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CALCAREOUS MATRIX BODY COATED WITH REACTION PRODUCT OF AN ALKALI METAL BORO-PHOSPHATE AND A METAL SILICOFLUORIDE

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This invention relates to an inorganic coating composition, and more particularly relates to an inorganic, incombustible surface-hardening coating treatment for fiber-reinforced panels having a calcareous matrix.

Various types of fiber-reinforced structural panels having an inorganic calcareous matrix such as hydraulic cement or hydrous calcium silicate have been fabricated for various purposes. One of the major uses of such panels is in construction where strong, rigid, and yet light weight inorganic insulating panels are desired. A product ideally suited for use in such a manner is one composed of a heat-stable fiber such as asbestos in a matrix of hydrous calcium silicate. While relatively strong and hard panels are formed from such compositions, the lower density and obviously lighter weight products are most desirable for many uses, as, for example, in maritime construction. It is apparent that as the density of such a fiber-reinforced calcareous matrix body decreases, the strength and hardness of the body decrease and the porosity of its surfaces increases.

Softer and more porous surfaces on such structural panels have the disadvantages of being subject to damage and marring by scratching, gouging, or the like, and also have the objectional characteristic of high capillarity and hence high absorption of paint applied thereto. Various coating materials have been proposed to serve as a paint-sealing and surface-hardening coating for such materials. Heretofore the panels have been treated with linseed oil, a phenolic resin, or the like, and the coating then heat-cured on the board. While these procedures lend a satisfactory surface to such panels for many purposes, they have often been considered unsuitable, particularly for use on panels to be used in confined quarters, due to their organic, thermally decomposable nature. Although the panels themselves are inorganic and hence incombustible, such coatings thereon are combustible; and, when such panels are exposed to high heat or flame, the coatings decompose with smoking, flaming, and the formation of disagreeable odors and gases.

Accordingly, it is an object of this invention to provide a fiber-reinforced, inorganic structural panel containing an inorganic and incombustible surface impregnant.

It is a further object of this invention to provide a relatively light weight panel having an inorganic, surface-hardening and sealing coating thereon.

It is an additional and more specific object of this invention to provide a light weight, asbestos-reinforced, lime-silica panel having an inorganic, incombustible surface-hardening coating thereon.

With the above objects and features in view, the invention consists in the improved coating composition and panel incorporating it hereinafter described and more particularly defined in the accompanying claims.

It has been found that structural bodies as, for example, light weight panels containing thermally staple reinforcing fiber in a calcareous matrix may be surface-hardened and sealed by initially impregnating the surface thereof with a

relatively small amount of an alkali metal boro-phosphate solution containing complex salts equivalent to those derived from a mixture of an alkali metal oxide, P_2O_5 and B_2O_3 in fixed proportions, and then treating the thus coated surface with a solution containing either magnesium or zinc silicofluoride.

The alkali metal boro-phosphate solution employed as the initial impregnant for surface-hardening panels in accordance with this invention is characterized by a pH of approximately 5.5 to 9 and may be obtained by dissolving a mixture of compounds which will result in a solution of complex salts equivalent to approximately 20 to 50% alkali metal oxide, 12 to 30% P_2O_5, and 30 to 65% B_2O_3, based on the dry solids. Such mixtures may be obtained, for example, by forming a solution of proper portions of borax and phosphoric acid; borax, di-sodium phosphate and caustic soda; boric acid, phosphoric acid and potassium hydroxide; borax, tri-sodium phosphate and phosphoric acid; etc. In the preferred embodiment of the invention the boro-phosphate solution is equivalent to approximately 20 to 30% alkali metal oxide, 15 to 25% P_2O_5 and 50 to 60% B_2O_3, with Na_2O being the preferred alkali metal oxide.

When a panel of the type herein disclosed is impregnated with the alkali metal boro-phosphate solution alone and the panel is baked and dried, the surface is substantially sealed and hardened by the setting of the inorganic solids to a glassy state. Unfortunately, however, the alkali metal boro-phosphate coating retains its water-solubility after such a treatment, is hygroscopic, and hence the surface of the panel tends to soften and become tacky when dampened or exposed to high humidity.

It has been found that treatment of the alkali metal borophosphate impregnated panel with a magnesium or zinc silicofluoride solution or a mixture of these silicofluorides, results in a surface coating, hardening and sealing impregnant which does not have this undesirable characteristic of water-solubility with its inherent tackiness and non-permanence of the coating. The magnesium and the zinc silicofluorides, as heretofore indicated, are water-soluble salts, whereas, unorthodox as it may seem chemically, the alkali metal silicofluoride salt is for all practical purposes, water-insoluble. While not limiting this invention to any particular theory, it would appear that the double coating treatment employed results in a double chemical interaction between the alkali metal boro-phosphate and the magnesium or zinc silicofluoride to produce an alkali metal fluosilicate and magnesium or zinc boro-phosphate. Both of these formed salts are water-insoluble and the resultant composition serves as a permanent hard surfacing coating on the panels treated in accordance with this invention.

In surfacing relatively light weight panels such as those formed of a fiber-reinforced calcareous matrix in accordance with this invention, the panels are initially impregnated with the alkali metal boro-phosphate solution, normally in amount sufficient to deposit approximately 50–200, and preferably about 100, lbs. of solids per 1000 square feet of surface treated. While the impregnant may be employed in the cold state, in order to obtain optimum impregnation or penetration of the boro-phosphate into the panel to be treated, the solution is preferably heated to a temperature of approximately 150–180° F. It has been found that the use of such a warm solution enables relatively fast and thorough surface impregnation of the panel. Any suitable coating means such as dipping, spraying, or brushing may be employed. In the preferred procedure it has been found that dipping of a panel in a warm coating solution for ½ to 5 minutes results in a thorough initial surface impregnation of the panel.

After the panels have been treated with the boro-phosphate solution, they are preferably allowed to surface

drain or partially dry and are then coated with the magnesium or zinc silicofluoride solution in amount sufficient to deposit approximately 5–30, and preferably about 10, lbs. of solids per 1000 square feet of surface treated. While not necessary for the invention, the surface draining or drying step is employed in any procedure where the bulk of the silicofluoride solution comes in contact with the initially coated panels in order to prevent, as much as possible, contamination of the silicofluoride solution with the borophosphate solution. Any suitable coating method may be employed for treatment of the panel with the silicofluoride solution, as for example, spraying, dipping, brushing and the like. In the preferred procedure, the silicofluoride solution is employed at a relatively low concentration, as for example, approximately 1 or 2 lbs. of salt per gallon of water, and the solution is employed at normal temperatures. A short dipping procedure has been found most suitable in the preferred embodiment of this invention.

After the alkali metal boro-phosphate impregnated panel has been coated with the magnesium or zinc silicofluoride solution, as indicated above, the treated panel is then dried, preferably in an oven, in order to drive off excess water, complete the chemical reactions, and produce a hard, moisture-resistant, paintable surface thereon. Optimum surface-coated panels have been obtained by baking the double coated panels in an oven at a temperature of, for example, 220–250° F. for a period of, for example, 2–4 hours.

In a specific embodiment of this invention a panel comprising asbestos reinforcing fiber in a hydrous calcium silicate matrix, having a density of approximately 36 lbs./cu. ft. was immersed for about one minute in an aqueous solution of sodium borophosphate having a specific gravity of approximately 1.2 and containing approximately 30% of sodium boro-phosphate solids composed of complex salts equivalent to approximately 37% Na_2O, 26% P_2O_5 and 37% B_2O_3, which was heated to a temperature of approximately 160–170° F. This coating procedure resulted in an impregnation of approximately 120 lbs. of solids per 1000 square feet of board surface. After impregnation, the excess coating solution was removed from the board by draining and partial surface drying at room temperature. The impregnated panels were then given a second treatment by spraying the sheets with a cold magnesium silicofluoride solution made by dissolving one lb. of the salt per gallon of water, in amount sufficient to deposit approximately 10 lbs. of magnesium fluosilicate solids per 1000 square feet of board surface treated. The double coated sheets were then dried in an oven at approximately 250° F. for about 4 hours. After drying, the impregnated panels obtained exhibited extremely hard and non-porous, inorganic, incombustible coated surfaces and were ideally suited for use as structural panels. The surfaces exhibited a Taber shear hardness of approximately 600 and required at least 50 Abraser cycles for removal under N. E. M. A. Standards.

Another asbestos fiber reinforced hydrous calcium silicate panel was similarly treated by impregnating it with a warm (160–180° F.) solution of a potassium boro-phosphate formed of boric acid, phosphoric acid and potassium hydroxide in proportions equivalent to approximately 43% B_2O_3, 43% K_2O and 14% P_2O_5, in amount sufficient to deposit 100 lbs. of solids per 1000 square feet of board surface. After allowing the panel to drain and partially dry, it was immersed in a solution of magnesium fluosilicate to deposit thereon approximately 10 lbs. of solids per 1000 square feet. The double coated sheets were then oven dried at approximately 250° F. After drying the panels were substantially similar to the surface hardened sheets obtained in the preceding example and exhibited a Taber shear hardness of approximately 580.

It has been found that the sequence of coatings hereinbefore disclosed is necessary to obtain the permanent hard surface coating employed in this invention. Treatment of the panels with the silicofluoride solution as the initial impregnant does not result in a permanent coating; rather, the surface coating obtained is comparable to that obtained when using the aqueous alkali metal borophosphate alone.

While this invention has been particularly disclosed as of prime utility in coating relatively light weight, fiber-reinforced, hydrous calcium silicate panels, it is to be understood that the invention has utility in coating any type body upon which there is desired a hard, inorganic, incombustible coating. It is also to be understood that the hard surface-coated bodies herein disclosed have utility other than as the surfacing materials disclosed; for example, such panels are ideally suited for use as core panels in the fabrication of various types of laminates since the inorganic coating allows strong bonds with common veneering adhesives.

It is immediately apparent from a consideration of this invention that the procedure defined herein has many advantages over the conventional linseed oil or phenolic resin treatment of similar products. Insofar as the finished product is concerned, the coated panels formed in accordance with this invention have the important advantages of being completely inorganic and incombustible and having relatively hard surfaces. Insofar as manufacturing problems are concerned, the herein-disclosed procedure has the advantages that the coating materials are all in water solution and are odorless, low temperature drying ovens rather than high temperature baking ovens may be employed, and danger of fires in the baking oven are eliminated.

This application is a continuation-in-part of application Serial No. 327,918, filed December 24, 1952.

It will be understood that the details given herein are for the purpose of illustration, not restriction, and that variations within the spirit of the invention are intended to be included in the scope of the appended claims.

What we claim is:

1. A body comprising staple reinforcing fibers in a calcareous matrix, said body having a surface hardening and sealing coating thereon, said coating comprising the reaction product of an initial surface impregnant comprising approximately 50–200 lbs. of solids per 1000 square feet of surface treated of an alkali metal borophosphate solution, and a coating of approximately 5–30 lbs. of solids per 1000 square feet of surface treated of a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

2. A body comprising staple reinforcing fibers in a calcareous matrix, said body having a surface hardening and sealing coating thereon, said coating comprising the reaction product of an initial surface impregnant comprising approximately 50–200 lbs. of solids per 1000 square feet of surface treated of an alkali metal boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 50% alkali metal oxide, 12 to 30% P_2O_5 and 30 to 65% B_2O_3, based on the dry solids, and a coating of approximately 5–30 lbs. of solids per 1000 square feet of surface treated of a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

3. A structural panel comprising staple reinforcing fibers in a calcareous matrix, said panel having a surface-hardening and sealing coating thereon, said coating comprising the reaction product of an initial impregnant comprising approximately 50–200 lbs. of solids per 1000 square feet of surface treated of a sodium boro-phosphate solution, and a coating of approximately 5–30 lbs. of solids per 1000 square feet of surface treated of a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

4. A structural panel comprising staple reinforcing fibers in a hydrous calcium silicate matrix, said panel having a surface-hardening and sealing coating thereon, said coat-

ing comprising the reaction product of an initial impregnant comprising approximately 50–200 lbs. of solids per 1000 square feet of surface treated of a sodium boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 50% Na_2O, 12 to 30% P_2O_5 and 30 to 65% B_2O_3, based on the dry solids, and a coating of approximately 5–30 lbs. of solids per 1000 square feet of surface treated of a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

5. The method of surface hardening and sealing a body comprising staple reinforcing fibers in a calcareous matrix, which comprises surface-impregnating said body with an alkali metal boro-phosphate solution, coating said body with a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides, and drying the body.

6. The method of surface hardening and sealing a body comprising staple reinforcing fibers in a calcareous matrix, which comprises surface-impregnating said body with an alkali metal boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 50% alkali metal oxide, 12 to 30% P_2O_5 and 30 to 65% B_2O_3, based on the dry solids, coating said panel with an aqueous solution of a salt selected from the group consisting of zinc and magnesium silicofluorides, and drying the panel.

7. The method of surface-hardening and sealing a structural panel comprising staple reinforcing fibers in a hydrous calcium silicate matrix, which comprises surface-impregnating said panel with a sodium boro-phosphate solution, coating said panel with a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides, and drying the panel.

8. The method of surface hardening and sealing a body comprising staple reinforcing fibers in a calcareous matrix, which comprises surface-impregnating said body with an alkali metal boro-phosphate solution in amount sufficient to deposit approximately 50–200 lbs. of solids per 1000 square feet of surface treated, coating said body with a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides in amount sufficient to deposit approximately 5–30 lbs. of solids per 1000 square feet of surface treated, and drying the body.

9. The method of surface hardening and sealing a panel comprising staple reinforcing fibers in a calcium matrix, which comprises surface-impregnating said panel with an alkali metal boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 50% alkali metal oxide, 12 to 30% P_2O_5 and 30 to 65% B_2O_3, based on the dry solids, in amount sufficient to deposit approximately 50–200 lbs. of solids per 1000 square feet of surface treated, coating said panel with a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides in amount sufficient to deposit approximately 5–30 lbs. of solids per 1000 square feet of surface treated, and drying the panel.

10. The method of surface-hardening and sealing a structural panel comprising staple reinforcing fibers in a calcareous matrix, which comprises surface-impregnating said panel with a sodium boro-phosphate solution in amount sufficient to deposit approximately 50–200 lbs. of solids per 1000 square feet of surface treated, coating said panel with a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides in amount sufficient to deposit approximately 5–30 lbs. of solids per 1000 square feet of surface treated, and drying the panel.

11. The method of surface-hardening and sealing a structural panel comprising staple reinforcing fibers in a calcareous matrix, which comprises surface-impregnating said panel with an alkali metal boro-phosphate solution having a temperature of approximately 150–180° F., coating said panel with a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides, and drying the panel.

12. The method of surface-hardening and sealing a structural panel comprising staple reinforcing fibers in a hydrous calcium silicate matrix, which comprises surface-impregnating said panel with an alkali metal boro-phosphate solution having a temperature of approximately 150–180° F. in amount sufficient to deposit approximately 50–200 lbs. of solids per 1000 square feet of surface treated, coating said panel with an aqueous solution of a salt selected from the group consisting of zinc and magnesium silicofluorides in amount sufficient to deposit approximately 5–30 lbs. of solids per 1000 square feet of surface treated, and drying the panel.

13. The method of surface-hardening and sealing a structural panel comprising staple reinforcing fibers in a calcareous matrix, which comprises surface-impregnating said panel with an alkali metal boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 30% alkali metal oxide, 15 to 25% P_2O_5 and 50 to 60% B_2O_3, based on the dry solids, in amount sufficient to deposit approximately 50–200 lbs. of solids per 1000 square feet of surface treated, coating said panel with an aqueous solution of a salt selected from the group consisting of zinc and magnesium silicofluorides in amount sufficient to deposit approximately 5–30 lbs. of solids per 1000 square feet treated, and drying the panel.

14. The method of surface-hardening and sealing a structural panel comprising staple reinforcing fibers in a calcareous matrix, which comprises surface-impregnating said panel with a sodium boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 30% Na_2O, 15 to 25% P_2O_5 and 50 to 60% B_2O_3, based on the dry solids, in amount sufficient to deposit approximately 50–200 lbs. of solids per 1000 square feet of surface treated, coating said panel with an aqueous solution of a salt selected from the group consisting of zinc and magnesium silicofluorides in amount sufficient to deposit approximately 5–30 lbs. of solids per 1000 square feet treated, and drying the panel.

15. A body comprising staple reinforcing fibers in a calcareous matrix, said body having a surface hardening and sealing coating thereon, said coating comprising the reaction product of an alkali metal boro-phosphate solution and a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

16. A body comprising staple reinforcing fibers in a calcareous matrix, said body having surface hardening and sealing coating thereon, said coating comprising the reaction product of an alkali metal boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 50% alkali metal oxide, 12 to 30% P_2O_5 nd 30 to 65% B_2O_3, based on the dry solids, and a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

17. A body comprising staple reinforcing fibers in a calcareous matrix, said body having a surface hardening and sealing coating thereon, said coating comprising the reaction product of an initial surface impregnant comprising an alkali metal boro-phosphate solution and a coating of a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

18. A body comprising staple reinforcing fibers in a calcareous matrix, said body having a surface hardening and sealing coating thereon, said coating comprising the reaction product of an initial surface impregnant comprising an alkali metal boro-phosphate solution having a pH of approximately 5.5 to 9 and equivalent to approximately 20 to 50% alkali metal oxide, 12 to 30% P_2O_5 and 30 to 65% B_2O_3, based on the dry solids and a coating of a solution of a salt selected from the group consisting of zinc and magnesium silicofluorides.

No references cited.

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