BUILDING NOTE

FIRE RETARDANTS FOR WOOD

by

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It is possible to make wood much harder to ignite either by correct impregnation with suitable chemicals or by applying suitable surface coatings resembling paint. In some circumstances this may be a justifiable means of improving the fire safety of a construction.

Neither impregnations nor surface coatings render wood incombustible, and in a severe fire impregnated or coated wood will be consumed and will contribute as much heat to the fire as if it were untreated. Treatments of wood with fire retardants, consequently, can be stated more clearly as aiming to prevent small fires from becoming large fires.

Impregnation is probably a more durable treatment than surface coating, but cannot be applied once the materials are in place, so that only the surface coatings are available for protection of an existing wooden building.

I. FLAME-RETARDING COATINGS

The degree of reduction secured in flame spread is dependent upon the original combustibility of the surface to be protected, the effectiveness of the treating materials used, the amount of materials applied, the thoroughness of application, and the severity of the igniting fire.

Among the many proprietary flame-retarding coatings, only a few have been listed by Underwriters' Laboratories. The American Underwriters (Coatings - Fire Retardant) list products of the following:

1. Albi Chemical Corporation,
   New York 7, N.Y..

2. Celotex Corporation,
   Chicago 13, Illinois.

3. Cheeseman Elliot Co.,
   Brooklyn 11, N.Y.

4. Flamort Chemical Co.,
   San Francisco 3, California.

5. Glidden Co.,
Cleveland 2, Ohio.

6. Morris Paint and Varnish Co.,
St. Louis 3, Mo.

7. O'Neill Floors Co.,
Cicero 50, Illinois.

Canadian Underwriters Listings Include Products of:

1. Building Products Ltd., (agents for Albi)
Montreal, Quebec.

2. Celotex Corporation.

3. Flamort Chemical Co.

4. Glidden Co.

Chemicals Commonly Used in Fire-Retarding Coatings

Flame-retarding chemicals are generally soluble in water, and when used in water-base coatings they will soften and lose their effectiveness if subjected to moist atmospheric conditions for long periods. High temperatures also accelerate deterioration. Coatings may be considered reasonably permanent for indoor use where the relative humidity is below 70 per cent and temperatures do not exceed 120°F. Solvent-base coatings are available which are about as stable as ordinary oil-base interior paint.

The principal fire-retardant chemicals in water-base paints are borax, sodium silicate and monammonium phosphate. The retardant chemicals mixed with ordinary oil paints for outside use have not yet been developed to the point of practicability, since chemicals added in sufficient quantity to be effective tend to interfere with the durability and weather-resisting qualities of the paint film. Fire-retardant paints, in general, are suitable only for inside use because the fire-retardant chemicals leach out on exposure to the weather.

The Forest Products Laboratory, Madison, Wisconsin developed fire-retardant linseed oil paints containing borax for indoor use mixed according to the following proportions by weight.

Pigment		Borax	Oil	Turpentine	Drier
	%	%	%	%	%
White Lead (basic carbonate)	41.0	32.0	22.8	3.6	0.6
Titanium-Calcium	30.0	35.0	30.8	3.6	0.6
Lithopone	24.0	39.5	32.3	3.6	0.6
Zinc Oxide	21.0	50.0	24.8	3.6	0.6

Application

Heavy applications of these paints are needed, consisting of about twice the amount of paint ordinarily applied in painting woodwork, or at least 8 gal per 1,000 sq ft. Proprietary coatings should be applied in accordance with the manufacturer's instructions.

Fire-retarding coatings are convenient for application to surfaces where the fire hazard does not warrant the higher cost of impregnated lumber or where the structure was erected before the need for additional fire protection was evident.

Most of the fire-retarding paints have fire-retarding chemicals incorporated in a vehicle for brush or spray application. (Van Kleeck, Arthur, Fire-retarding Coatings. U.S. Forest Products Laboratory Report R1280, 1948, 11p.)

Fire-hazard classifications for fire-retarding coatings are given in Underwriters' Laboratories of Canada Fire Protection Equipment List contained in their List of Inspected Appliances, Equipment, and Materials, September 1956.

The Canadian Government Specifications Board has issued a provisional specification entitled Paint; Fire Retardant, for Interior Use (1-GP-51 P). This specification applies to fire-retardant paints suitable for interior use on wood, plywood and fiberboard.

II. IMPREGNATION TREATMENTS

Many chemicals exhibit fire-retardant properties, but because of cost limitations or various objectionable characteristics, comparatively few are considered practical. Penetration into the wood is usually obtained by vacuum-pressure methods similar to those used in the wood-preserving industry, and the operation is controlled to secure a predetermined adsorption of solution. Subsequent to treatment, the material must usually be dried before use.

Besides the actual cost of the fire-retardant chemicals used, impregnated wood must bear the overhead of a treating plant, technical control and inspection cost, rehandling and redrying costs, and, probably, additional transportation charges. The fact that lumber impregnated with flame-retarding salts is very hard on ordinary machine tools should be considered. Special tools prove an economy if machine work is extensive.

On surfaces exposed to the weather, a paint coating to protect against leaching is usually provided.

Impregnation can be made more effective than coatings. Such treatments will not prevent wood from charring when exposed to fire or fire temperatures, but they can be expected to delay ignition, sometimes even prevent ignition, and to retard the burning and spread of fire beyond the point of ignition. Properly treated wood will not continue to burn when the igniting source is removed or exhausted.

The greatest benefit from these treatments is the reduction in the tendency for wood to ignite and to support the spread of flame.

The fire-retarding effect of impregnation treatments is dependent upon:

(a) chemicals used;
(b) depth of impregnation;
(c) amount of chemical retained;
(d) severity of fire exposure, particularly size of fire and duration.

Method of Impregnation

The chemicals in solution are usually injected into wood by a full-cell pressure method. For a high degree of effectiveness 5 to 6 lb of the more effective chemicals per cu ft of wood in thicknesses of less than 2 inches are required, or approximately 400 to 500 lb per thousand bd ft. Lumber in thicknesses greater than 2 inches requires proportionately less chemical. Dipping, brief soaking, and superficial treatments do not usually give sufficient absorption or penetration in lumber to yield adequate fire retardance.

Impregnation should be as complete as possible for 2-inch or smaller members. Partial impregnation is more common, cheaper, and generally more practical than complete impregnation for timbers larger than 2 inches in minimum dimension, and if the retention is high in the outer layers, the protection is adequate for most purposes. Only partial impregnation is possible with some species of wood and with most timbers of large commercial size.

Lumber and plywood impregnated with fire retardants are commercially available in Canada.

Specifications are available from the Navy Department, Washington 25, D.C., which can be used as guides in the purchase of fire-retardant treated lumber. These are the following:

(1) Departments of Army, Navy, and Air Force. Chemicals, fire retardant, for lumber and timber. Military Spec. MIL-C-2865, 1951.

(2) Departments of Army, Navy, and Air Force. Chemicals, fire retardant, for lumber and timber (recommended treating practice). Military Spec. MIL-C-2799, 1951.

Chemicals Used for Impregnation Treatment

Fire-retarding chemicals commonly used include monammonium phosphate, diammonium phosphate, ammonium sulphate, borax and boric acid, and zinc chloride. The ammonium phosphates are effective in checking both flaming and glowing. Borax is effective in checking flaming but is not a good glow retardant. Boric acid is effective in stopping glow but is not so effective against flame. Therefore, borax and boric acid are usually used in combination.

Fire-retarding treating formulations are usually mixtures of chemicals. Typical formulations are given in the following:

(1) American Wood Preservers' Association. Report of Committee 9, fireproofing, American Wood Preservers' Association, Proceedings, vol. 40, 1944.

(2) Angell, H.W. Production and use of fire retardant treated lumber. Forest Products Research Society, Proceedings, vol. 5, Madison, Wis., 1951.

(3) Departments of Army, Navy, and Air Force. Chemicals, fire retardant, for lumber and timber. Military Spec. MIL-C-2865, 1951.

Results of fire tests of wood impregnated with several fire-retarding formulations and chemicals that protect against both fire and decay are discussed in (1) above.

Three formulations of fire-retardant chemicals are given in the standards of the Canadian Standards Association (080-P10) as follows:

(a) chromated zinc chloride (FR) consists of 80 per cent chromated zinc chloride, 10 per cent ammonium sulphate, and 10 per cent boric acid.

(b) "minalith" contains 10 per cent diammonium phosphate, 60 per cent ammonium sulphate, 10 per cent sodium tetaborate, and 20 per cent boric acid.

(c) "pyresote" contains 35 per cent zinc chloride, 35 per cent ammonium sulphate, 25 per cent boric acid, and 5 per cent sodium bichromate.

From 2 1/2 to 5 lb of chemical (dry basis) per cu ft of wood treated are needed to give good protection against ignition and burning. Pressure treatment is required to get these concentrations.

Effect of Treatments

(1) permanence - most chemicals used are more or less soluble in water and leach out after continued exposure to the elements. No practical treatment has, as yet, been developed which is permanently effective for exposed wood (e.g. shingled roofs).

(2) strength - treatments may reduce the strength of materials treated, though with commonly used materials this is not important.

(3) effect on woodworking tools.

(4) deterioration - some treatments tend to promote deterioration of the material, i.e., corrosion of metal fastenings.

(5) effect on paints, dyes, and glues - some chemicals have an adverse effect on paints or tend to affect colors.

Bibliography (i) Departments of Army, Navy and Air Force. Chemicals, fire retardant, for lumber and timber. Military Spec. MIL-C-2865, 1951.

(ii) McNaughton, G.M. Fire retardant treatments for wood. National Fire Protection Association Quarterly, January, 1943.

(iii) Black, John M. The effect of fire retardant chemicals on glues used in plywood manufacture. U.S. Forest Products Laboratory Report No. R1427, 1943, 7p. illus.

(6) moisture absorption - some otherwise effective chemicals are hygroscopic and absorb moisture from the atmosphere to make the treated material objectionably damp.

(7) toxicity - certain chemicals such as those containing arsenic are sufficiently poisonous to be unsuitable for some uses.

(8) cost - the cost of the treatment must be moderate if it is to be practicable; cost should be considered in relation to the length of life of the structure, maintenance expense, etc.

III. STANDARD TESTS

The following standards of the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. are available at 30 cents each:

(1) ASTM E69-50 - Method of test for combustible properties of treated wood by the fire-tube apparatus.

(2) ASTM E84-50T - Method of fire hazard classification of building material (tentative).

(3) ASTM E119-54 - Methods of fire tests of building construction and materials.

(4) ASTM E160-40 - Method of test for combustible properties of treated wood by crib test.

(5) ASTM E152-41 - Methods of fire tests of door assemblies.

The occupational disease hazard in preparing, applying, and using fire-retardant chemicals is slight. However, protective equipment such as rubber gloves and splash-proof goggles, is recommended when mixing the chemicals, and respirators should be worn while spraying, particularly in poorly ventilated spaces.

Additional Bibliography

"Fire-Retarding Treatments for Wood" published by the National Safety Council as Data Sheet 372 in National Safety News, August 1955.