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ARTIFICIAL BOARD AND ITS MANUFACTURE.

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The present invention relates to artificial board and its manufacture, and more especially to an insulating board made of matted cellulose plant fibres having air spaces so as to serve as an efficient heat insulator. The board is made from the fibres of plants which contain a natural binding material which may be converted into a waterproof binder by suitable reagents, as hereinafter described. This application is directed particularly to the toughening of such binder by the addition of some tough water-resisting substance, such as a pitch, which makes the board tougher and less brittle.

The present invention is in the nature of a modification of an improvement on artificial board and its manufacture as developed by Clarence C. Vogt and covered by an application filed by him of even date herewith, Serial No. 222,937. In order to explain the present invention, it will be first necessary to outline the Vogt process. Certain plant materials of the character hereinafter described contain a natural binding material which may be made the basis of a waterproof binder of the completed board.

According to the Vogt process, plant materials of this character are cooked with water to partially dissolve the natural binder of the plant fibres and the material is mechanically disintegrated so as to produce a fibrous mass which is saturated with the water solution containing the natural binder. This mass is treated with a suitable reagent, such, for example, as a phenolic compound, which will convert the water soluble natural binder into a water insoluble binder, and the mass is formed into board form and so treated, as by baking, to set the binder and form the completed board product. The binding material is allowed to remain with the fibres to serve as the basis of the waterproof binder of the completed board. The binder thus formed serves to unite the fibres into a stiff structurally strong board but with a considerable number of minute spaces between the fibres in which air is entrapped and held so that the board is particularly useful as a heat insulating building material.

Plant materials other than the wood of usual trees have been found satisfactory as a basis. For example, corn stalks, corn cobs, straw, sugar cane bagasse, oat hulls, peanut shells, cat tails, salt hay, peat moss and the like, may be used. These materials, and particularly materials such as corn stalks and straw, contain a natural binder which may be partially dissolved or decomposed by cooking with water, either hot water or steam, and which serves as the basis for the waterproof binder of the completed board. Materials such as wood pulp made from ordinary pulp making trees do not contain such binder or sufficient quantity of the binder to be satisfactorily used alone, although the wood pulp may be used in combination with the pulp formed from materials, such as corn stalks, which are relatively rich in such binder. The binding material apparently consists of pentosans (substances from which the five carbon atom sugars may be formed by hydrolysis or other chemical means) and other organic compounds forming the binder which cements together the plant fibres. This binder, after the cooking treatment with water, may be converted into a water insoluble or difficultly soluble binder by a treatment with a suitable chemical reagent, such, for example, as a phenol, which forms upon suitable treatment, such as heating, a resin-like condensation product.

According to the preferred Vogt process, any part of the plant may be used so long as it contains the fibrous cellulose material and the natural binder. For example, the corn stalks, including the leaves, as harvested from the cornfields, may be used. The material is first preferably cut up into convenient size for handling and is cooked with water, in the form of either hot water or steam (water vapor). Therefore, when we speak of cooking or treating with water, we intend to include water either in the liquid state or in the vapor state (steam). This cooking treatmeant is preferably carried out in an autoclave under pressure at a temperature between 140° and 180° centigrade for half an hour to an hour, either using water which is heated in the autoclave or admitting steam under pressure into the autoclave. The water either in the form of hot water or steam at these temperatures dissolves or partially dissolves and decomposes the pentosans and other organic compounds which serve as the natural binder of the cellulose fibres in the plant. This treatment does not decompose or weaken

the cellulose fibres, as is the case where chemicals are used to remove the binder as has been the usual commercial practice in preparing fibres for making boards of this type. This cooking treatment softens the material so that the fibres are readily separated by suitable mechanical means, as for example, by rolling or beating in a beater, grinding in a rod mill, treating in a Jordan engine, or the like. Such treatment reduces the material into a fibrous mass, which is saturated with the water solution containing the natural plant binder. The solution is allowed to remain in the mass, so that the fibres are kept in contact and are saturated with the solution containing the natural plant binder. The natural binding material may be either dissolved in water without chemical change or may be partially decomposed by the cooking operation. The actual chemical formulæ and constitution of the substance as they exist in the water solution are not known since they apparently consists of many complex compounds.

These materials have adhesive qualities, as may be demonstrated by separating the water solution and boiling it down to a syrup-like consistency. The binding material, however, is readily soluble in water and would not in its form as produced by the cooking operation be satisfactory where a waterproof binder is desired, as in an insulating board.

The fibrous mass saturated with the water solution containing the natural binding material of the plant, is treated with a suitable reagent to render the binding material water-insoluble. For this purpose Vogt prefers to use a phenolic compound containing the characteristic phenolic OH group, together with a suitable condensing agent, such as hydrochloric acid, ammonium chloride or the like, which will react with the natural binding material to form an insoluble resinous condensation product when subjected to heat.

These reagents are preferably added to the mass before it is formed into board form, although our process is not to be limited to any particular sequence of such steps unless so specifically stated. In the preferred process, the phenolic body and the condensing agent are thoroughly mixed with the fibrous mass or pulp, which is then made into board form by the usual insulating board making machinery. This operation mats the fibres together to form the fibre board. The excess solution may be drained off from the pulp during the board making operation, although it is preferable to allow as much as possible of the solution containing the natural binder to remain in the board.

The board thus formed is baked to drive off the water and convert the natural binder into a water insoluble binder. Under the action of heat and the condensing agent, the natural binder combines with the phenolic compound used to form a resin-like water insoluble condensation product, which serves to bind together the fibres into a water repellent structurally strong but porous board. The baking may be carried out in ovens or other suitable devices, but care should be taken not to overheat the material during baking so as to weaken or char the fibres or the binder. It has been found safe to heat up to about 160° centigrade, although a somewhat lower temperature at longer times is preferable. The board as thus produced by the Vogt process, while a good board, possesses the disadvantage of being somewhat brittle. According to our improvement, the Vogt process is modified by the addition to the mixture containing the solution of the natural binder, phenolic body and condensing agent, of some tough insoluble substance, preferably a pitch-like material such as stearin pitch, petroleum pitch, wax tailings, asphalt, coal tar, wood tar, or similar materials, which does not interfere with the formation of the resinous binder but does improve its toughness. These materials may be added either with the addition of the phenolic compound before or after. Materials such as those specified do not interfere with the condensing reaction which takes place between the natural binding material or the phenol. They also tend to improve the water repelling properties of the board, as well as toughening the board making it less stiff and brittle.

In making the board, fillers may be used. For example, organic fillers such as wood pulp, paper pulp which do not contain the natural binder, or materials such as sugar cane residue, peanut hulls, corn cobs, and the like, which may contain a natural binder but which have not been cooked to render such binder available, or even inorganic materials, such as mineral wool, asbestos, or the like, may be added in various percentages, depending upon the amount of binder yielded by the plant material being used in excess of that necessary to bind it own fibres in the completed board. When such filling material is added, it is mixed with the pulp-like mass containing the plant fibres and saturating solution, so that the fibres of the filler become also saturated with the natural binder obtained from the plant, and upon condensation of the binder the whole mass is bound together.

If a fire retarding board is desired, it may be rendered resistant to fire by treatment with ammonium sulphate or ammonium phosphate or other well known fire preventing agents. This treatment does not interfere with the process of manufacture as herein outlined.

While we have specifically described the preferred embodiment of our invention, it is to be understood that the invention is not limited to the described details or sequence

of steps, but may be otherwise embodied and practiced within the scope of the following claims.

We claim:

1. The process of making board from plants of the character described, which comprises cooking the plant material and mechanically separating the fibres so as to produce a fibrous mass saturated with a water solution containing a natural binder of the plant fibres, adding to the mass a phenolic body toegther with a water insoluble toughening agent and forming it into board form, and baking the board to form a water repellent phenolic condensation product from the natural binder.

2. The process of making board from plants of the character described, which comprises cooking the plant material and mechanically separating the fibres so as to produce a fibrous mass saturated with a water solution containing the natural binder of the plant fibres, adding to the mass a phenolic body, a condensing agent and a water insoluble toughening agent and forming it into board form, and baking the board to form a water insoluble condensation product binder containing a toughened water insoluble phenolic condensation product binder from the water soluble natural binder.

3. The process of making board from plants of the character described, which comprises cooking the plant material and mechanically separating the fibres so as to produce a fibrous mass saturated with a water solution containing the natural binder of the plant fibres, and treating the mass so formed with a reagent which converts the natural plant binder into a water repellent binder, and also adding to the mass a pitch-like water insoluble material which serves as a toughening agent for the binder.

4. The process of making board from plants of the character described, which comprises forming from the plant material a disintegrated fibrous pulpy mass saturated with a water solution containing the natural binder of the plant, and adding to the mass a reagent which converts the natural binder of the plant into a water repellent binder for the board together with an agent which toughens the binder.

5. The process of making board from plants of the character described, which comprises forming from the plant material a disintegrated fibrous pulpy mass saturated with a water solution containing the natural binder of the plant, and adding to the mass a reagent which converts the natural binder of the plant into a water repellent binder for the board together with a pitch-like water insoluble agent which toughens the binder.

6. An artificial board containing fibres cemented together with a water repellent binder formed from the natural binder of the fibrous plant material employed and containing a toughening agent.

7. An artificial board containing fibres cemented together with a water repellent binder formed from the natural binder of the fibrous plant material employed and containing a pitch-like water insoluble toughening agent.

8. An artificial board containing matted fibres cemented together with a phenolic condensation product of the natural binder of the plant material employed, and containing a water insoluble toughening agent.

In testimony whereof we have hereunto set our hands.

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