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Research Paper :

Launderings effect of FR treated fabric on dimensional parameters

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ABSTRACT

The choice of flame retardant systems for any particular application depends on how the material decomposes in a fire, as well as the materials' physical property. Brominated flame retardants, because they act in the flame, can be used in just about every application. To achieve the objective of the study, 100% white mercerized cotton fabric, Zirconium dioxide as flame retardant (FR) chemical (12% and 15%) and two binders namely, SLN and PVA (5% each) and (2.5% each) were selected on review basis and used separately and in combination. Recipe was made on the weight of the fabric for making suspension of FR finish. To apply flame retardant finish, pad-dry-cure method on padding mangle was used with 1 dip 1 nip, 2 dip 1 nip and 3 dip 1 nip systems. After application of FR finish, launderings was done 5, 10 and 15 times. Constructional parameters were assessed of treated and washed fabrics. Results interpreted that after launderings, 5 per cent PVA binder gave the best results with 15 per cent concentration of finish as compared to 5 per cent SLN binder and 12 per cent finish concentration.

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Flame retardant chemicals have been used since Roman times when they prevented siege towers from catching fire. In textile industry, brominated flame retardants were first used in cellulose nitrate which is extremely inflammable. In the early 1970's, the increasing use of flammable materials such as synthetic fibres in sofas and curtains led to the wider use of flame retardants. Flame retardants are able to contribute greatly to reducing the risk of fires providing safety in the home and in public places (Moghaddam and Saedi, 2000).

The stability of bromine in a typical flame retardant molecule means that the molecule can offer the highest activity as a flame active retardant, while also being cost effective (WHO, 2000). The main types of flame retardants are based on compounds containing: Halogens (Bromine and chlorine), phosphorous, nitrogen, minerals (based on aluminum and magnesium) and others (Edward and Manjiri, 2004).

METHODOLOGY

To conduct the experiment, 100% pure white mercerized cotton fabric ; having GSM 220 g was selected. Flame retardant chemical named, Zirconium dioxide and two binders' namely, Polyvinyl alcohol (PVA) and Silicon Liquid Nitrile (SLN) were selected on review basis.

Applications of FR finish with varying treatments/ dips:

For 1st application of finish, on the weight of the fabric, 12 per cent Zirconium dioxide and 5 per cent SLN binder were mixed in (MLR 1:40) water. Fabric was dipped in that suspension for five minutes and rolled out using pad dry cure method in instrument named padding mangle at room temperature and 50 Pascal pressure. Fabric was dried in sun light on grass horizontally. This is known as 1 dip 1 nip (dipped once in suspension and squeezed once through padding rollers). Further, application for 2 dip 1 nip was dip the fabric twice in suspension and once pass through the padding mangle. Similarly for 3 dip 1 nip accordingly dip thrice and squeezed once. For 2nd application of finish, instead of SLN binder 5 per cent PVA binder was used with same concentration of FR chemical. For 3rd application of finish, 15 per cent Zirconium dioxide and 5 per cent SLN binder was mixed in water. For 4th application of finish, instead of SLN binder 5 per cent PVA binder was used with 15 per cent application of finish. For 5th application of finish, 12 per cent Zirconium dioxide on the weight of the fabric and both binders *i.e.* 2.5 per cent each were used in combination. For 6th application of finish instead of 12 per cent finish, 15 per cent finish was used and rest of the procedure was same.

Launderings of fabrics:

Treated fabrics with varying concentrations of FR finish were laundered following the procedure of AATCC standard (No. 88A-1964T) using 5 per cent neutral detergent solution with Material Liquor Ratio (MLR) 1: 20 at temperature of 25-30^0 C for five minutes. The laundering cycle was carried out for 5, 10 and 15 times.

Measurement of dimensional parameters of treated and washed fabrics:

Thickness:

The thickness of the test specimens was measured as the distance between the reference plate on which the specimen rests and parallel circular pressure foot that exerts a specified pressure on the area under test. The thickness of fabric was studied by the "Prolific Thickness Tester" using BS 2544, 1967 test method.

Moisture regain:

The amount of water reabsorbed by a dried material at specified equilibrium condition of temperature and humidity, compared to the mass of the dried material is called moisture regain.

Moisture regain was calculated by using BS 1051, 1964 test method.

Air permeability:

The rate of air flow through a material under a differential pressure between the two fabric surfaces is known as air permeability. In other words, it is the property of fabrics to allow air to pass through under the effect of a difference in pressure. Air permeability was calculated by "Shirley air permeability tester" using BS 3321, 1960 test method.

FINDINGS AND DISCUSSION

Results of treated and washed fabrics are presented are as follows:

Table 1 indicates the results of dimensional parameters of cotton treated with varying treatments/dips after 5, 10 and 15 launderings. After 5 launderings, by the application of 15 per cent finish with 5 per cent PVA binder thickness was observed from 2.5 mm to 2.6 mm of I to III dip. Results of thickness after 10 launderings were found as 2.3 mm of all the dips with same concentration of finish and binder and after 15 launderings, it was measured as 2.4 mm in Ist as well as in II dip and 2.5 mm in III dip followed by 12 per cent finish concentration and 5 per cent PVA binder in comparison to following the results obtained by 12 and 15 per cent finish with 5 per cent SLN binder after all the treatments/ dips as well as after all the number of launderings with a significant difference of 0.07. This may be because to a particular extent, fabric can't be swollen enough. Davis and Tsai (2008) said that thickness of the FR finished composite to an ultra light weight panel, increase may be around 1/16 ± ¼ inch as compared to thickness of untreated composite panel for airlines.

It is clear from Table 1 that moisture regain was increased with increased treatments/dips *i.e.* observed as 8.0 per cent (I dip), 8.2 per cent (II dip) and 8.4 per cent (III dip) followed by 15 per cent finish with 5 per cent SLN binder *i.e.* 7.7 per cent, 7.8 per cent and 7.9 per cent in I, II and III dip, respectively after 5 launderings. After 10 and 15 launderings, same trend was followed in comparison to 12 per cent finish concentration with both binders (5 % each). Significant difference (0.03) was found. This may be due to increased concentration of finish with 5 per cent PVA binder.

The results of air permeability have been shown in Table 1 that it found maximum with the application of 12 per cent finish and 5 per cent SLN binder as 22.674 m^3/m^3/min in I dip, 22.340 m^3/m^3/min in II dip followed by 22.006 m^3/m^3/min in III dip whereas it was observed that by the application of 15per cent FR finish and 5 per cent PVA binder, it was found minimum as 20.005 consequently 19.198 and 19.175 m^3/m^3/min in I, II and III dip, respectively after 5 launderings. Same trend was followed after 10 and 15 launderings having a significant difference of 1.47. This may be due to absorption of finish in fabric structure.

Results indicate in Table 2 *i.e.* dimensional parameters of FR finished cotton with combined binders (2.5 % each) after launderings. Thickness was found as 2.5 mm after 5 and 10 launderings followed by 2.4 mm after 15 launderings by the application of 12 per cent finish with SLN and PVA binders. By the application of 15 per cent finish with both the binders it decreased to 2.6 mm (after 5 launderings) and 2.5 mm (after 10 and 15 launderings). Significant difference was calculated very less as 0.04. These increased in thickness of the treated fabric with 15 per cent finish concentration due to more concentration of finish as well as increased treatments/ dips.

It is affirmed from the data in (Table 2) that moisture regain was found 8.3 per cent after 5, 10 and 15 launderings by the application of 12 per cent finish concentration with SLN and PVA binders (2.5 % each) but by the application of 15 per cent finish concentration moisture regain was increased as 8.5 per cent after 5, 10 and 15 launderings with CD 0.02. This may be because

Table 1: Dimensional parameters of cotton treated with varying treatments/dips after launderings

Dimensional parameters	Trts/dips	Launderings	Finish concentrations: 12% Zirconium dioxide, Binders (5% each): SLN ( )*	12% Zirconium dioxide, Binders (5% each): PVA ( )*	15% Zirconium dioxide, Binders (5% each): SLN ( )*	15% Zirconium dioxide, Binders (5% each): PVA ( )*	F-cal	C.D.
Thickness (mm)	I	5	2.3 (2.3)	2.4 (2.5)	2.4 (2.5)	2.5 (2.5)	16.61	0.07
	II		2.4 (2.4)	2.5 (2.5)	2.4 (2.5)	2.6 (2.6)		
	III		2.4 (2.5)	2.5 (2.5)	2.4 (2.5)	2.6 (2.6)		
	I	10	2.3 (2.3)	2.4 (2.5)	2.4 (2.5)	2.5 (2.5)		
	II		2.4 (2.4)	2.4 (2.5)	2.4 (2.5)	2.5 (2.6)		
	III		2.4 (2.5)	2.4 (2.5)	2.4 (2.5)	2.5 (2.6)		
	I	15	2.3 (2.3)	2.4 (2.5)	2.4 (2.5)	2.4 (2.5)		
	II		2.4 (2.4)	2.4 (2.5)	2.4 (2.5)	2.4 (2.6)		
	III		2.4 (2.5)	2.4 (2.5)	2.4 (2.5)	2.5 (2.6)		
Moisture regain (%)	I	5	7.1 (7.1)	7.6 (7.6)	7.7 (7.2)	8.0 (7.8)	2.69	0.03
	II		7.2 (7.1)	7.7 (7.6)	7.8 (7.2)	8.2 (7.8)		
	III		7.3 (7.1)	7.8 (7.7)	7.9 (7.2)	8.4 (8.0)		
	I	10	6.8 (7.1)	7.5 (7.6)	7.8 (7.2)	7.9 (7.8)		
	II		6.9 (7.1)	7.6 (7.6)	7.8 (7.2)	8.1 (7.8)		
	III		7.0(7.1)	7.7 (7.7)	7.9 (7.2)	8.3 (8.0)		
	I	15	6.9 (7.1)	7.6 (7.6)	7.9 (7.2)	8.0 (7.8)		
	II		7.0 (7.1)	7.7 (7.6)	7.9 (7.2)	8.0 (7.8)		
	III		7.0 (7.1)	7.7 (7.7)	8.0 (7.2)	8.3 (8.0)		
Air permeability ($m^3/m^2/min$)	I	5	22.674(23.674)	22.004(22.338)	20.668(22.672)	20.005(19.004)	0.47	1.47
	II		22.340(22.340)	20.668(21.670)	20.002(22.338)	19.198(18.672)		
	III		22.006(23.006)	20.004(20.668)	19.004(22.004)	19.175(17.672)		
	I	10	22.692(23.674)	22.338(22.338)	20.972(22.672)	20.335(19.004)		
	II		22.534(22.340)	21.009(21.670)	22.005(22.338)	20.005(18.672)		
	III		22.430(23.006)	21.002(20.668)	19.004(22.004)	19.198(17.672)		
	I	15	22.692(23.674)	22.338(22.338)	20.972(22.672)	21.009(19.004)		
	II		22.534(22.340)	21.009(21.670)	21.009(22.338)	20.002(18.672)		
	III		22.430(23.006)	21.002(20.668)	19.175(22.004)	19.198(17.672)		

Trts. = treatments, Significant at 5% level

( )* = values of treated FR finished fabric before launderings

Table 2 : Dimensional parameters of FR finished cotton with combined binders after launderings

Dimensional parameters	Finish concentrations with combined binders (2.5% each)	Launderings: 5	Launderings: 10	Launderings: 15	F-cal	C.D.
Thickness (mm)	12% Zirconium dioxide	2.5 (2.4)	2.5 (2.4)	2.4 (2.5)	17.61	0.04
	15% Zirconium dioxide	2.6 (2.5)	2.5 (2.5)	2.5 (2.6)		
Moisture regain (%)	12% Zirconium dioxide	8.3 (7.3)	8.3 (7.3)	8.3 (7.4)	0.13	0.02
	15% Zirconium dioxide	8.5 (7.4)	8.5 (7.5)	8.5 (7.6)		
Air permeability ($m^3/m^2/min$)	12% Zirconium dioxide	21.392(22.672)	21.604(22.338)	22.749(21.837)	2.89	0.85
	15% Zirconium dioxide	19.198(21.172)	20.175(20.505)	20.786(20.005)		

Significant at 5% level

( )* = values of treated FR finished fabric before launderings

of penetration of FR finish into fabric structure.

With the perusal of data showed in Table 2 it was observed that air permeability increased after launderings. By the application of 12 per cent finish and combination of two binders it was measured as 21.392 $m^3/m^3/min$ after 5 launderings and further increased after 10 launderings

(21.604 m^3/m^3/min) followed by 15 launderings (22.749 m^3/m^3/min) whereas it was observed that by the application of 15 per cent finish and combined binders, air permeability decreased in comparison to air permeability of 12 per cent finish concentration but though increased with CD 0.85 as 19.198, 20.175 and 20.786 m^3/m^3/min, respectively after 5, 10 and 15 launderings. The reason behind this may be absorption of chemicals used for FR finish and it avoided the passing of air between fabric structures.

Conclusion:

Not much difference was found between the thickness of the treated and washed fabrics. Moisture regain and air permeability were slightly improved after launderings in comparison to treated fabrics.

Better results were obtained with 12 per cent FR finish and 5 per cent SLN binder regarding dimensional parameters.

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