EVALUATION OF EFFICACY OF MELAMINE TREATMENT ON COTTON FABRICS

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Melamine resin-treated cotton fabric was exposed to outdoor weathering for 12 months at Kanpur to study its efficacy against weathering degradation. Along with this, fabrics treated with (*i*) hydrated oxides of copper + manganese (*ii*) nickel naphthenate and (*iii*) urea-formaldehyde resin, were also exposed to find out the most efficacious treatment of these. Pre-monsoon exposure of the three sets commenced from 29th of April, May and June '65 respectively. Breaking strength and tear strength data for 12 months exposure have revealed that treatment with hydrated oxides of copper + manganese affords maximum protection to cotton fabrics against weathering degradation irrespective of the month of exposure. Urea-formaldehyde resin and nickel naphthenate treatments are the next best. Melamine treatment is equally good as hydrated oxides of copper+manganese if the results are based on breaking strength alone but considering loss in tear strength it gave a poor performance. All the treatments have been found to afford protection against irradiation from mercury arc lamp (rich in ultra-violet light). Melamine and urea-formaldehyde resin treatments were found completely resistant to microbiological attack in soil burial.

In recent years studies have been undertaken by several workers[1—5] on protection of cotton textiles from microbiological, actinic and weathering degradations. Traditionally fungicides have been used to inhibit the growth of micro-organisms and some have been found quite effective. However, most of them lack durability and discolour the fabric, while others increase photo-chemical degradation. Many workers [1—4,6,7] have shown that resin-impregnated cotton textiles exhibit resistance against microbiological attack and this resistance increases with the amount of resin used. Urea-formaldehyde resin treatment[4] has been found to possess resistance against microbiological, actinic and weathering degradations. This holds good for the melamine[1—3] formaldehyde type of resins also.

This report summarises results of testing of melamine treated fabrics when subjected to microbiological attack, ultraviolet irradiation and weathering degradation in hot-humid climate. Efficacy of this treatment has also been compared with other treatments i.e. urea-formaldehyde resin[4], hydrated oxides of copper+managanese[8] and nickel naphthenate which have been found quite effective in hot-humid climate.

MATERIALS AND METHODS

(*a*) *Cellulosic fabric:*

Thoroughly scoured undyed cotton dosuti (240 gm/sq. m.) was used in these experiments.

(*b*) *Methods of treatment :*

(*i*) *Melamine treatment :* Melamine was mixed with formalin (37% w/w) in the ratio of 1 : 2 and boiled for 10–12 mts. under reflux at 9-10 *pH*. After cooling to room temperature, it was diluted with 20 per cent formic acid solution and the concentration adjusted to 16–17° Tw.

Scoured cotton dosuti was kept immersed in the formic acid colloid solution of melamine for about 20 mts. and given three ends in padding mangle. The hold-up was adjusted to 95–100 per cent. The treated fabric was air-dried and baked for4–5 mts. at 140°C. The baked fabric was washed in hot water (80°C) and air dried. The add-on of melamine resin was 11–12 per cent.

(*ii*) The methods of treatment with hydrated oxides of copper+manganese, nickel naphthenate and urea-formal-dehyde resin were the same as described earlier[4,8].

(*c*) *Weathering exposure :*

The efficacy of each treatment was assessed by exposing the treated fabrics along-with untreated controls to out-door weathering at Kanpur (Latitude 26°, 28′ N; Longitude 80°, 21′ E and altitude 416 ft. above m.s.l.). In order to study the effect of pre-monsoon period, exposure of three sets commenced from 29th of April, May and June 1965 respectively and continued for 12 months.

One yard square panels of the fabrics were fixed on wooden frames and mounted on racks 4 ft. above the ground at an inclination of 45° facing south. The samples were drawn initially and after every month for a total period of 12 months. The extent of degradation was assessed by subjecting the samples to the following test :

(*i*) *Breaking strength*: This was determined after conditioning the test samples at 21°C and 65–70% R.H. for 48 hrs. The pieces were broken warpwise ($2'' \times 6\frac{5}{8}''$ between grips) in a cloth testing machine, in which the test piece was stretched at a constant rate of 18 inches per minute.

(*ii*) *Tear strength* : The tear strength was measured through weft, after conditioning the samples at 21°C and 65–70% R.H. for 48 hours, by Single Rip Method[9].

(*iii*) *Microbiological tests*: The treated and untreated fabrics were subjected to soil burial test as per method given in specification No. IS. 1389, 1959.

(*iv*) *Copper number* : Copper number of the samples was estimated by the method of Clibbens and Geake[10].

(*v*) *Estimation of nitrogen* : Nitrogen content of the resin treated cotton fabrics was determined by Kjeldahl's Method as described by Koch Frederick & Hanke Martin[11].

(d) Ultra violet irradiation:

The treated and untreated fabrics were irradiated by "Hanovia" mercury arc lamp. The exposure was carried out 30 cm. below the lamp and current of air was maintained above the samples during exposure. After continuous exposure for 48 hours, percentage loss in breaking strength was determined.

(e) Meteorological data;

A weather chart depicting monthly maximum and minimum temperature, rainfall and relative humidity was maintained during the period of exposure and is represented graphically in Fig. 1.

RESULT

Tables 1 and 2 show the average percentage loss of breaking strengths and tear strength respectively after 1–12 months exposure of treated and untreated fabrics. Table 3 gives the rise in copper number during exposure and Table 4 shows the percentage loss in breaking strength due to the irradiation by mercury vapour lamp and soil burial test. The nitrogen content of melamine treated fabrics during exposure is represented in Fig. 2.

DISCUSSION

The melamine treatment reduces the initial breaking strength of the fabric by an average of 36 per cent whereas no loss in breaking strength is observed due to the other treatments. The nickel naphthenate treatment shows about 20% gain in the initial breaking strength of the fabric. The percentage loss in breaking strength after 12 months of weathering exposure is minimum i.e. 36–44% for melamine treated fabric as compared to the loss in breaking strength for the fabrics treated with hydrated oxides of copper+manganese (38–49%), nickel naphthenate (57–63%), urea-formaldehyde resin (43–49%) and untreated (65–68%) in all the three sets exposed (Table 1). The statistical analysis of the breaking strength data has revealed that hydrated oxides of copper+manganese treatment is extremely resistant against weathering degradation and is closely followed by melamine, urea formaldehyde resin and nickel naphhenate treatments. The performance of all the treated fabrics is better than the untreated control. The behaviour of treated fabrics is not much affected by the period of exposure as indicated in Table 1.

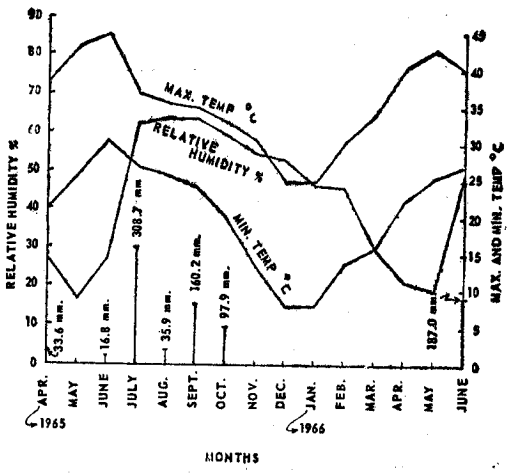

Fig. 1—Climatic data of Kanpur for the period April 1965 to June 1966 (Figures at the top of vertical bars represent total monthly rainfall)

The tear strength of all the treated fabrics is significantly lowered during the process of treatment, the maximum reduction of about 50 per cent being in the case of melamine treatment.

TABLE 1

PERCENTAGE LOSS IN BREAKING STRENGTH OF VARIOUSLY TREATED FABRICS DURING OUTDOOR WEATHERING AT KANPUR

Treatments	Set No*	Initial BS Kg.	Exposure in months					
			1	2	3	6	9	12
			% age loss (average of 5 replicates)					
Melamine	I	42	2	2	7	19	26	36
	II	37	20 (gain)	11 (gain)	11 (gain)	nil	24	36
	III	45	9 (gain)	2	4	16	31	44
Hydrated oxides of copper+manganese (*Cu*—0·5%, *Mn*—1·0%)	I	68	4	4	6	13	23	38
	II	65	2	6	2	8	21	49
	III	66	9	9	11	20	23	41
Nickel-Naphthenate (*Ni*—1·0%)	I	79	15	20	27	43	53	59
	II	74	9	16	23	39	46	63
	III	80	16	21	30	40	46	57
Urea-formaldehyde resin (12°Tw)	I	67	12	12	22	30	37	43
	II	63	9	13	11	16	38	49
	III	67	13	18	33	34	37	49
Untreated	I	65	12	21	25	48	60	68
	II	63	13	21	24	38	54	65
	III	66	17	24	35	53	58	65

*Date of exposure for

Set I—29-4-65

Set II—29-5 65

Set III—29-6-65

The percentage loss in tear strength after 12 months of weathering exposure is 78–83 per cent in melamine, 50–53 per cent in hydrated oxides of copper+manganese, 64–67 per cent in nickel naphthenate, 72–75 per cent in urea-formaldehyde treated fabrics and 76–85 per cent in untreated fabric (Table 2). The statistical analysis of tear strength data has revealed that hydrated oxides of copper+manganese treatment affords maximum protection against weathering degradation and is followed in decreasing order of effectiveness by urea-formaldehyde resin and nickel naphthenate treatments. The tear strength of the melamine treated fabric falls very rapidly during exposure and behaviour is not better than even untreated control.

TABLE 2

PERCENTAGE LOSS IN TEAR STRENGTH OF VARIOUSLY TREATED FABRICS DURING OUTDOOR WEATHERING AT KANPUR

Treatments	Set No*	Tear strength before exposure (lb.)	Exposure in months					
			1	2	3	6	9	12
			% age loss (average of 5 replicates)					
Melamine	I	2·9	62	62	79	..	55	..
	II	3·5	63	46	37	54	71	78
	III	2·9	14	14	14	41	55	83
Hydrated oxides of copper + manganese (*Cu*—0·5%, *Mn*—1·0%)	I	4·6	15 (gain)	..	..	..	46	50
	II	5·6	..	7	12	..	30	53
	III	5·4	9 (gain)	17	7	26	40	50
Nickel-naphthenate	I	6·0	20	48	33	..	78	65
(*Ni* —1·0%)	II	4·4	14 (gain)	2 (gain)	2 (gain)	32	64	67
	III	6·7	9	19	34	42	58	64
Urea-formaldehyde resin (12°Tw)	I	5·8	50	53	59	48	62	72
	II	5·7	68	56	54	..	..	75
	III	5·0	44	46	44	58	58	73
Untreated	I	5·9	17	39	..	75	80	80
	II	5·9	2	20	37	58	81	76
	III	7·1	20	34	54	69	84	85

*Date of exposure for

Set I—29-4-65

Set II—29-5-65

Set III—29-6-65.

.. Could not be done

There is steep rise in copper number of fabrics during weathering (Table 3) showing that actinic degradation is also taking place in this locality. The average copper number after 12 months of exposure is about 3·52 of melamine, 2·01 of hydrated oxides of copper+ manganese, 4·02 of nickel naphthenate, 3·73 of urea-formaldehyde resin treated and 4·99 of untreated fabric.

TABLE 3

COPPER NUMBER OF VARIOUSLY TREATED FABRICS DURING OUTDOOR WEATHERING AT KANPUR

Treatments	Set No*	Exposure in months						
		Initial copper number	1	2	2	6	9	12
Melamine	I	0·48	1·54	1·67	1·93	2·21	3·46	4·05
	II	0·52	1·08	1·36	1·66	1·75	2·45	3·32
	III	0·44	0·78	1·05	1·11	1·55	2·91	3·20
Hydrated Oxides of copper + manganese (*Cu*—0·5%, *Mn*—1·0%)	I	0·01	0·23	0·25	0·27	0·32	0·55	2·05
	II	0·03	0·06	0·06	0·08	0·22	0·59	1·91
	III	0·04	0·04	0·04	0·04	0·09	0·78	2·07
Nickel-naphthenate (*Ni* —1·0%)	I	0·06	1·15	1·15	1·23	1·55	2·84	4·06
	II	0·19	0·42	0·59	1·02	2·45	3·20	4·10
	III	2·12	0·34	0·64	0·87	1·55	2·41	3·90
Urea-formaldehyde resin (12°Tw)	I	0·06	0·53	0·74	1·01	1·12	3·01	3·56
	II	0·06	0·56	1·11	1·83	1·90	3·79	3·98
	III	0·06	0·92	1·36	1·48	1·75	3·32	3·65
Untreated	I	0·07	0·97	1·17	1·26	2·69	4·69	5·03
	II	0·08	0·83	1·22	2·03	2·48	4·08	4·95
	III	0·06	1·26	1·50	1·63	2·21	4·41	4·98

*Date of exposure for

Set I—29-4-65

Set II—29-5-65

Set III—29-6-65

Melamine and urea-formaldehyde resin treated fabrics show no loss in breaking strength due to the soil burial test in both leached and unleached conditions whereas the fabrics treated with hydrated oxides of copper+manganese and nickel naphthenate show even in unleached condition about 50 per cent loss in breaking strength, and untreated fabric shows 97 per cent loss in breaking strength (Table 3). Thus the rot-resistant properties of melamine and urea-formaldehyde resin treatments are excellent as compared to the other treatments under study which are still better than untreated control. The melamine treatment shows no loss in breaking strength when subjected to irradiation under mercury arc lamp. The fabrics treated with hydrated oxides of copper+manganese, nickel naphthenate and urea-formaldehyde resin and untreated, show 5 per cent, 17 per cent, 14 per cent and 29 per cent loss in breaking strength due to irradiation by mercury arc lamp respectively (Table 4).

TABL 4

EFFECT OF IRRADIATIONS BY MERCURY VAPOUR LAMP AND MICROBIOLOGICAL ATTACK ON THE BREAKING STRENGTH OF TREATED FABRICS

Treatments	% loss in breaking strength due to irradiation for 48 hrs. by mercury arc lamp	%loss in breaking strength due to soil burial test	
		Leached	Unleached
Melamine	Nil*	Nil	Nil
Hydrated oxides of copper+manganese (*Cu*—0·5%, *Mn*—1·0%)	5	47·6	50·2
Nickel naphthenate (*Ni*—1·0%)	17	..	50·8
Urea-formaldehyde resin (12° Tw)	14	Nil	Nil
Untreated control	29	97·4	96·7

*Each Fig. is an average of 5 replicates

.. Could not be done

Nitrogen content of melamine-treated fabric falls steeply during weathering exposure (Fig. 2). Initially, melamine-treated fabric contained about 5 per cent nitrogen, while after 12 months exposure, it came to approximately 3 per cent. The fall of nitrogen in urea-formaldehyde resin treated fabrics was from 4 per cent to 3 per cent in the same period of exposure. The physical loss of resin nitrogen may be due to leaching.

The melamine and urea-formaldehyde resin treatments are colourless and resistant to leaching whereas hydrated oxides of copper+manganese impart brown colour and nickel naphthenate greenish shade to the fabric. The colour of all the fabrics was found to be faded during exposure. The incidence of micro-organisms is slight in all the treated fabrics while in untreated control it is moderate.

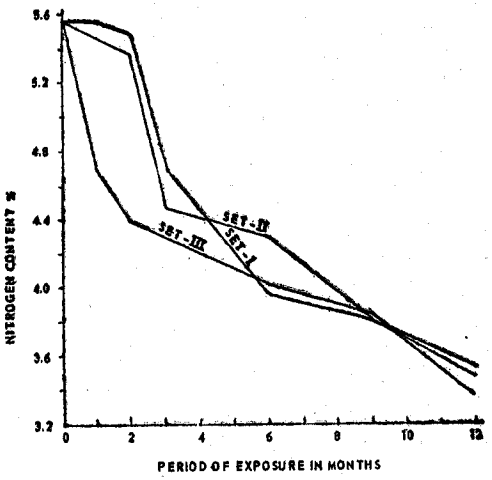

Fig. 2—Nitrogen content of melamine treated fabric during exposure

The overall performance of melamine treatment is quite satisfactory against microbiological, ultraviolet and weathering degradations though there is considerable fall in the initial strength (tear as well as breaking) of the fabric.

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