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METHOD OF PRODUCING NONCOMBUSTIBLE BUILDING BOARDS

Erik B. Björkman, Fagersta, Sweden

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The present invention relates to a method of producing non-combustible building boards which can be used both as lining on the inside of walls or ceilings and as insulating material.

The need of such boards has long made itself felt but the problem has not hitherto been solved in a technically or economically satisfactory manner. For the said purposes porous and hard wood-fibre wall-board is generally used with resultant great fire hazards by reason of the fact that these products easily catch fire and burn with great violence, thereby giving spread to the fire from room to room.

Another well-known product are so called gypsum boards comprising a layer of plaster surrounded by a paper cover. Apart from the fact that in a fire the paper cover burns up immediately on the side exposed to the flames this product is non-combustible but has little insulating value and is expensive in production, particularly in countries lacking in native gypsum deposits.

According to the present invention building boards are produced predominantly from inorganic fibre materials with high melting point which serve to inhibit combustion. Suitable fibres for the purposes of the invention are artificially produced mineral wool fibres, by which are understood glass wool, rock wool and slag wool, or natural fibre materials, such as asbestos.

As a binding material to bond the fibres together into a strong nonflexible board, organic or inorganic materials of such nature and in such concentrations are used, that the finished board does not support combustion.

Characteristic of the invention is the fact that the mineral wool or asbestos fibres, or both in combination, are made into a pulp by being added to a dilute solution of gelatinized starch, with or without other binding agents, whereupon the pulp is dewatered and made into a board on a continuous boardmaking machine of conventional type, and dried. Pressure may or may not be applied to the board in the drying process.

The invention is carried into effect in such manner that a dilute solution of the binding materials is first prepared. Thereupon the fibre material, for example dry mineral wool emerging directly from the mineral wool plant, is pulped in the solution. A wet sheet is then formed by means of a board machine of suitable type such as that commonly employed in the manufacture of wallboard.

The wet sheet having been formed and cut into desired lengths, it is transferred by suitable mechanical means known in the art to a dryer of conventional type, for example a continuous multistorey dryer or a press. The former type of equipment is employed when porous insulating boards are to be made, while press-drying is employed in the production of hard boards. In the drying process hardness and strength are imparted to the board thanks to the bonding action of the glue.

After sawing to requisite size the board is ready for immediate use.

The binder comprises starch which has been made to swell by heating in water above the gelatinizing temperature with or without the addition of other binding materials of organic or inorganic origin. Suitable such additions of organic composition are partially or wholly saponified resin acids present in rosin, colophonium, tall oil and the like, or saponified fatty acids, with or without an emulsified surplus of the original compound, i. e. the rosin, colophonium, tall oil, fats, etc. A suitable inorganic addition is waterglass.

Other suitable additions are blood albumins, phenolic resins, melamine resins, urea resins, soluble cellulose derivatives, and similar binding materials known in the art.

The starch solution with or without additions is diluted in water to low concentration, for example less than 1% or at any rate rather less than 2% by weight of the organic matter, whereupon the mineral wool or the asbestos or both together are pulped therein. It will now be found that the starch molecules are attracted to the surface of the fibres with the result that far higher starch concentration will be present in the finished product than could be expected from the concentration of the starch solution itself.

This effect which would appear to originate in electrophoresis is highly important from the technical aspect, in that thereby the formation of a board by means of a continuous wire-cloth in a board machine of conventional type becomes a practical possibility. Thus, mass production may be carried out and the cost of producing the board may be reduced to such levels that the article may find employment in house building as well as for such specialized purposes as acoustical tiles, insulation, etc. Thanks to the low concentration of binding agents in the return water from the board machine, rapid drainage of surplus liquid required for the pulping of the fibres and the felting of the board on the machine takes place, with the result that normal production procedure becomes possible.

Control of the operation and as a result thereof of the content of organic substance in the finished product is obtained by regulating the pH-value of the pulp. When starch alone is employed as the binder, the regulation of the pH-value is suitably carried out by addition of a strong base, such as sodium hydrate, to the water in which the starch is gelatinized and by subsequently acidifying by means of a dilute acid, such as sulphuric acid. The final pH-value should suitably be kept below 6.

Example 1.—Mineral wool was pulped to a concentration of 40 kg. per cubic metre of pulp in a solution of starch gelatinized in water made alkaline with sodium hydroxide, the starch concentration being 0.24%. Sulphuric acid was then added until the pH-concentration became 5.8. After having been made into a board by means of a continuous board-machine employed in the ordinary manner, and dried, the product was found upon analysis to contain 4.5% of organic matter by weight of the mineral wool. Thus about 70% of the original starch weighed in for the gelatinization was found to have adhered to the mineral wool. The modulus of rupture of the board was 19.7 kg./cm.² while the corresponding value of a commercial insulating wood-fibre board of the same thickness was 24 kg./cm.². The mineral wool board was slightly heavier than the wood-fibre board but did not ignite when subjected to a Bunsen flame whereas the wood-fibre board when exposed to the flame immediately caught fire and burnt briskly to ashes.

An even more complete retention of the organic binding material on the mineral wool fibres is obtained when

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the gelatinized starch is mixed with an emulsion of partly saponified resin acids and is acidified by means of a suitable metal salt, such as aluminium sulphate, iron sulphate, zinc sulphate, or the like. The salt lowers the pH-value and thereby breaks the emulsion, thus precipitating the surplus resins, and also precipitates insoluble metal soaps. By this means complete precipitation of all organic matter on the fibres takes place, and a method is provided according to which the content of binding material in the finished product may be controlled at will.

Example 2.—A pulp was made of mineral wool fibres, the concentration being 40 kg. per cubic metre of pulp, in a solution of starch gelatinized in slightly alkaline water containing 0.24% starch with an admixture of 0.024% of tall oil emulsified in water made alkaline by the addition of very small quantities of sodium hydroxide. The pulp was thereupon acidified by adding a 10% solution of aluminium sulphate until the pH-concentration had fallen to 5.6. A board was made by means of a commercial board machine and analysed. It was found that complete precipitation of the added organic compounds on the mineral fibres had occurred. The mineral wool board had greater strength than a commercial wood-fibre board but did not ignite or support combustion.

Example 3.—The same procedure as that described in Example 2 was followed in making a board from asbestos fibres. The product obtained had approximately the same density as that made according to Example 2 but showed on testing a modulus of rupture of 54.7 kg./cm.².

In the same manner additions of blood albumin, phenolic resins and similar binding materials may be precipitated on the fibres.

The return water circulates in the process in the usual way or may be discarded. In the former case additions of fresh binding material is made continuously to maintain proper concentration.

After drying and cutting to size the board is ready for immediate use. When insulating board is to be made the process is normally conducted in such manner that the organic substance comprises 5% by weight of the total.

The resulting board has then a strength in the order of that of porous wood-fibre boards. For the same fibre volume and air volume the board will then weigh nearly twice as much as the corresponding wood-fibre board on account of the difference in the specific weights of the component fibres.

When the board is made into a hardboard, and mineral wool is employed as the fibre material, it has been found judicious from the point of view of strength development to add a small proportion of wood fibres or asbestos to the mineral wool during the pulping thereof. Naturally, when combustible wood-fibres enter into the composition the content of the former must not be such as to endanger the non-combustible properties of the board. Should asbestos be employed it is advisable to use long fibre quality. Additions of less than 5% of these fibres by weight of the mineral wool is sufficient to ensure a strength comparable with that of hard wallboard made of wood-fibres. It has been found convenient when hard wallboard is to be made from mineral wool to place the wet board on a thin sheet of wood-pulp or asbestos fibres. This is in practice carried out in such manner that a thin paper is fed continuously underneath the wet board when the latter leaves the board machine to go to the roller table. The paper is cut off together with the wet board. Alternatively, the wire cloth of the board machine may first be made to pick up a thin sheet of wood or asbestos pulp on top of which the mineral wool pulp is placed.

Example 4.—A hard board was made by pulping mineral wool with an addition of 5% by weight of wood-fibres defibrated by means of the Asplund defibrator in a solution of gelatinized starch in water, the concentrations

being 40 kg. of mineral wool, 2 kg. dry wood-fibre pulp and 2.4 kg. of starch per cubic metre of pulp. The binding agents were precipitated by means of aluminium sulphate, and the pulp was formed into a wet sheet which was placed upon a thin paper and was thereupon pressed and dried in the kind of press employed in making hard wood-fibre wallboard. The hard mineral wool wallboard thus produced had the same thickness as commercial wallboard and showed on test to have a modulus of rupture of 231 kg./cm.².

Mineral wool used in the process should not be impregnated at all or if it is, one should use a compound that contributes to the valuable properties of the article. Thus, suitable impregnating materials are rosins and resins of the type already referred to.

Although the procedure described in the foregoing examples is preferred in practical application of the invention, the precipitation may also be carried out in the reverse order without prejudice to the invention, i. e. the starch can be gelatinized in an acid or an acidic salt such as aluminium sulphate and the emulsion of tall oil added thereto after the addition and pulping of the mineral fibres.

So called "shot" which often occurs in mineral wool is of no value to the process and should be removed before the mineral wool pulp is delivered into the board machine.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Method of producing stiff hard non-combustible building boards comprising the steps of heating a slurry of starch and alkaline water above the gelatinizing temperature of the starch, preparing therefrom a diluted starch solution containing less than 2% of starch, pulping mineral fibers in said solution, acidifying said solution by adding an acid thereto until the pH-value is below 6, dewatering the resulting pulp and forming it into a sheet or board on a continuous board machine and drying the sheet.

2. Method of producing stiff hard non-combustible building boards comprising the steps of heating a slurry of starch and alkaline water above the gelatinizing temperature of the starch, adding thereto a solution of a binder comprising a saponified resin acid, preparing from the mixture a diluted starch solution containing less than 2% of starch, pulping mineral fibers in said solution, acidifying said solution by adding an acid thereto until the pH value is below 6, dewatering the resulting pulp and forming it into a sheet or board on a continuous board machine and drying the sheet.

3. Method of producing stiff hard non-combustible building boards comprising the steps of heating a slurry of starch and alkaline water above the gelatinizing temperature of the starch, adding thereto a solution of a binder comprising a saponified resin acid, preparing from the mixture a diluted starch solution containing less than 2% of starch, pulping mineral fibers in said solution acidifying said solution by adding a solution of an acid metal salt thereto until the pH value is below 6, dewatering the resulting pulp and forming it into a sheet or board on a continuous board machine and drying the sheet.

4. Method of producing stiff hard non-combustible building boards comprising the steps of heating a slurry of starch and alkaline water above the gelatinizing temperature of the starch, adding thereto a solution of a binder comprising a saponified resin acid and a saponified fatty acid, preparing from the mixture a diluted starch solution containing less than 2% of starch, pulping mineral fibers in said solution, acidifying said solution by adding a solution of an acid metal salt thereto until the pH value is below 6, dewatering the resulting pulp and forming it into a sheet or board on a continuous board machine and drying the sheet.

5. Method of producing stiff hard non-combustible building boards comprising the steps of heating a slurry of starch and alkaline water above the gelatinizing tem-

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perature of the starch, adding thereto a solution of saponified fatty acid, preparing from the mixture a diluted starch solution containing less than 2% of starch, pulping mineral fibers in said solution, acidifying said solution by adding a solution of an acid metal salt thereto until the pH value is below 6, dewatering the resulting pulp and forming it into a sheet or board on a continuous board machine and drying the sheet.

6. Method of producing stiff hard non-combustible building boards comprising the steps of heating a slurry of starch and alkaline water above the gelatinizing temperature of the starch, adding thereto a solution of saponified resin acid binder, adding the mixture to the return

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water from a continuous wallboard machine to produce a diluted starch solution containing less than 2% of starch, pulping mineral fibers in said solution, acidifying said solution by adding a solution of an acid metal salt thereto until the pH value is below 6, forming a sheet or board from said pulp on said board machine and drying the sheet.

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