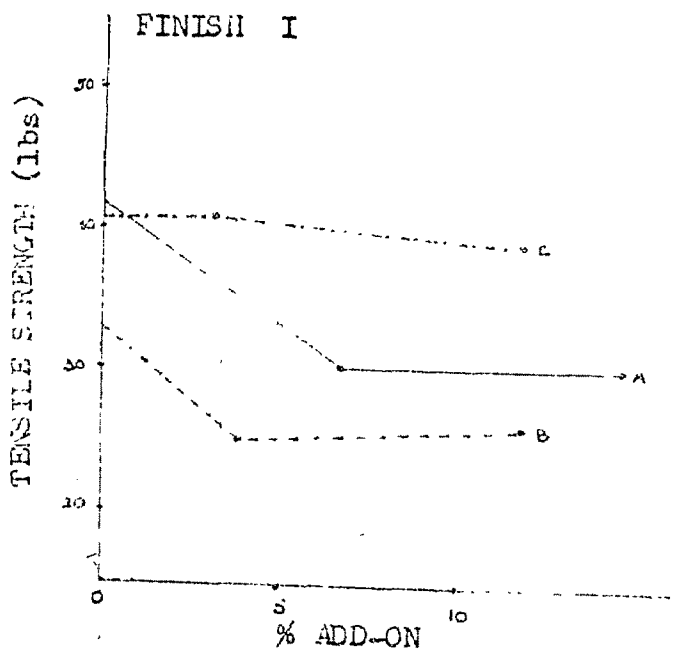
Ix = acrylamide precondensate finish

IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD-ON OF FINISH I AND FINISH II ON TENSILE STRENGTH OF FABRICS (CURED AT 130°c)

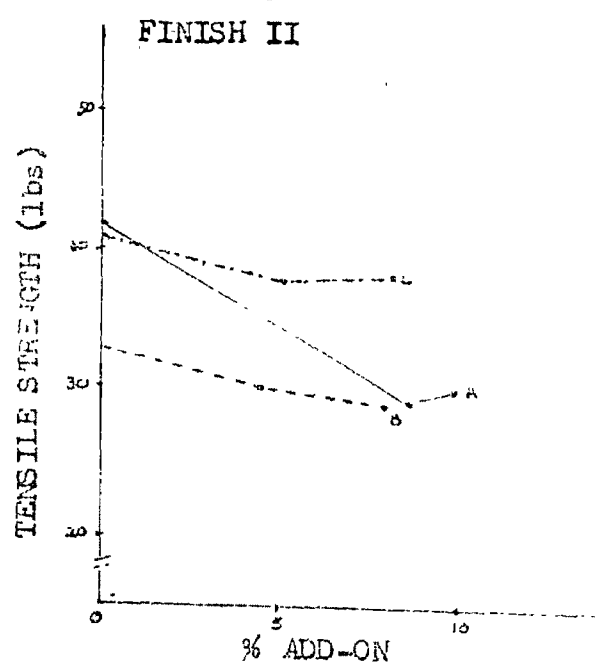
GRAPH 8a

FINISH I



GRAPH 9a

FINISH II



——— Cotton Fabric - A

– – – – Cotton/Polyester Fabric - B

—•— Polyester Fabric - C

FINISH I=Acrylamide Finish

FINISH II = Combination Fin
(I + DMDHEU III)

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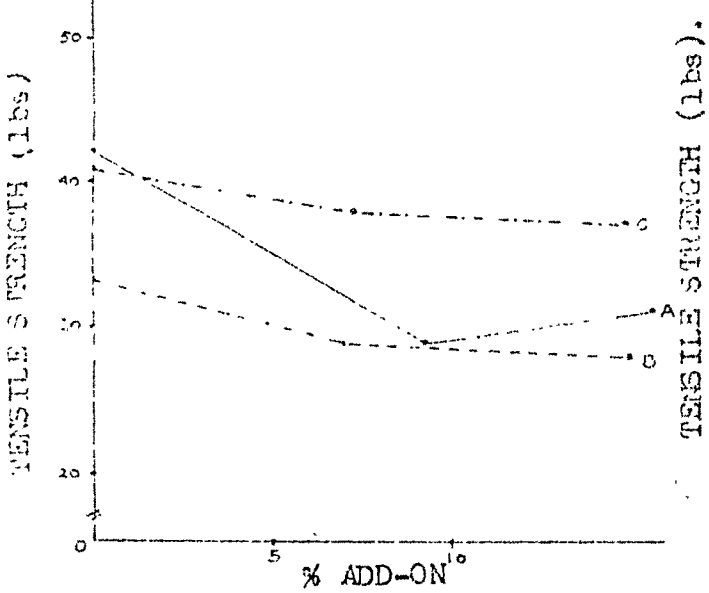
EFFECT OF ADD-ON OF FINISH Ix AND IIx ON TENSILE STRENGTH OF FABRICS (Cured at 130°)

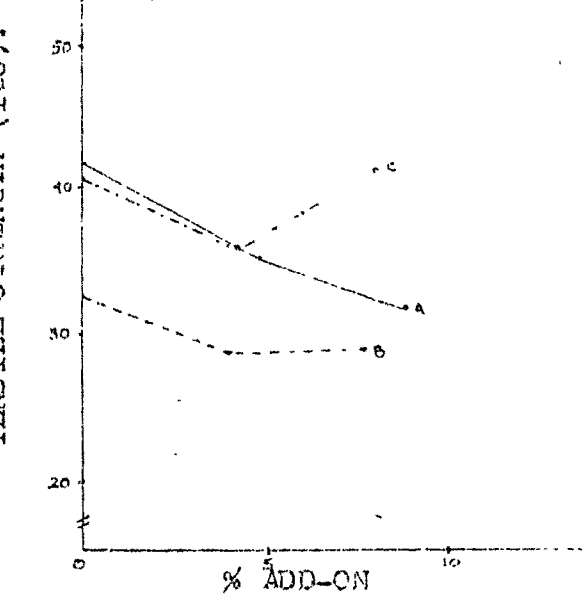
GRAPH 36a

FINISH Ix



GRAPH 37a

FINISH IIx



——— Cotton Fabric - A

- - - - - - Cotton/Polyester Fabric - B

--o-- Polyester Fabric - C

FINISH Ix =Acrylamide Finish

FINISH IIx=Combination of Ix and DMDHEU

TABLE 21

PERCENT ELONGATION OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (AIR DRIED)

			% Add-on and % Elongation			
Fabric Code	Soln. Conc. %	Control To E	Finish Ix add-on	E	Finish IIx add-on	E
A	5	25	9.3	15	5.0	23
	10	25	15.7	18	9.0	20
B	5	13	6.9	9	4.0	11
	10	13	15.0	10	7.9	12
C	5	41	7.4	27	4.3	26
	10	41	14.9	30	8.2	26

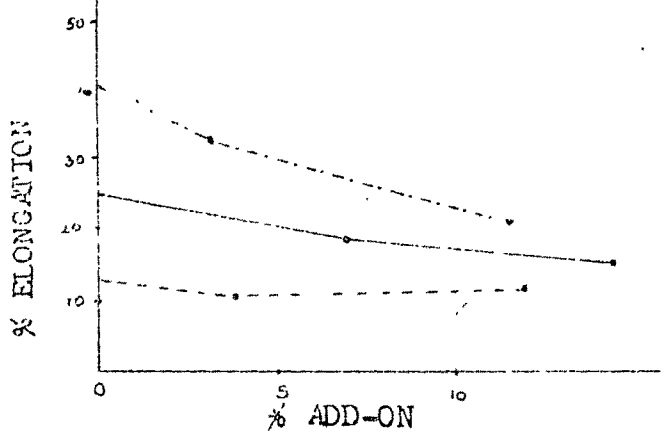
A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

Ix = acrylamide precondensate finish

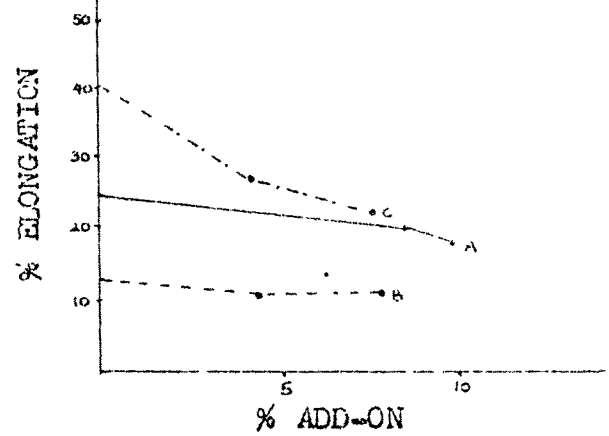
IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD-ON OF FINISH I AND FINISH II ON PERCENT ELONGATION (AIR DRIED)

GRAPH 11
FINISH I



GRAPH 12
FINISH II



——— Cotton Fabric - A

–·–·– Cotton/Polyester Fabric - B

---o--- Polyester Fabric - C

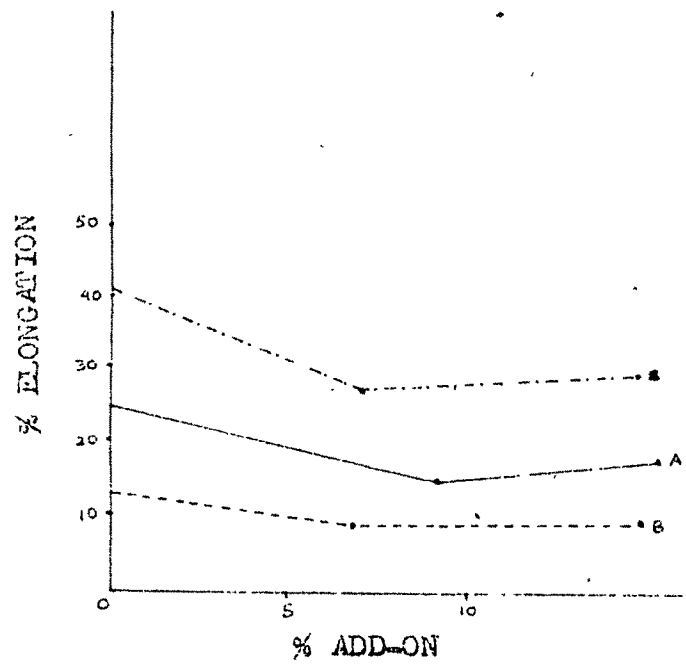
FINISH I =Acrylamide Finish

FINISH II = Combination Finish (I+DMDHEU III)

EFFECT OF ADD-ON OF FINISH Ix AND IIx ON
PERCENT ELONGATION OF FABRICS (AIR DRIED)

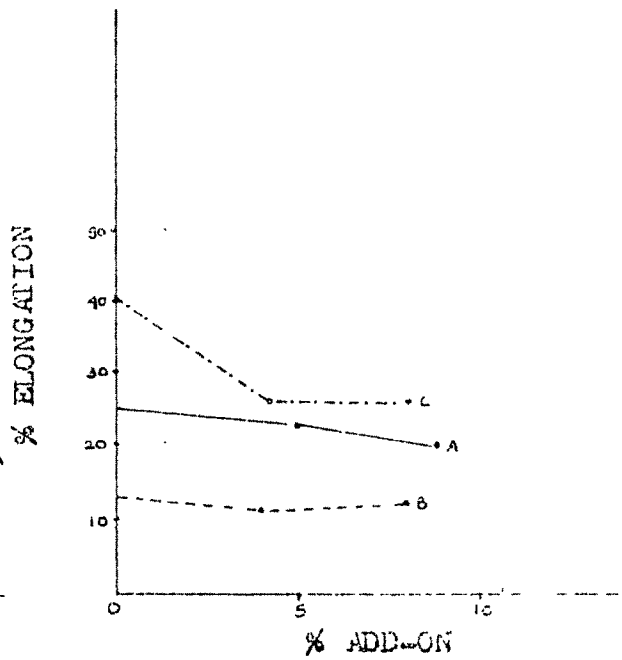
GRAPH 38

FINISH Ix



GRAPH 39

FINISH IIx



——— Cotton Fabric - A
------ Cotton/Polyester Fabric - B
---•--- Polyester Fabric - C

FINISH Ix = Acrylamide Precondensate Finish
FINISH IIx = Combination of Ix and DMDHEU

TABLE 21a

PERCENT ELONGATION OF FABRICS (WARP) AT VARYING ADD-ON OF ACRYLAMIDE PRECONDENSATE AND ITS COMBINATION WITH DMDHEU (CURED AT 130° C)

			% Add-on and % Elongation			
Fabric Code	Soln. Conc. %	Control To E	Finish Ix add-on	E	Finish IIx add-on	E
A	5	25	9.3	15	5.0	15
	10	25	15.7	15	9.0	17
B	5	13	6.9	10	4.0	14
	10	13	15.0	10	7.9	16
C	5	41	7.4	22	4.3	23
	10	41	14.9	21	8.2	26

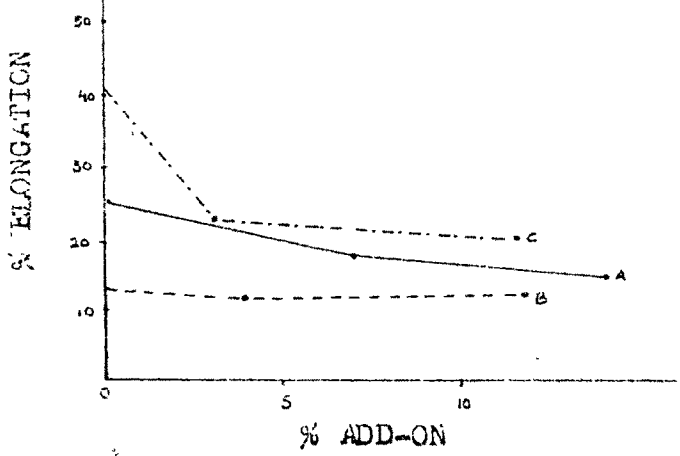
A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

Ix = acrylamide precondensate finish

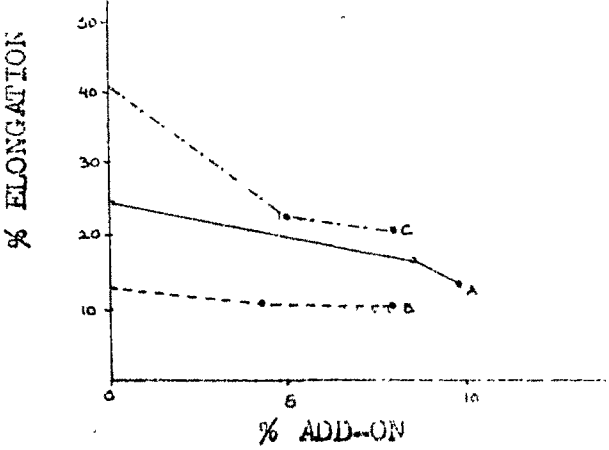
IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

EFFECT OF ADD-ON OF FINISH I AND FINISH II ON PERCENT ELONGATION OF FABRICS (CURED AT 130°C)

GRAPH 11a
FINISH I



GRAPH 12a
FINISH II



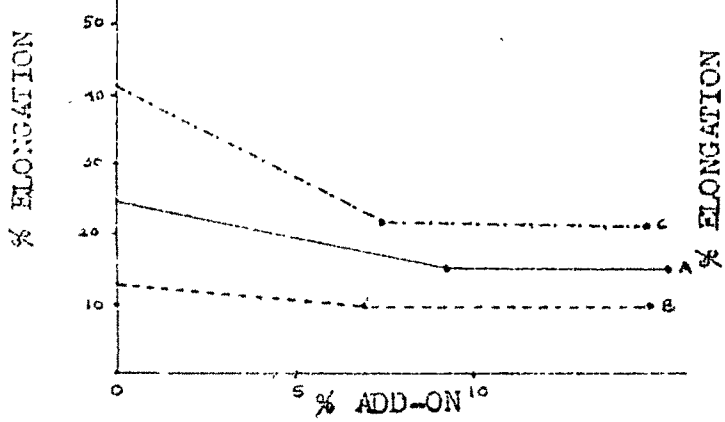
——— Cotton Fabric - A
------ Cotton/Polyester Fabric - B
---o--- Polyester Fabric - C

FINISH I = Acrylamide Finish
FINISH II = Combination Fini
(I+DMDHEU III)

EFFECT OF ADD-ON OF FINISH Ix AND IIx ON
PERCENT ELONGATION OF FABRICS (Cured at 130°C)

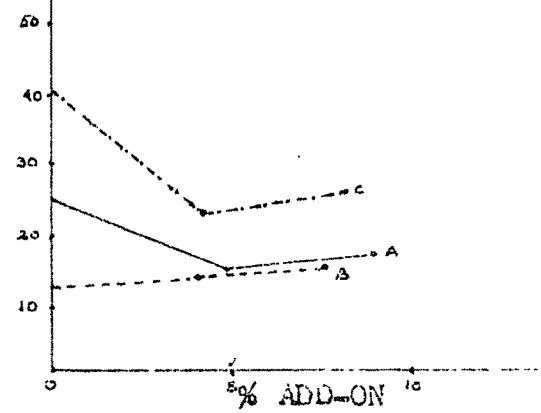
GRAPH 38a

FINISH Ix



GRAPH 39a

FINISH IIx



——— Cotton Fabric - A

----- Cotton/Polyester Fabric - B

--o-- Polyester Fabric - C

FINISH Ix = Acrylamide Precondensate Finish

FINISH IIx = Combination of Ix and DMDHEU

As compared to the acrylamide finish I, acrylamide precondensate, finish Ix seemed to have a better reaction with the fibre. Cotton and cotton/polyester fabrics could be better treated with an acrylamide precondensate for an improvement in properties. With the precondensate, a reaction (like crosslinking) seemed to have been achieved, as seen from increase in wrinkle recovery angle. The combination of acrylamide precondensate and DMDHEU (finish IIx) also showed an increase in wrinkle recovery in cotton and cotton/polyester fabrics, in comparison to non-precondensate combination II.

The increase in wrinkle recovery with acrylamide precondensate Ix can be very well compared with DMDHEU III. Acrylamide precondensate Ix behaved like a thermosetting finish, it also improved the wrinkle recovery as it can penetrate the fibre. It helped some strength retention due to some thermoplasticity.

The nature of the reaction here in was expected to be as follows :

Cell-O-CH_2-NH-CO-CH_2-CH_2-O-Cell

5.8 Analysis of finishes Ix and IIx for durability

The retention of wrinkle recovery and stiffness, on washing, of the samples were compared with percent add-on.

TABLE 22

FINISH CONTENT, AS PERCENT ADD-ON AT VARYING CONCENTRATIONS (AIR DRIED)

% Add-on and % Retention

Finish and Conc.	A X	A Y (% R)	B X	B Y (% R)	C X	C Y (% R)
Control	0	0	0	0	0	0
Ix 5%	9.3	1.6 (17.2)	6.9	2.6 (37.6)	7.4	1.86 (25.0)
Ix 10%	15.7	1.95 (12.4)	15.0	1.6 (10.6)	14.9	2.6 (17.4)
IIx 5%	5.0	1.77 (35.4)	4.0	1.8 (45.0)	4.3	0.99 (23.0)
IIx 10%	9.0	2.75 (30.5)	7.9	2.06 (26.0)	8.2	2.1 (25.6)

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish Ix = acrylamide precondensate finish

Finish IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

TABLE 22a

FINISH CONTENT, AS PERCENT ADD-ON AT VARYING CONCENTRATIONS (CURED AT 130° C)

% Add-on and % Retention

Finish and Conc.	A X	A Y (% R)	B X	B Y (% R)	C X	C Y (% R)
Control	0	0	0	0	0	0
Ix 5%	9.3	5.8 (62.3)	6.9	3.85 (55.7)	7.4	3.66 (49.4)
Ix 10%	15.7	11.0 (70.0)	15.0	7.6 (50.6)	14.9	8.7 (58.3)
IIx 5%	5.0	2.6 (52.0)	4.0	2.4 (60.0)	4.3	1.35 (31.3)
IIx 10%	9.0	4.96 (55.0)	7.9	4.02 (53.1)	8.2	4.5 (54.8)

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish Ix = acrylamide precondensate finish

Finish IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

TABLE 23

WRINKLE RECOVERY OF FINISHED FABRICS (AIR DRIED)

Finish and Conc.		A		B		C	
		X	Y	X	Y	X	Y
Control		68	68	120	120	159	159
Ix	5%	92	81	130	128	154	159
	10%	113	78	141	142	148	163
IIx	5%	90	85	121	121	150	159
	10%	113	117	142	132	160	154

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish Ix = acrylamide precondensate finish

Finish IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

TABLE 23a

WRINKLE RECOVERY OF FINISHED FABRICS (CURED AT 130° C)

Finish and Conc.		A		B		C	
		X	Y	X	Y	X	Y
Control		68	68	120	120	159	159
Ix	5%	119	124	139	138	160	164
	10%	111	114	145	141	160	161
IIx	5%	110	113	136	140	157	153
	10%	129	131	144	141	148	147

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish Ix = acrylamide precondensate finish

Finish IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

TABLE 24

STIFFNESS OF FINISHED FABRICS (AIR DRIED)

Finish and Conc.	A		B		C	
	X	Y	X	Y	X	Y
Control	4.4	4.4	3.8	3.8	3.0	3.0
Ix 5%	3.8	4.1	5.7	4.1	4.7	3.2
Ix 10%	3.8	3.4	5.2	4.2	4.5	3.7
IIx 5%	3.7	3.6	5.7	3.3	4.9	3.0
IIx 10%	3.4	3.3	5.5	3.3	5.0	3.2

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

Y = after washing

Finish Ix = acrylamide precondensate finish

Finish IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

TABLE 24a

STIFFNESS OF FINISHED FABRICS (CURED AT 130° C)

Finish and Conc.	A		B		C	
	X	Y	X	Y	X	Y
Control	4.4	4.4	3.8	3.8	3.0	3.0
Ix 5%	4.2	4.1	5.0	5.0	4.1	3.2
Ix 10%	5.2	4.9	4.5	3.8	3.0	2.9
IIx 5%	3.7	3.2	3.7	3.1	2.9	3.0
IIx 10%	3.7	3.3	4.2	3.4	4.1	3.1

A = 100% cotton; B = 30/70 cotton/polyester; C = 100% polyester

X = before washing

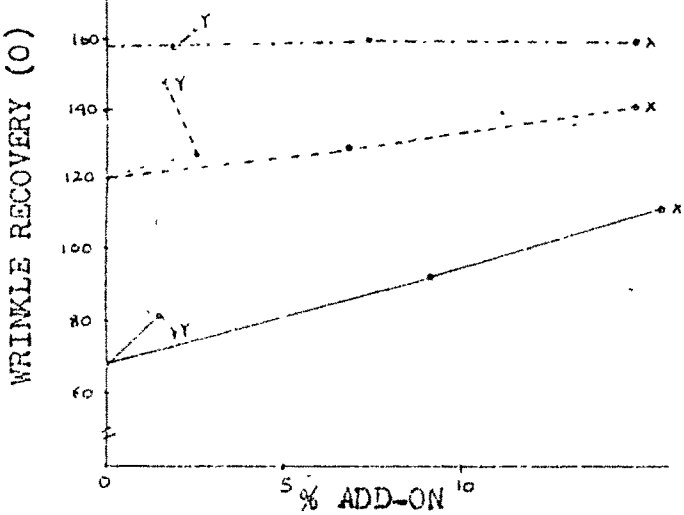
Y = after washing

Finish Ix = acrylamide precondensate finish

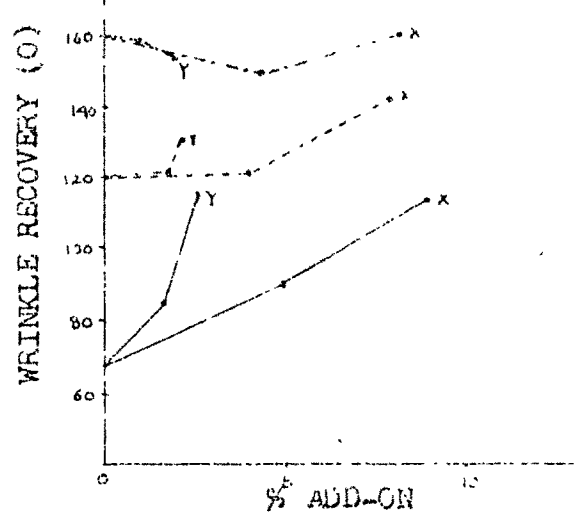
Finish IIx = combination of acrylamide precondensate (Ix) and DMDHEU finish III

RELATIONSHIP BETWEEN WRINKLE RECOVERY AND PERCENT ADD-ON ON FABRICS BEFORE AND AFTER WASHING(AIR DRIED)

GRAPH 40
FINISH Ix



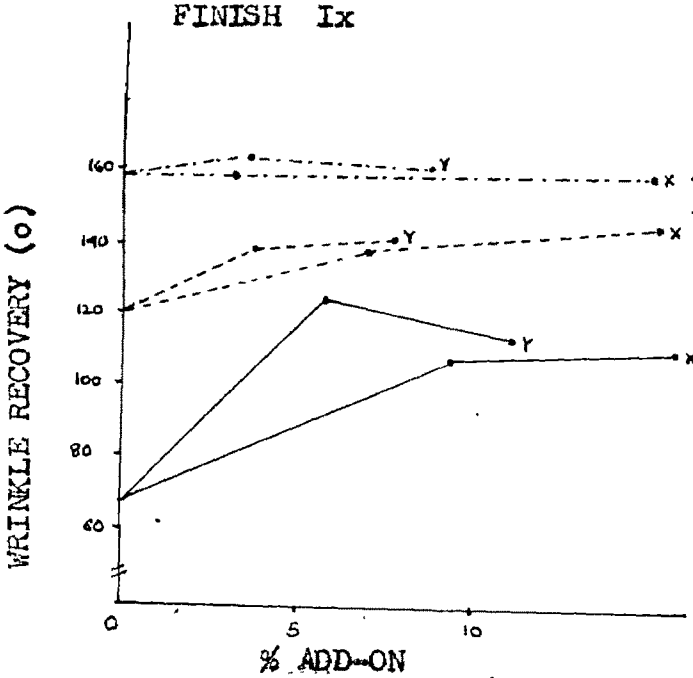
GRAPH 41
FINISH IIx



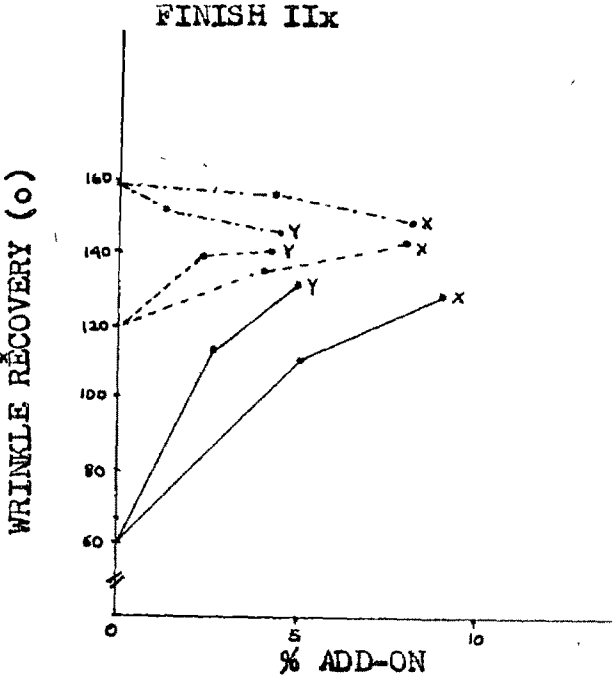
——— Cotton Fabric - A
– – – – Cotton/Polyester Fabric - B
–·–·– Polyester Fabric
x = before washing
y = after washing
Ix = Acrylamide Precondensate Finish
IIx = Combination of Ix and DMDHEU

RELATIONSHIP BETWEEN WRINKLE RECOVERY AND PERCENT ADD-ON BEFORE AND AFTER WASHING (Cured at 130°C).

GRAPH 40a
FINISH Ix



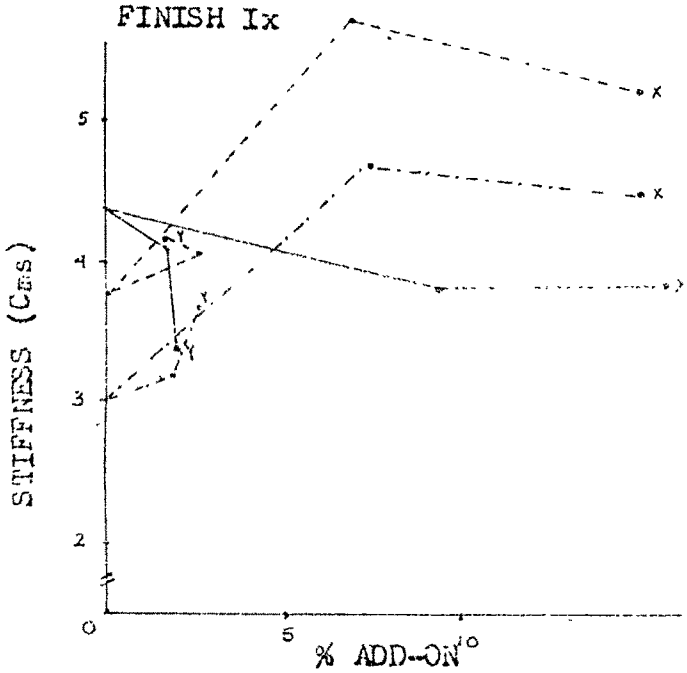
GRAPH 41a
FINISH IIx



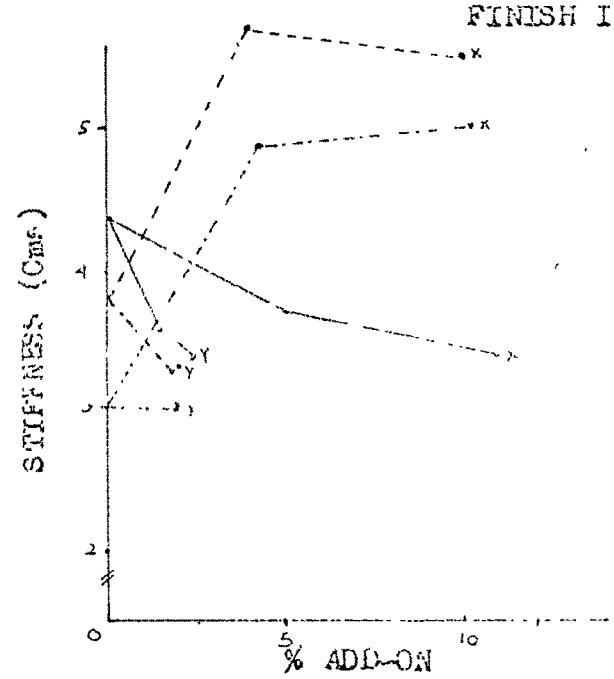
——— Cotton Fabric -A
----- Cotton/Polyester Fabric - B
--o-- Polyester Fabric - C
x = before washing
y = after washing
Ix = Acrylamide precondensate Finish
IIx= Combination of Ix and DMDHEU

RELATIONSHIP BETWEEN STIFFNESS AND PERCENT ADD-ON ON FABRICS BEFORE AND AFTER WASHING (AIR DRIED)

GRAPH 42
FINISH Ix



GRAPH 43
FINISH IIx



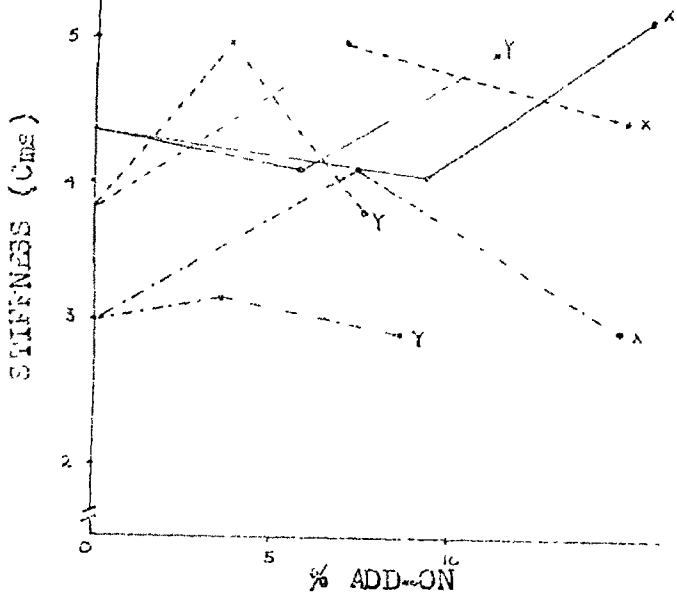
——— Cotton Fabric - A
– – – – – Cotton/Polyester Fabric - B
–·–·– Polyester Fabric - C

x = before washing
y = after washing
Ix = Acrylamide Precondensate Finish
IIx = Combination of Ix and DMDHEU

RELATIONSHIP BETWEEN STIFFNESS AND PERCENT ADD-ON
BEFORE AND AFTER WASHING (Cured at 130°C)

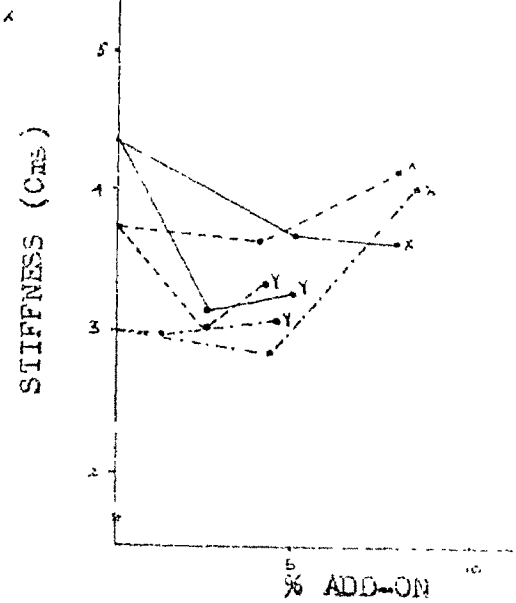
GRAPH 42a

FINISH Ix



GRAPH 43a

FINISH IIx



——— Cotton Fabric - A
– – – – Cotton/Polyester Fabric - B
– – • – – Polyester Fabric - C
x = before washing
y = after washing
Ix = Acrylamide precondensate Finish
IIx = Combination of Ix and DMDHEU

From the results shown in Table 22 and 22a it was observed that, in general, finished samples, (air dried) on washing lost considerable add-on. On curing the retention of add-on (Table 22a) improved to 60-70% from its very low value before curing.

Finished samples (air dried) on washing lost the wrinkle recovery and stiffness with the loss in percent add-on (Tables 23-24). The retention of properties was observed in the case of samples cured at 130°C in comparison to air dried samples. (Tables 23a-24a and Graphs 40-43 and 40a-43a).

Samples treated with combination finish, IIx, showed better retention of properties and of add-on in comparison to Ix. The effect of DMDHEU in the combination was thus observed.

Microscopic examination of acrylamide finish and acrylamide precondensate finish Ix.

Finishes from cotton fabric treated with acrylamide finish I and acrylamide precondensate finish Ix were extracted with 80% acetone. Weighed samples (1 gm) were kept in a covered beaker and 80% acetone was added (1:10 material : liquor ratio). The sample was then removed after 15 minutes. The solution was left to dry. The dried solid content was weighed. The extract of the finish was observed under a microscope, by allowing a drop or two to dry on a glass slide. (Microscopic views are given on next page).

	Finish I	Finish Ix
% Add-on	14.6	15.7
% extracted	5.0	3.9
% retention	9.6	11.8

These values were comparable to % retention values of finishes of fabric A by washing (pg. 99 & 150).

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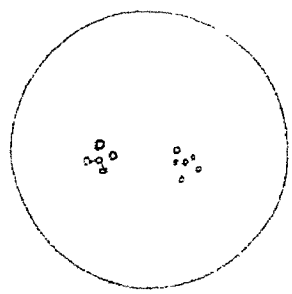
MICROSCOPIC VIEW

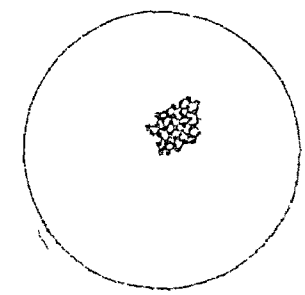
Acrylamide finish
I



Molecules observed
to be scattered
and not so close

(Less of reaction)

Acrylamide precondensate
Ix



Molecules observed to
be very closely joined
like a polymer network

(More of reaction)