BORAX FIRE-RETARDANT PAINTS

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No paint can be expected to protect wood effectively against long exposure to fire temperatures, but paints with good fire-retarding properties can greatly retard the progress of small fires and often may be able to afford complete protection against fires of this kind that otherwise could grow quickly to uncontrollable size. Of the hundreds of paint formulas that have been tested for fire-resisting properties at the Forest Products Laboratory during the past few years, the most nearly satisfactory formulas developed to date are linseed oil paints containing finely ground borax. These formulas are still in the experimental stage and the limits of their performance and reliability are not fully known. The evidence thus far available, however, shows that they stand high in fire-retarding properties and that they may prove satisfactory in other respects. The formulas are being made public, therefore, for experimental use during the period of years that will be required to develop fully their advantages and limitations.

Borax-Linseed Oil Preparation

Borax alone with linseed oil does not produce so satisfactory a coating as when it is combined with pigments. The pigments aid in providing better brushing qualities and, of course, furnish the hiding power desired. The method used thus far to prepare the borax paints at this Laboratory is as follows:

Borax is ground in a pebble mill and screened through a 200 mesh sieve. The borax is then mixed with raw linseed oil by grinding in a pebble mill. A stock preparation containing two parts of borax to one part of oil by weight has been used for compounding with various pigment-oil pastes.

For the experimental preparations, commercial, soft paste white lead and either titanium-calcium, lithopone, or zinc oxide ground in oil have been used. The desired amount of borax-oil paste and pigment-paste have been mixed by hand or in a paint mill. A few preparations have been made by grinding all the ingredients in a pebble mill. Either method is satisfactory but the former is preferable for preparing small batches for experimental purposes. The turpentine and drier are added before use.

More tests have been made on a paint of the following composition than on any other preparation:

	Percent by weight
White lead (basis lead carbonate)........	41.0
Borax	32.0
Raw linseed oil	22.8
Turpentine	3.6
Japan drier	.6

A series of exposure tests was made on specimens coated with this paint applied at the rate of 60 grams per square foot (3 to 4 coats). Previous tests had indicated that this coating weight was necessary for good protection. Three lots of specimens were placed in rooms at a temperature of 80° F. and relative humidities of 30 percent, 65 percent, and 90 percent, respectively, and a fourth lot was placed out of doors on the Laboratory roof. Fire tests were made on specimens that had been exposed to each condition for 1, 3, 6, 12, and 30 months. No significant change in fire-retardant effectiveness was noticed in the specimens placed in the 30 percent and 65 percent relative humidity rooms even after 30 months of exposure. The fire retardance of specimens in the 90 percent room was unchanged after 12 months of exposure, but dropped considerably after 30 months of exposure. The specimens on the roof retained their effectiveness for 1 month, but after 3 months most of the fire retardance had been lost.

The behavior of this coating under 90 percent relative humidity conditions is decidedly better than most coatings of other types that have been tested. It did, however, deteriorate seriously. Whether the performance under high humidity can be improved by substituting an alkali-resistant vehicle for the linseed oil remains to be determined.

The only objectionable features of this preparation noticed were a decided yellowing of the coating and the fact that the gloss of the coating could be removed with a damp cloth. It seems possible that the yellowing can be reduced or possibly eliminated by making changes in the oil (vehicle) part of the formula.

After the foregoing exposure tests had demonstrated the possibilities of this type of paint, many additional preparations were made and tested, in which lithopone, titanium-calcium, and zinc oxide were substituted for white lead and in which the percentages of pigment, borax, and oil were varied.

Paints with satisfactory fire retardance have been prepared containing the foregoing pigments, but their fire retardance is not quite so good as that of the white lead-borax preparations. Typical formulas of these preparations having good fire retardance are:

	Percent by weight		
Pigment..........	(Titanium-calcium) 30.0	(Lithopone) 24.0	(Zinc oxide) 21.0
Borax	35.0	39.5	50.0
Raw linseed oil	30.8	32.3	24.8
Turpentine	3.6	3.6	3.6
Japan drier	.6	.6	.6

The tests with varying percentages of oil and pigment, although not entirely consistent, have shown that decreasing the percentage of oil tends to increase the fire-retardant effectiveness. From a paintability standpoint, the use of an unusually high percentage of borax is undesirable, but, on the other hand, the fire-retardant effectiveness is either lost or decreased by dropping the borax content too low. A minimum of 25 percent by weight of borax appears necessary.

The tests to date have been only with paints containing one of the four pigments listed. It is not known whether satisfactory effectiveness can be obtained with other pigments or combinations of pigments in common use, but that seems probable. Presumably, colored pigments for tinting paints containing borax must be alkali resistant.

To secure maximum fire protection, heavy applications of the paint, (3 or 4 thick coats or at least 8 gallons per 1,000 square feet) were found necessary. This is about twice the amount of paint ordinarily applied in painting woodwork. Coatings of ordinary thickness undoubtedly possess considerable fire retardance and would provide protection against comparatively weak fires.

The fact that borax is a chemically active ingredient would suggest that the paint in the can might not be stable and that the coatings, likewise, might be seriously altered in time. With the exception of the yellowing that occurs, no serious alterations of either paint in the can or of the coatings have been observed to date. Fire-tube tests on specimens coated with a white lead-borax paint prepared one year before application have shown that the fire retardance of such a paint is not decreased. Furthermore, the stock borax-linseed oil preparation containing no pigment has not deteriorated after one year in a paint can. This points to the possibility of marketing a borax-ground-in-oil preparation to be added by the user to prepared paint. The borax in oil should be made, of course, by the manufacturer of the prepared paint in which it is to be used.

The addition of borax to a paint by the small user is not very practical from the standpoint of production of a smooth coating. Fine grinding of the borax and subsequent milling in oil are necessary for smoothness. However, where appearance is no factor, the borax can be added in the home. A lumpy, rough coating results from such a preparation.

There is need for a fire-retardant paint for exterior use. Some specimens have been coated with a borax paint and then with a borax-free outside coat. No success has, as yet, been achieved by this procedure. The addition of a borax-free coat, if heavy, weakens the fire-retardant effectiveness of the borax, and, if light, does not prevent the leaching of the borax by rain. All possibilities in this respect, however, have not been exhausted.

Method of Test

The method that has been used to determine the fire-retardant effectiveness of these coatings is the fire-tube test developed at this Laboratory. In this method, fire-tube specimens measuring 40 by 3/4 by 3/8 inches, are coated with the preparation under test. The specimens are weighed before and after coating to determine the weight of coating. Coatings of various weights are normally applied to determine the minimum coating weight necessary to provide the desired protection. After a suitable conditioning period in a room maintained at 30 percent relative humidity and a temperature of 80° F., the specimens are tested in the fire-tube, as follows:

The specimen is suspended in the fire-tube and a Bunsen burner with an 11 inch flame is placed beneath the specimen. The loss in weight of the specimen and the temperature at the top of the fire-tube are recorded at intervals of 30 seconds. At the end of 4 minutes the burner is removed, but losses in weight and temperatures are recorded until burning ceases.

By this method of test, an uncoated specimen loses approximately 80 percent of its weight, only pieces of unconsumed charcoal remaining at the end. A specimen given a good coating of fire-retardant paint will lose only about 18 percent of its weight.