Fire retardant intumescent coating for lining materials

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Abstract

A few fire retardant intumescent coatings free from asbestos and halogenated compounds are developed for lining materials. Fire performance and emission of smoke have been evaluated employing different BS and ASTM standards. The results were found well within the limits. On exposure, the coated specimens neither showed any surface spread of flame nor any after glow combustion.

Introduction

LINING materials are used in various types of buildings for partitions, false ceilings and for decoration purposes. These are very much used in cinema halls, auditoriums and cold storages for acoustical and thermal insulations. These materials are intrinsically combustible and therefore pose a great fire hazard. It is possible to retard the ignition and surface spread of flame on these materials to a considerable extent by application of different techniques such as chemical impregnation or spray, surface treatment and incorporation of fire retardants during manufacturing stages. Fire protection by a coating is very useful method and has engaged the attention of research workers and industrialists. There are two types of coatings which retard the spread of flame. One based on materials which do not support combustion such as alumina, borax, boric acid and antimony trioxide, chlorinated paraffins and rubber etc. [1,3] and other type produces a residue which is puffed by escaping gases when heated. It produces, a tough insulating foam which will protect materials over which it is formed. Such type of coating is known as an intumescent coating [1-9]. Various workers are engaged in developing coatings but they have their some limitations in terms of availability of chemicals, water repellency, adhesion, shelf life and generation of smoke. The increasing demand of asbestos and halogens free fire retardants have forced the scientists and industrialists to develop such coatings.

The present paper deals with results of the investigations on asbestos and halogen free fire and smoke retardant intumescent coating for lining materials.

Experimentation

A few fire retardant coating compositions were prepared using different types of phosphates, amides, polyols and acrylic binders in different weight ratios *(Table 1)*. The coatings were pre-

Table 1: Composition of Coatings

Ingredients *	Parts by weight
Phosphates	14-24
Blowing agents	11-17
Char forming components	7-14
Thickener	0.2-0.8
Binders	20- 28
Pigment	3-7
Filler	4-9
Plasticizer	2-4
Paint Accessories	0.5 - 1.0
Solvent / Water	7-15

* The particular compound used and their weight ratio has been withheld as the findings are proposed to be covered under a patent.

Table 2: Results of Coating (as per ASTM D-1360)

Material	After Flame Time (Secs.)	After glow Time (Secs.)	Average Char Volume (cc)	Average Weight loss (gms)
Coated				
Rice husk Board (12 mm)	0	0	6.18	3.06
Fibre board (12 mm)	0	0	7.46	3.92
Uncoated				
Rice husk board (12 mm)	38	514	67.2	24.35
Fibre board (12 mm)	48	Continues	Burnt completely	

pared by mixing fire retardant ingredients of 325-400 mesh size with 2-5 per cent solution of thickener along with an appropriate quantity of antisettling wetting and antifoaming agents. The binder was modified by reacting with a methylol urea and polymeric plasticizer at appropriate temperature and duration of reaction to increase the adhesion as well as to improve the physical properties of the coating. The required quantity of this modified binder was added to make a homogenous mixture. In order to obtain brush consistency requisite amount of water was added. It was stirred vigorously with heavy duty stirrer.

The coatings were applied by brush on combustible surfaces of particle board and fibre board. In order to obtain an effective fire retardancy the coating was applied at the rate of 1.5 - 1.8 m^2 per litre which could be achieved by applying two or three successive coats.

Evaluation of coating

Flame spread rate, after glow combustion, weight loss, char index and generation of smoke during fire exposure are the main criteria to determine the effectiveness of the coating. Following international standard methods were employed to evaluate the different properties of the coating.

Fire performance as per ASTM D-1360 (Cabinet Method)

This method determines the weight loss and char index of specimens when subjected to a flame. Corresponding percentage factors are calculated by comparing the performance of a painted test specimen with an uncoated specimen. The test specimens of size 150 x 305 mm of approximate equal weight were exposed in test chamber. The panels were placed facing downwards on the angular supports with the lower edge 50 mm from the angle formed by the floor and the side wall of the cabinet. A fuel cup placed at room temperature on the pedestal so that the vertical distance from the cup nearest to the face of the specimen is exactly 25 mm. Absolute ethyl alcohol (5 ml) is taken as an ignition fuel. The draft is adjusted to ensure complete burning of alcohol. The test is allowed to continue until all flames extinguish. The results are recorded in *Table 2*.

Determination of surface spread of flame (as per BS: 476 Pt.7)

The specimens of size 270 x 900 mm were subjected to gas fired radiant panel of approximately 900 mm^2. A small gas flame is located at the intersection of the specimen and the radiant panel. Perpendicular to one side of the radiant panel at its mid point a specimen holder is arranged to hold the specimen with its long axis horizontal. The apparatus is calibrated by measuring intensity of heat at measured distances as specified in the standard. Specimen is placed in test position with the radiant panel functioning a 75 mm to 100 mm long vertical gas flame is applied to the hotter end of the specimen for one minute.

Observations are made in respect of the time of spread of the flame front for measured distances along the specimen, until the flames have died out or for 10 minutes whichever is longer. On the basis of observed behaviour during test, specimens were classified. The test data are recorded in *Table 3*.

Determination of fire propagation index (as per BS:476 part 6)

In this test, the rate and amount of heat evolved by the specimen is determined when it is heated in an enclosed chamber under prescribed conditions. Specimens of size 228 x 228 mm were placed in test chamber and exposure is initially given from a gas jet liberating 7560 Cal./min. After 2 minutes 45 seconds radiant heat of 1800 W is added from two electrical heating elements. The test duration is 20 minutes during which the temperature difference between the ambient conditions and the inside temperature is recorded at half minute, one minute and 2 minutes intervals.

The index of performance is determined using formula given in the standard. The performance of the coating is given in *Table -3*.

Determination of smoke emission

Tests were carried out in the NBS (National Bureau of Standards) Smoke Density Chamber. The coated and uncoated specimens of 76 x 76 mm size were arranged to face the electrically heated radiant energy source which is mounted within an insulated ceramic

Table 3: Performance of Coatings

Materials	Performance as per		
	Index as per BS:476 Pt.6	Classification as per BS: 476 Pt.7	Optical Density as per ASTM E-662
Coated			
Rice husk board (12 mm)	12.76	Class I	41.22
Fibre board (12 mm)	13.16	Class I	40.76
Uncoated			
Rice husk board (12 mm)	36.54	Class -3	406.8
Fire board (12 mm)	71.08	Class - 4	298.4

Class 1,3 & 4 represent very low, medium and rapid flame spread respectively.

tube and positioned so as to produce an irradiance level of 2.5 w/cm² averaged over the central 38.1 mm diameter area of vertically mounted specimen. Maximum specific optical density (SoD.) was determined according to ASTM E-662 method.

The results are reported in *Table 3.*

Results & Discussion

It is clear from the results of burning tests that formulated coatings are very effective in reducing fire growth. The coated specimens neither show any spread of flame nor after glow combustion on exposure. Weight loss and char volume measured after exposure found very low in coated specimen as compared to the uncoated specimen. On applying the coating on rice husk board fire performance was found to improve from class 3 to class - 1 indicating that no flame spread was noted during the test. Similarly in the case of fibre board it was found to improve from worst class-4 to class-1 *(Table 3)* The index of performance as determined by BS:476 Part - 6 was improved significantly in coated specimens. The production of smoke is also a great problem from fire safety point of view. The coating so formulated was also found quite effective in reducing the amount of smoke.

The main constituents of the coating under study are blowing agents, char forming components and phosphates. When this combination is exposed to fire, the phosphate produce an acid which act as dehydrating agent. The char forming compound is dehydrated by acid resulting large amount of char which produces a barrier to protect the substrate [1,5,8]. Blowing agent gives off non-flammable gases causing the foamable carbon to produce a honeycomb blanket causing a highly effective insulation. The binder on softening forms an expandable skin over the char to resist the escape of gases produced by blowing agents. These reactions take place within the coating, thus the material is well protected from heat.

Conclusions

A fire retardant intumescent coating based on indigenously available chemicals free from halogens and asbestos was developed. The specimens of rice husk board and fibre board with these coatings showed neither surface spread of flame nor after glow combustion which is prime combustion property of fibre board. The coating was also found quite effective in reducing generation of smoke.

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