Fire Retardant Treatment for Absorbing Lining Materials

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Fire retardant treatment given to a material increases its resistance from flame attack. The article deals with different aspects of fire retardant treatment for lining materials on which the authors are carrying out Research work. —*Ed.*

Introduction

Lining material are being increasingly used in various types of buildings for false ceiling, partitions and for decorative purposes. These are very much used in cinema halls, auditorium etc. for acoustical treatment and in air-conditioning ducts and cold storages for thermal insulations. When a fire occurs, these materials generally help its spread and faster growth. If these materials are rendered fire retardant the fire hazard would be reduced and loss of property and life especially in buildings can thus be minimised.

There are different methods for rendering fire retardant treatment to lining materials such as:

i) Immersion Method.
ii) Spray Method
iii) Surface Treatment
iv) Incorporation Method.

This paper describes in detail the first two methods of treatment i. e. the Immersion and Spray Methods.

Theories of Flame Retardance

There are four important theories which explain the phenomenon of flame retardance. These are the chemical, coating, thermal and gas theories.

A flame retardant additive operates by interfering with at least one of the individual stages of burning process. These stages include

— Heating of material;
— Its degradation and decomposition;
— Ignition of flammable gases evolved;
— Continued combustion with sufficient net heat to sustain and continue flame propagation.

There are various ways in which a flame retardant may act at a particular stage.

— An additive may increase the production of non-combustible gases inhibiting the burning

process.

— An additive may produce by its own degradation, products which inhibit combustion or it may produce inert gases which blanket the material excluding oxygen.

— An additive may modify the thermal property by lowering the normal melting point giving it the capability of absorbing heat at a lower temperature. Many flame retardant additives degrade endothermically evolving non-combustible gases.

Treatment by Immersion Method

Many chemicals have a fire retardant effect when materials are impregnated with them. Such chemical are ammonium chloride, ammonium sulphate, ammonium phosphate, borates, zinc chloride etc A solution of cyanamide and phosphoric acid is a very good fire-retardant for cellulosic materials. But there is a loss of strength of about 35 to 40 pescent with this process.

A cheap and effective aqueous solution of fire retardant agents has been developed in the Fire Research Laboratory at the Central Building Research Institute, Roorkee for rendering lining materials fire retardant. Samples of soft boards were immersed in the solution and it was determined that the adequate retention could be achieved by immersion for 50 to 55 minutes to get the required retention of about 12 to 14 percent Fig. 1.

The treated samples were tested on a 2-5 cm. dia. bunsen burner and the char area calculated is given in table 1, Fig. 2.

Treatment by spray Method

For employing spray method specimens were mounted in a horizontal position in the form of false ceiling. The chemical solution of 10 percent concentration of fire-retardant chemical constituents was employed for spray treatment. A spray gun of 500 ml. capacity was connected through a a pneumatic air hose to air compressor and air pressure was maintained to the order of 35 to 40 psig. Specimen of size $1m^2$ was treated by spraying 5 litres of solution giving 11 to 13 percent retention by weight on dry basis. The spray is done in two stages. Three litres of solution is sprayed uniformly on $1m^2$ area in the first stage in such a way that it should not drip and is allowed to be absorbed by the specimen for about one hour. The remaining two litres solution is sprayed in the second stage and the specimen is left to dry completely. Samples treated as above were tested by using Bunsen burner 2.5 cm. dia. flame. The calculated char area is gien in Table 2, fig. 3.

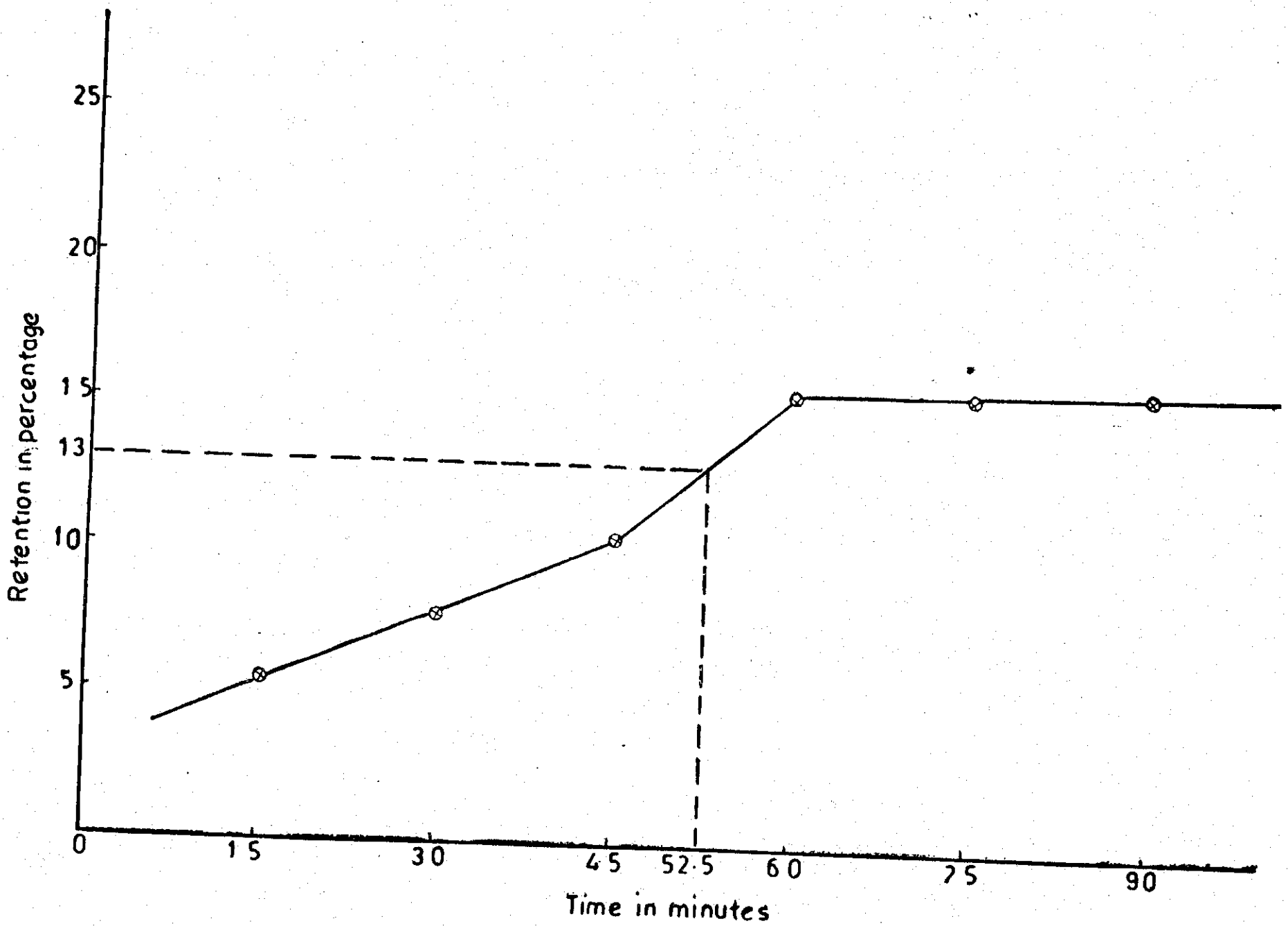
The above experiments were also conducted according to B.S. 476-Pt. 7 test for Surface Spread of Flame for materials to verify the results.

Results and Discussion

Tests on the specimen treated by impregnation method showed that there is no glow if materials are treated with 9 percent or 10 percent or solutions of higher concentrations (table 1). Samples impregnated with these concentrations have a self-extinguishing tendency. Since it was observed that 9 percent concentration leads to a border line case so a higher concentration of 10 percent was selected for experiment so as to be on safer side. Time of impregnation for maximum retention is 60 minutes. As the time of impregnation increases the percentage retention also increases upto 16 percent after which no further retention has been observed even though time of impregnation is increased (Fig. 1). It is also observed that 12 to 14 percent retention (by dry weight) is quite adequate to render the material fire retardant.

Fig. 2 represents the variation in char area with retention and concentration of solution. Curve A shows that, as the concentration of solution increases the char area decreases up to about 12 cm^2 after which there is no reduction in char area. Curve B represents that as retention increases char area decreases. At the retention of 14 percent (by dry weight) there was neither glow nor flamming and char area was minimum.

Similarly specimens treated by spray method were also tested. The results show that as the retention of chemical solution increases the char area decreases and when the retention reaches about 14 percent the char area becomes constant i.e. 52.5 cm^2 (fig. 3). This char area is high because samples were treated in situ since it could not be tested by vertical method so it was tested by mounting it at 45° angle. (However the case is not similar for impregnation method). But at this reten-



FIG·1·TIME OF IMPREGNATION FOR MAXIMUM RETENTION

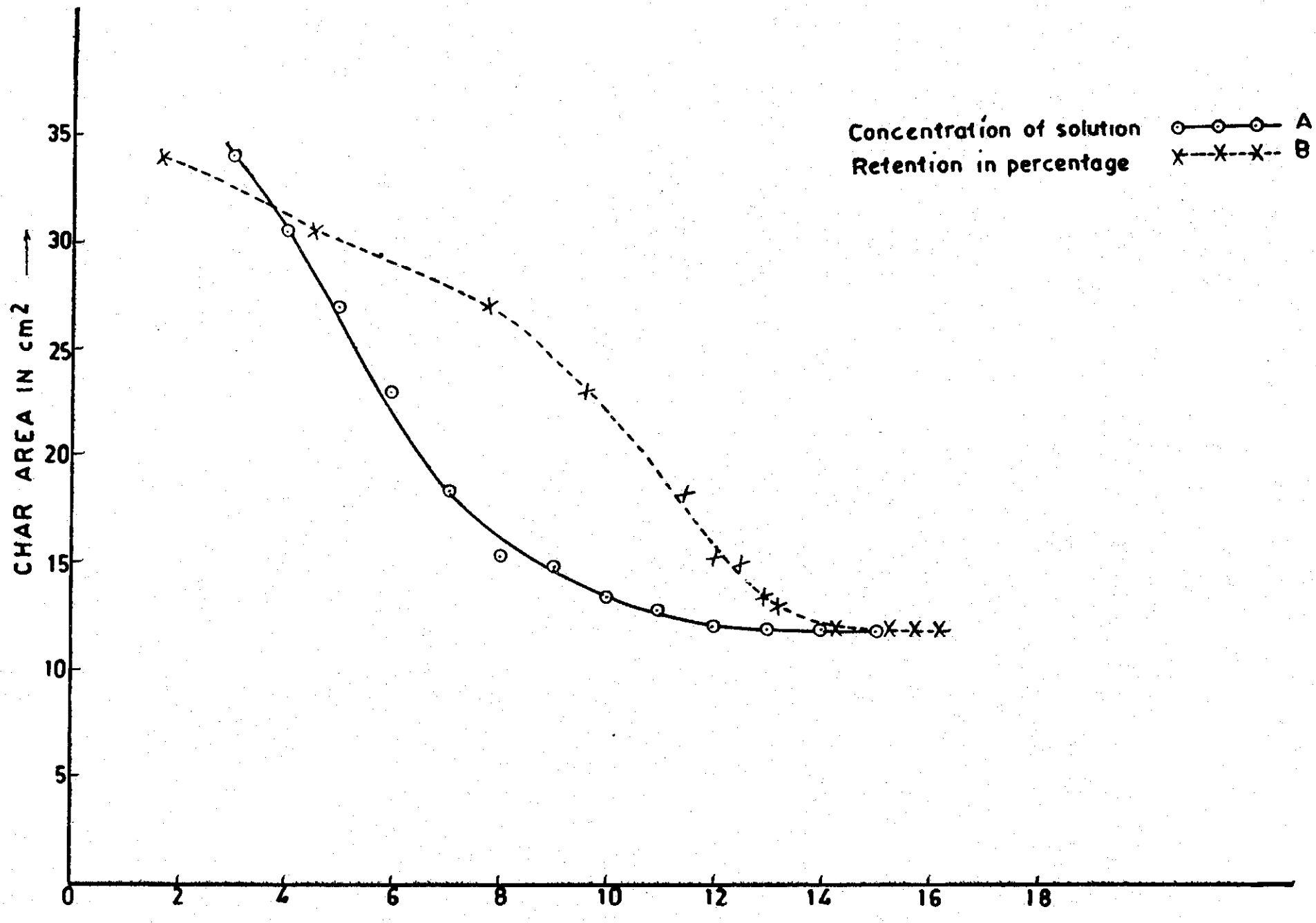
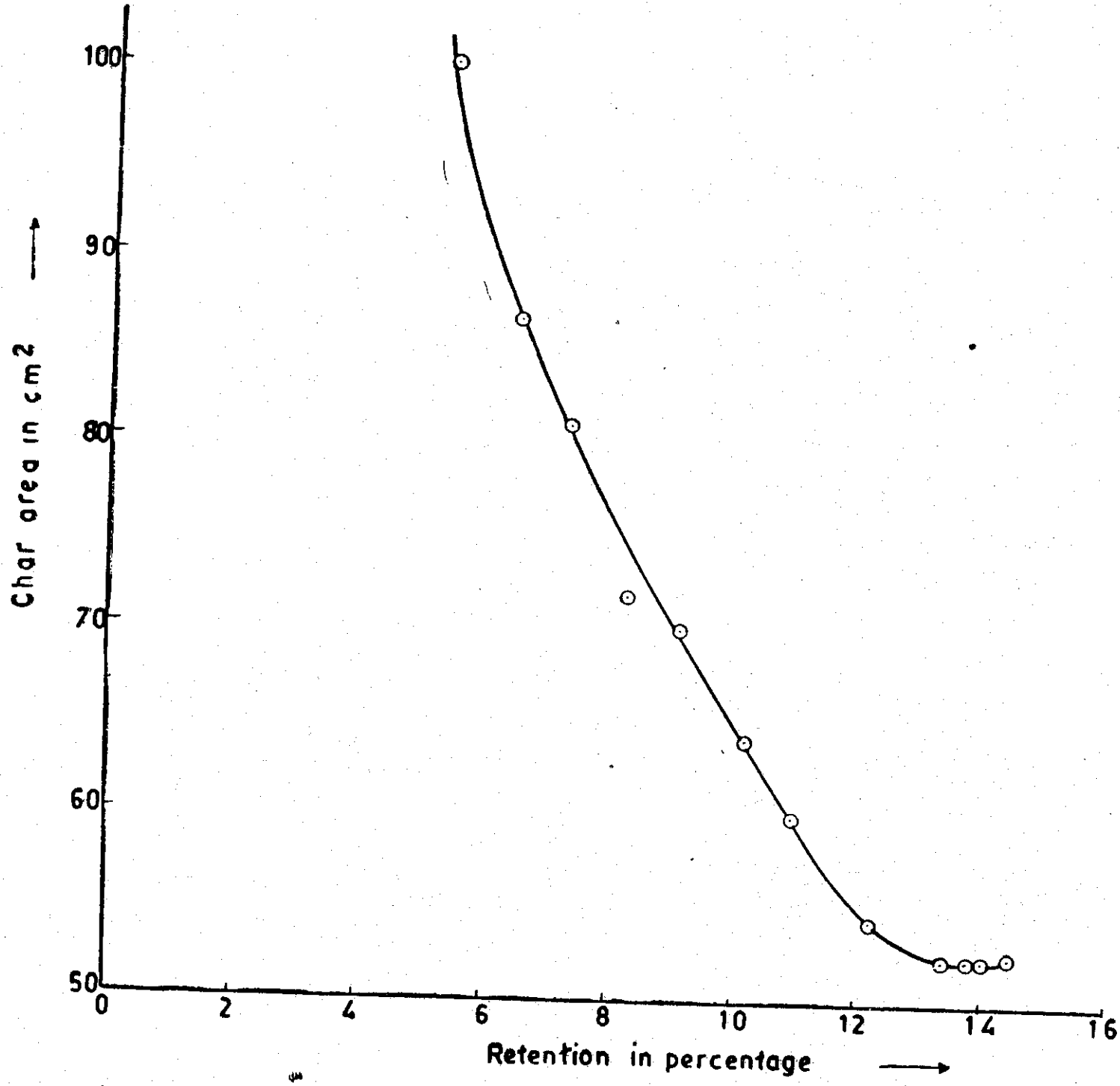


FIG. 2 • VARIATION IN CHAR AREA WITH RETENTION AND CONCENTRATION OF SOLUTION



FIG·3·EFFECT OF RETENTION IN PERCENTAGE ON CHAR AREA FOR SPRAY METHOD

Table 1 : Variation in Char Area with Retention and Concentration of the Solution

S. No.	Concentration of solution (%)	Retention by weight (%)	FIRE TEST			
			Time of exposure (Sec.)	Flaming (Sec.)	Glow Time (Sec.)	Char Area (cm^2)
1.	1	0.23	30	5	Continued	—
2.	2	0.32	30	5	,,	—
3.	3	1.67	30	No flaming	10	34
4.	4	4.62	,,	,,	5	30.5
5.	5	7.86	,,	,,	4	27.00
6.	6	9.6	,,	,,	2	23 0
7.	7	11.56	,,	,,	1	18.3
8.	8	12.00	,,	,,	1	15.2
9.	9	12.5	,,	,,	Nil	14.8
10.	10	12.9	,,	,,	Nil	13.3
11.	11	13.2	,,	,,	,,	13.0
12.	12	14.2	,,	,,	,,	11.9
13.	13	15.1	,,	,,	,,	11.8
14.	14	15.8	,,	,,	,,	11.8
15.	15	16.2	,,	,,	,,	11.7

Table 2 : Effect of Retention on Char Area (Spray Method)

S. No.	Retention by weight (%)	FIRE TEST			
		Exposure time (Sec.)	Flaming (Sec.)	Glow (Sec.)	Char Area (cm^2)
1.	5.4	30	0	5	100
2.	6.3	30	3	4	86.7
3.	7.3	,,	0	4	81.00
4.	8.2	,,	0	4	72.2
5.	9.1	,,	0	2	70.0
6.	10.2	,,	0	2	64.00
7.	11.	,,	0	1	60.00
8.	12.2	,,	0	0	54.5
9.	13.6	,,	0	0	52.5
10.	13.8	,,	0	0	52.5
11.	14	,,	0	0	52.5
12.	14.4	,,	0	0	52.5

tion there was neither any surface spread of flame nor glow and the char area is minimum. After the removal of burner, the samples remains unaffected except of course for the charred portions where the flame had been in contact with the specimens. To verify the results, tests were also conducted as per B.S. 476-Part 7.

Conclusion

(a) An aqueous solution of fire retardant agents of 10 percent concentration is suitable for rendering materials having absorbing tendency fire retardant by immersion method and spray method.

(b) The required minimum retention is 12 to 14 percent for providing adequate fire retardant treatments.

(c) Time needed for the required retention is 50 to 55 min. in case of immersion method.

(d) The formulation developed for impregnation method can also be suitably applied by spray method.

(e) It provides a cheap and effective fire-retardant treatment and does not effect the strength of material. The treatment cost comes to approximately Rs. 5.50/m^2.

Acknowledgement

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