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FIRE PROTECTION OF CELLULOSIC LINING MATERIALS

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INTRODUCTION

Cellulose based lining materials such as fiber board, particle boards etc. are used very widely in various types of occupancies. Their main applications are in the area of decorative lining for aesthetic purpose as well as for thermal and acoustical insulation in air conditioning ducts, cinema halls, auditoriums etc. These materials are intrinsically combustible and hence pose great fire hazard. In order to retard the ignition and spread of flame to considerable extent different methods such as impregnation, spray, surface coating and incorporation of fire retardants during manufacturing stage are used. Various workers have suggested several chemical treatments to retard burning characteristics of cellulose based products (1-6). Most of the flame retardant compositions reported are based on organophosphorous and halogenated compounds. Although, few treatments exhibit good fire retardancy however, they enhance smoke generation causing hindrance in protecting life by physical incapacitance and reduced visibility. Therefore, there is ample scope to develop suitable fire and smoke suppressants for Cellulosic lining materials. The present study deals with the development and evaluation of fire and smoke retardant compositions suitable for absorbing lining materials such as fiber insulation boards.

EXPERIMENTATION

Aqueous solutions of 1-15 percent concentration containing phosphates, borates amides etc. in different ratios were prepared. Specimens of fiberboards were immersed in the solution for different duration. Retention of chemicals with respect to immersion time was determined. Data is represented graphically in Fig.-1. Effect of chemical compositions and dry chemical retention on fire performance was determined following standard procedures.

FIRE TEST

Treated specimens of fiber insulation boards 315 x150x12mm size were dried at 50± 20 C for a period of 40 hours. Dried specimen was placed in a test chamber, facing downwards (towards the ignition source) on the angular supports with the lower edge 50 mm from the angle formed by the floor and the sidewall of the test cabinet. Specimen was ignited using 5ml. absolute alcohol in a cup, which was placed nearest to the specimen. The test was allowed to continue until all flames were extinguished. After flame and afterglow time were recorded and char volume was calculated following ASTM D-1360 (7) standard procedure. Effect of chemical compositions and dry chemical retention on fire performance was determined. Results with different compositions and dry chemical retention are recorded in Table –1. Treated specimens were further evaluated by using BS
476 Part-7 (Test for surface spread of flame for materials) (8). This property assumes considerable significance where continuous surfaces of materials are available such as for wall linings, false ceiling, insulation in air conditioning ducts etc.

For fire safety it is necessary to restrict the use of materials based on the surface spread or flame classification. The classification of materials for surface spread of flame is determined using the apparatus described in British Standard BS 476 Part 7 (8) The specimens 900x230x12 mm size were exposed to gas fired radiant panel of 900 mm to the specified radiation level and in addition a luminous gas flame of 75 mm to 100 mm long was also applied to its hotter end for the first one minute. The time of flame spread was recorded for measured distances. The measurements were continued for 10 minutes unless the flame front reached the far end of the specimen in a shorter time. The distance of flame spread at 1.5 minute and10 minutes are recorded in Table-2.

SMOKE GENERATIOIN

During burning of specimen generation of smoke is also an important aspect. Presence of certain fire retardants may increase the potential amount of smoke generated during fire, however it depends on the severity of the ignition source in case of real fire scenario. Generation of smoke with different compositions was determined as per ASTME-662 in a smoke density chamber (9). Specimens of size 76x76x12 mm size were used to

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SMOKE GENERATIOIN

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Dm = Maximum Specific Optical Density

T 90% = Time where upon 90% of Dm is reached (minute)

D90s = Optical density at 90 seconds

SON = Sum of specific optical densities at 1, 2, 3 and 4 minutes, a measure for the rate of smoke development.

Vmax. = Maximum rate of smoke generation estimated at every 30 seconds and expressed as density of smoke per minute (Ds/min.)

The results are recorded in Table-3.

RESULTS & DISCUSSION

Fire test on the fiber insulation board treated with different compositions show that there is no afterglow combustion in the material having about 12% dry chemical retention. Specimens treated with these concentrations have a self-extinguishing tendency and show minimum char volume. Time of impregnation for maximum retention to be achieved was found to be 70 minutes (Fig.-1). As the time of impregnation increases the percentage retention was also found to increase up to a maximum retention of 16.5% after which no further increase in chemical retention was observed. However, required chemical retention of 12% was achieved at about 45- 50 minutes impregnation. Data reveals that combination of phosphate & borate is quite effective in reducing the burning behaviour of specimen. Minimum char volume was noted with this combination when exposed as per ASTMD- 1360.

The classification of materials for surface spread of flame is determined following BS476 Part-7. Based on the extent and rate of flame spread the material is classified into one of four classes. Class-1, 2, 3 and Class-4 in descending order of merit. Specimens treated with different compositions exposed to determine surface spread of flame classification. Data reveals that specimens treated with combination based on phosphate-copper/calcium and zinc were placed in class-3. However, specimens treated with combinations based on phosphate-borate and amide were placed in class-2 (Table- 2).which is relatively a good grading while untreated specimens were found in class-4 indicating rapid flame spread on surfaces.

These formulations were also found quite effective in reducing the rate and amount of smoke generated (Table-3).The value of t90% was increased from 4 to12 minutes indicating that the escape time was three times greater in the treated specimens. The maximum specific density of smoke was also reduced drastically in treated specimens.

CONCLUSION

A few fire retardant compositions based on indigenously available chemicals have been developed and found to be quite effective. Cellulosic lining material (fiber boards) treated with these combinations neither showed surface spread of flame nor any afterglow combustion. Generation of smoke was also reduced considerably as compared to untreated specimen. Thus compositions studied were found quite effective for fiber board in reducing the burning characteristics as well as generation of smoke and hence enhanced the fire safety in buildings.

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TABLE-1 EFFECT OF COMPOSITIONS AND CHEMICAL RETENTION ON FIRE PERFORMANCE

COMPOSITION	DRY CHEMICAL RETENTION (%)	AFTER FLAME TIME (S)	AFTERGLOW TIME (S)	CHAR VOLUME (CC)
Phosphate – Calcium / Copper salt	5.86	5	92	115.20
	8.36	3	18	63.42
	12.70	2	0	45.88
	15.02	0	0	44.10
	16.12	0	0	43.58
Phosphate-Zinc salt	7.98	2	5	54.72
	12.14	1	0	45.0
	14.56	0	0	43.24
	16.20	0	0	42.72
Phosphate-Borate	7.16	2	8	55.15
	10.58	0	0	38.28
	12.68	0	0	36.80
	14.36	0	0	36.50
Phosphate-Amide	8.10	0	2	52.32
	12.56	0	0	38.88
	13.21	0	0	38.40
	15.14	0	0	38.24
Untreated	-	8	Contd.	540 (Burnt Completely)

TABLE-2. PERFORMANCES OF COMPOSITIONS AS PER BS 476 PART 7

COMPOSITIONS.	FLAME SPREAD AT 1.5 MIN. (MM)	FINAL FLAME SPREAD AT 10 MIN. (MM)	CLASSIFICATION
1	285	705	Class-3
2	260	695	Class-3
3	205	435	Class-2
4	215	450	Class-2
Untreated	525	900	Class-4

TABLE-3. SMOKE DENSITY AS PER ASTM E 662

COMPOSITION NUMBER	DM	T90%	D90S	SON	VMAX.
1	96.2	8.1	8.2	39	10.5
2	88.5	9.3	7.5	34	9.6
3	51.4	12.2	5.0	28	6.4
4	54.7	11.0	5.4	30.2	7.2
Untreated	308	4	40	670	216

Lower value of Dm, D90s, SON, Vmax. and higher value of T90% indicate better the performance.

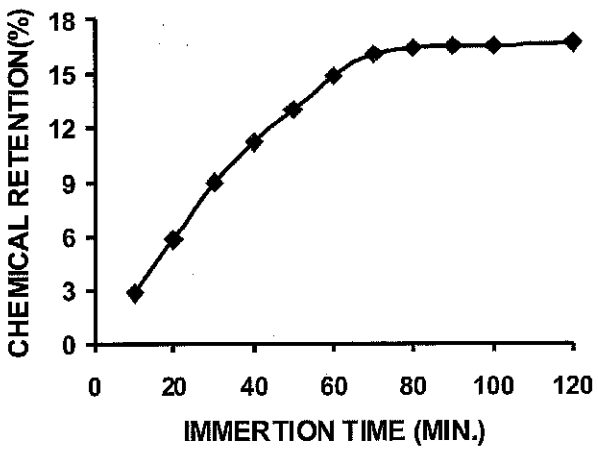

Fig 1. Effect of Immerstion Time on Chemical Retention