Effect of binders on fire performance of intumencent coatings

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Introduction

EACH year fire causes considerable loss of life and property. Although much attention has been paid towards the fire protection of commercial buildings and their occupants, very little attention has been paid to reduce fire spread on surfaces as there are several combustible materials inside the buildings. It is now well recognised that a fire retardant coating when properly applied, can reduce spread of flame and minimise damages caused by it.

There are generally two types of coatings which retard the flame spread. One type employs additives which do not support combustion such as borax, boric acid, antimony trioxide, zinc oxide, zinc borate and chlorinated hydrocarbons etc.[1-5] and these are known as fire retardant coatings. The other types on heating produce a residue which is puffed up by escape of gases. A combustion residue should efficiently be puffed up to produce a tough insulating foam over the surface thereby protecting the materials.[5-8] The latter are termed as intumescent coatings

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Table 1: Effect of binders on the fire performance

Name of Binder	Binder (%)	Weight loss (gms)	Char volume (C.C.)	Height of intumescence (mm)
Calimul 6815	10	4.14	Nil	17
	12	4.20	Nil	17
	14	4.22	Nil	16
	16	4.26	Nil	16
	18	4.83	Nil	14
	20	5.32	2.60	12
	22	5.65	3.84	09
	24	5.88	5.26	06
Calimul 6825	10	2.97	Nil	18
	12	2.98	Nil	18
	14	3.00	Nil	17
	16	3.04	Nil	16
	18	3.54	Nil	15
	20	4.40	1.20	13
	22	4.75	2.35	09
	24	5.05	4.80	07
Pidivyl C.P. 651	10	2.95	Nil	19
	12	3.00	Nil	19
	14	3.02	Nil	18
	16	3.04	Nil	18
	18	3.09	Nil	17
	20	3.56	2.10	15
	22	4.17	6.30	11
	24	4.80	9.54	08
Rollex-50	10	2.75	Nil	14
	12	2.80	Nil	14
	14	2.88	Nil	13
	16	2.90	Nil	12
	18	3.10	Nil	10
	20	3.60	Nil	08
	22	4.05	Nil	07
	24	4.34	Nil	06

which possess better fire performance than the fire retardant coatings.

The most important characteristic in maintaining the stability of fire retardant intumescent paint lies in the selection of a binder. The choice of a binder should be such that it causes fire protection and at the same time does not reduce the durability of the paint. Generally polyvinyl acetate dispersions are sensitive to electrolytes which cause their coagulation. For this reason, it is only possible to combine water insoluble salts with these electrolyte sensitive dispersions. Compared with water soluble salts, however, the insoluble salts possess decreased fire retardancy and do not produce requisite effectiveness in the case of fire retardant intumescent paints. The most suitable binders for such paints are amino resins of suitable grades, chlorinated rubber or polyvinyl acetate dispersions.[6] In view of availability, durability and the cost, four binders have been selected for the present study.

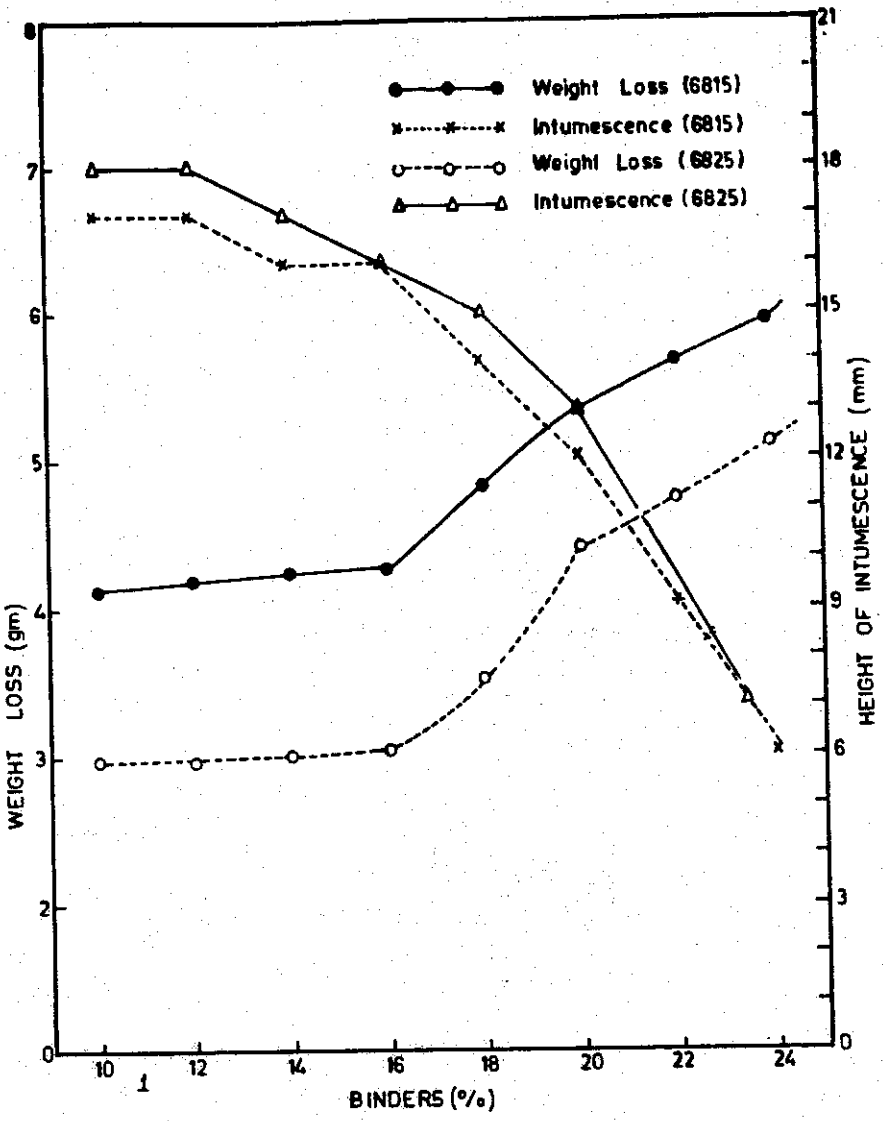

Fig-1 EFFECT OF BINDERS (6800 Range) ON WEIGHT LOSS AND INTUMESCENCE ON MANGO WOOD

Experimental

Materials and method

The four binders namely Calimul 6800 range, Pidivyl CP 651 and Rollex-50 were obtained from Calico Chemicals Ltd., Bombay, Parekh Dyechem Industries Pvt. Ltd., Bombay and Synthetic and Polymer Industries, Ahmedabad respectively.

Characteristics of binders

(i) Calimul 6800 range i.e. (a) 6815 and (b) 6825: These binders are internally plasticised vinyl acetate copolymer. Internal plasticisation is achieved by copolymerising vinyl acetate with 2-ethyl hexyl acrylate. Binder 6825 contains larger quantities of the plasticizer than present in 6815. These are milky white in colour with 57 ± 1 percent solid contents and are stable within the pH range 2-10.

(ii) Pidivyl C.P. 651:

This binder is a vinyl acetate-acrylate copolymer emulsion of milky white colour having $56 \pm 1\%$. solid content, acid value 2-4 pH 4 to 6 and viscosity 15-20 poises. This binder is also stable within the pH range of 2-10.

(iii) Rollex-50

Rollex-50 is a colourless liquid of urea-formaldehyde resin of specific gravity 1.14 to 1.18 with $50 \pm 2\%$ active resin content and pH 8 to 9.

Preparation and application of coating

Fire retardant intumescent coating was prepared by mixing a spumific or blowing agent (dicyandiamide, melamine or urea etc., 14-20 gms), a carbonific agent (Pentaerythritol or starch, 8-12 gms), a dehydrating agent (ammonium phosphate, 21-30 gms), a pigment (titanium dioxide, 325-400 mesh size, 3-5 gms) with a 2 percent solution (20-22 ml) of sodium salt of d-mannuronic acid and an appropriate binder. A re-

quisite amount of water was added for obtaining brush consistency. The paint was applied by a brush on mango wood. The thickness of the paint film was maintained at 10 to 12 mil for obtaining effective fire retardancy. A coat of a copolymer of VC/VA (Caliplast 613) in ethyl acetate at the rate of 220 ml/m^2 was applied on the surface of the wood in order to render it water repellent.

Fire performance

The fire retardancy of paints was evaluated by ASTM D-1360 method[9]. After subjecting the specimens to a flame, their weight loss and char volume are determined. The weighed panels (6×150×305 mm size, free from knots and other imperfections) were tested employing ethyl alcohol (5 ml) as an ignition fuel. The experiment was continued till the flames extinguished. The effect of different binders as well as their amounts on the fire performance is recorded in Table 1.

Results and discussion

Flame spread rate, afterglow time, weight loss, char index and time for which a coating retards the spread of flame are major factors governing the effectiveness of a fire retardant coating. A fire retardant coating affects mainly the flame spread thereby increasing the margin of safety for occupants to evacuate a burning building.

It is evident from Table 1 Figs. 1 and 2 that the fire performance of the coating is very much dependent on the amount and types of the binders used. The paint with binder Calimul 6825 possesses better performance than the one containing calimul 6815 (Table 4 Fig. 1). Coatings with binder CP 651 (18%) show almost equal fire performance as coatings with binder 6825. However, coatings with binder 6825 give satisfactory performance when binder is used to an extent of 16%, beyond which the fire performance decreases.

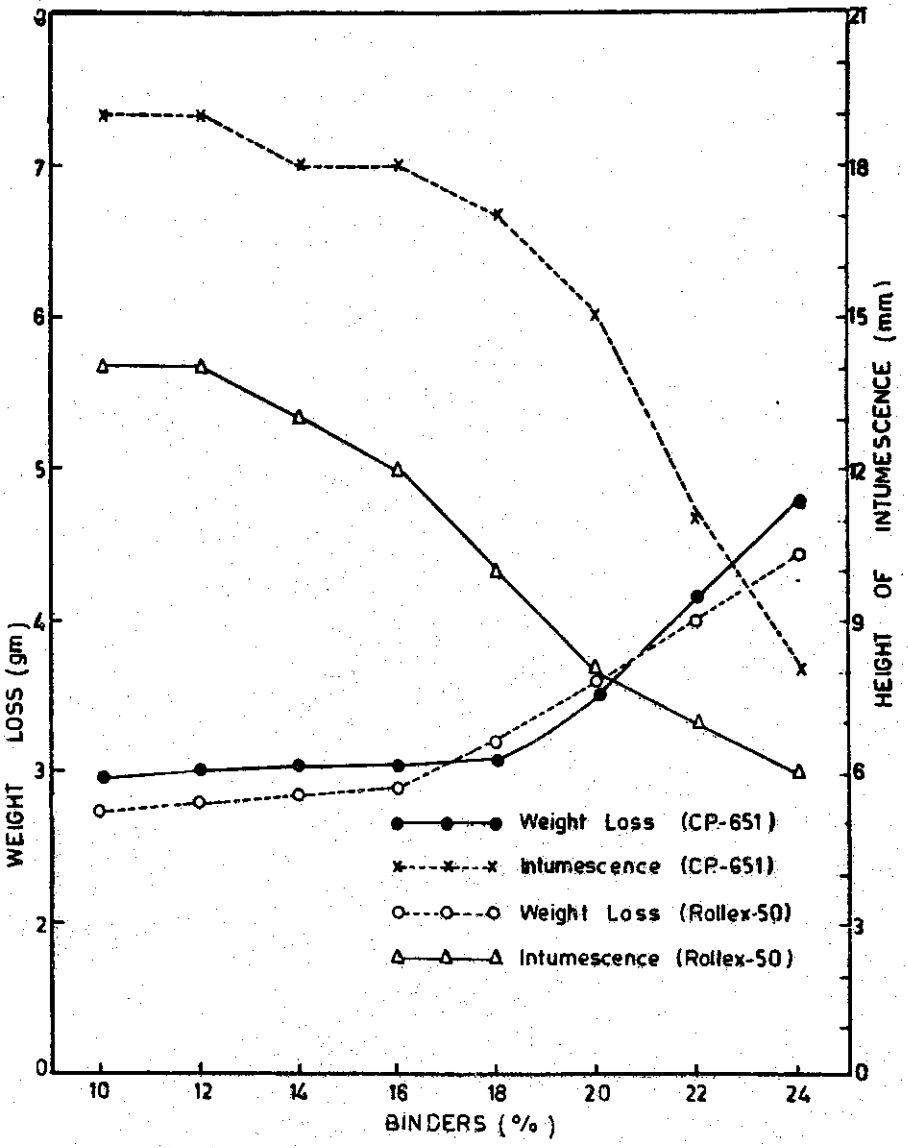

Fig. 2 EFFECT OF BINDERS ON WEIGHT LOSS AND INTUMESCENCE ON MANGO WOOD

When 16% Rollex-50 is used as a binder, the fire performance of the coating is better than the paints containing calimul 6825 binder and pidivyl C.P. 651, excepting that the height of intumescence in case of Rollex-50 being lower. The major drawback with binder Rollex 50 is that it reduces the brush consistency. This problem can be overcome by diluting the paint with water as and when the flow is decreased, though this requires a number of coats to achieve the required effectiveness. When higher amounts of these binders are used in the paint compositions, fire performance reduces gradually due to the fact that the binders copolymerise firmly and form a tough film which does not melt at decomposition temperatures of intumescence ingredients. Very little intumescence takes place and consequently the fire performance is reduced.

Summary

A few fire retardant intumescent coatings have been developed using three different types of binders i.e. (i) a copolymer of vinyl acetate

and 2-ethyl hexyl acrylate, (ii) a vinyl acetate-acrylate copolymer emulsion and (iii) an amino resin. The effect of binders on the fire performance of the coatings has been evaluated.

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