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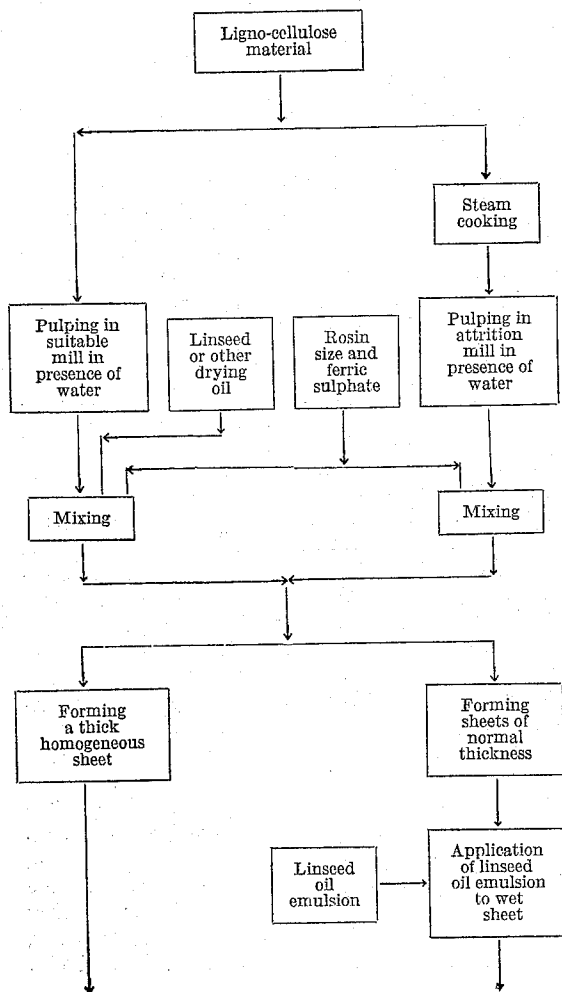
COMPRESSED CELLULOSIC PRODUCT AND METHOD OF MAKING SAME

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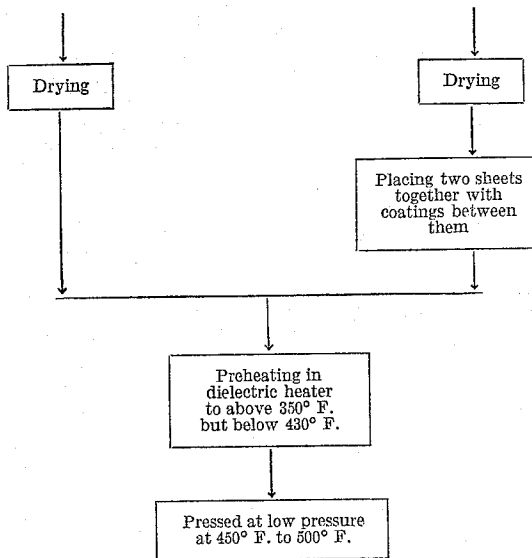
This invention relates to the production of compressed cellululosic products, particularly wherein the temperature conditions conducive to the formation of autogenously developed resinous binders resulting from the partial pyrolysis of the cellulose and/or lignocellulose therein contained. More particularly, our invention deals with the production of compressed cellululosic and/or lignocellulose products exemplified by wood, sugar cane bagasse, and the like, processed so as to produce slabs of a thickness of approximately five-sixteenths of an inch ($\frac{5}{16}$ "') to one inch (1"') or even thicker.

More particularly, the invention deals with products of the kind defined, wherein the density range of 30 pounds per cubic foot to approximately 65 pounds per cubic foot is maintained. Still more particularly, the invention deals with the production of slabs of the class described with sufficient rigidity so that they can be used, for example, as concrete forms, table tops, door panels and the like, where such rigidity as well as strength is an important factor.

A flow diagram of the process is as follows:



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While hot pressed cellululosic and lignocellulosic products, smooth on both sides, have been developed such products include the consolidation of cellululosic or lignocellulosic material at temperatures between 350° F. and one short of the development of free carbon, the upper temperature in general being somewhere around 525° F., depending upon the time of pressing. The lignocellulosic material may first be processed in steam to develop the binders from the lignocellulosic material itself and following this processing, these cooked materials are reduced to a pulp in an attrition mill. Alternatively, the lignocellulosic material may be reduced directly to a pulp through an attrition mill without first steam cooking, but, in this case, it is necessary to add certain binders, for example, linseed oil or other such binders as have been covered in certain prior art patents. The pulp however produced is formed into a sheet or mat, either on a screen wire or between the screen wires, which permits the water to be filtered away from the fibers leaving a wet mat. This wet mat is dried in a hot air dryer and following this is pre-heated and then compressed to its final condition in a hydraulic press between heated plates or platens.

Heretofore, hardboard or semi-hardboard products of the kind under consideration have not been made homogeneously in thicknesses of over approximately one-quarter inch ($\frac{1}{4}$ "') or at most, three-eighths of an inch ($\frac{3}{8}$ "'). In the past, thicker boards, for example, one-half inch ($\frac{1}{2}$ "'), even one inch (1"') or one and one-half inch ($1\frac{1}{2}$ "') boards have been made by the process of gluing a plurality of laminations together after the pressing operation. This procedure is not only expensive but laminated boards so produced have limited practical successful commercial uses.

With our improved process, thick hardboard products can be produced in an efficient and economical manner. In the formation of the wet sheet, we prefer to use either a single wire which may be either stationary or travelling, but so arranged that a fairly high head of stock can be flowed over the wire. Naturally, if it is a stationary wire, then sides like a box must be provided to retain this head of dilute pulp on the wire while the water is being drained out. If it is a travelling wire or screen, then such a screen must be of sufficient length so that the free water is drained out to a degree sufficient to permit its handling through press rolls without the pulp being squeezed out and the formation destroyed. We prefer, however, to use a double cylinder forming machine with the drainage taking place through the wire

screens on the cylindrical surfaces. With such a machine, it is possible to exert a certain pressure between the two cylinders, thus effectively squeezing out more of the water from the pulp and making it more workable through the press roll section. With such a machine, we have found it possible to make a homogeneous wet mat or sheet with a weight of as much as 1.8 pounds per square foot of area and, with certain modifications, a sheet may be formed with a weight of as much as 2.4 to 2.8 pounds per square foot of area. The above weights are on a dry basis, that is, they are the weights of the sheet after they have been passed through the dryer to remove substantially all of the water from the pulp.

The next step in the process is drying and this is done in a dryer using circulating hot air with or without radiant heat.

Following the drying operation, the sheets are then cut to the size required for pressing in a hydraulic hot plate press. Prior to pressing, it is necessary to pre-heat the mats. This pre-heating step has been done in the past in hot air dryers using circulating hot air and sometimes radiant heat as well. A limitation on such dryers has been that the hardboard mat at this stage is of low density and, by its very nature, is a heat insulating material which makes it exceedingly difficult to heat the mat completely from the outside to the center core. Such heating on dry mats weighing from $\frac{7}{10}$ of a pound to one pound per square foot of area has, in the past, taken from one to two hours exposure to the heat. A further limitation of this method of heating is that with higher temperatures than approximately 320° F. to 350° F. (depending upon the composition of the mat), there is great danger of fires. A further limitation is the fact that because of this danger of fires, the pre-heating cannot be carried to temperatures on the order of 400° F. to 450° F. which are most desirable for making the thick hardboards weighing from one pound per square foot of area up to two or three pounds per square foot of area.

A further objection to the present method of heating for long period in hot air is that the cellulosic fibers become embrittled, causing a loss of strength.

With our improved method, we use high frequency dielectric heating for pre-heating the mats. By this method, we are able to heat up the hardboard mats throughout their whole mass. By this we mean that the entire mass of the mat, whether laid individually or in superimposed piles, will be substantially heated throughout simultaneously, so that the center of each mat is being heated at the same time that outer surface portions of the mat are heated.

The heating time is on the order of one to ten minutes, depending upon the number of sheets being heated at one time and their weight per unit area. Further, this time will also depend upon the power developed in the dielectric heater.

One advantage which we have found from such heating is that the fibers are not embrittled, as in the case of the long hot air heating. Therefore, a greater strength is developed in hardboard products, in which dielectric heating is used. This strength increase is on the order of 10% on board weighing approximately one pound per square foot of area and may be as much as 20% to 30% on boards weighing from two to three pounds per square foot of area. We have found that, in conventional hot air pre-heaters with a mat entering the pre-heater with, for example 2% to 3% moisture and at a temperature of 80° F. to 100° F., after one and one-half hours in the oven used for pre-heating, the moisture has been reduced to approximately zero, but the temperature within the center of the mat, as measured by inserted thermocouples, is generally not greater than 280° F. Naturally, in a hot air oven where the hot air cannot be raised above 350° F. without danger of fire, it would be impossible (except by uncontrollable exothermic reaction) to get a temperature within the mat any higher than 350° F. and, practi-

cally, we find that this temperature within the mat is generally not more than 280° F. to sometimes 300° F. In the past, this has been satisfactory for making hardboard for the reason that, with mats which are to be compressed to one-quarter of an inch ($\frac{1}{4}$ ") or less, it is possible in the hardboard press with platens heated to approximately 500° F. to transmit sufficient heat from the outside surfaces to the center of the board, where the final thickness is no greater than approximately one-quarter of an inch ($\frac{1}{4}$ "). However, when boards are being pressed to, for example, three-eighths of an inch ($\frac{3}{8}$ ") to one inch (1"), then it becomes increasingly difficult to transmit sufficient heat to the center of the board to develop the thermoplastic properties of the ligneous binders and it becomes practically impossible in finished thicknesses in the range of three quarters of an inch ($\frac{3}{4}$ "). In other words, the board remains undercooked in the center and there is a plane of weakness down this center in the finished product.

In using high frequency dielectric heating, we heat the hardboard mat throughout, from 350° F. preferably to a temperature somewhat above 400° F., for example, 420° F. to 430° F. and then transfer this heated mat directly into the hot plate hydraulic press and immediately subject it to heat and pressure. While there is a range of temperatures which may be used in these hot plate presses, for example 410° F. to 510° F., we prefer to press at a temperature of approximately 450° F. to 500° F. Depending upon the mass and thickness of the final product, the time of pressing may vary from, for example, three minutes on a board five-sixteenths of an inch ($\frac{5}{16}$ ") thick to nine or ten minutes on a board seven-eighths of an inch ($\frac{7}{8}$ ") thick or thicker and weighing in its finished state three pounds per square foot.

While the present invention has been described for the manufacture of non-laminated homogeneous board, it is not limited to such a board, as we have found that using this dielectric heating makes it possible to apply a thin coat of certain materials which, under the influence of heat and pressure, will bond these thinner sheets together to form a single thick sheet, for example, three-quarters of an inch ($\frac{3}{4}$ ") to one inch (1") or even one and one-half inches ($1\frac{1}{2}$ "). While obviously such bonding material could be applied to the dried sheet after pressing, it is not convenient to do so and adds considerably to the cost of the product. The bonding material may be applied at any convenient point before the pre-heating. However, we prefer to apply this bonding material to the wet mat after it has left the roller press section and before it enters the dryer and, while numbers of different materials may be suitable for this bonding, we have found that an emulsion of linseed oil in water is most suitable. Such an emulsion can be roller or otherwise applied onto the wet sheet in exceedingly dilute form and so the total amount of active ingredient (linseed oil) is on the order of six to twelve pounds per one thousand (1000) square foot of area. This oil remains on the surface of the sheet and, when two such sheets are placed face to face, then pre-heated further in the dielectric heater and finally pressed in the hydraulic press hardboard of the thicknesses indicated before can be made.

For extreme thicknesses of hardboard, for example, on and one-half inches ($1\frac{1}{2}$ "), we have laminated during the pressing of the hardboard as many as four sheets into one compressed finished board and, on final testing, have found that it is not possible to separate these sheets one from another at the point of the lamination.

Hardboard of such thicknesses would not be possible even with lamination as described above, when a conventional hot air pre-heating oven is used, for the reason that, in such an oven, it is not possible to pre-heat the mats to temperatures above 350° F. and, because they cannot be pre-heated to approximately 400° F. or higher, it is not possible within the press during the hardboard

pressing time to completely cook or cure the hardboard throughout its center.

Having fully described our invention, what we claim as new and desire to secure by Letters Patent is:

1. The process of producing a homogeneous board product in a thickness greater than one-half inch which comprises forming a sheet, then drying the sheet, then dielectrically preheating the dried sheet at temperatures above 350° F. and below 430° F., and finally pressing the sheet between smooth heated platens in forming an end product having smooth opposed surfaces.

2. The process of producing a homogeneous board product in a thickness greater than one-half inch which comprises forming a sheet, then drying the sheet, then dielectrically preheating the dried sheet at temperatures from 400° F. to 430° F., and finally pressing the sheet between smooth heated platens in forming an end product having smooth opposed surfaces.

3. A process as defined in claim 2, wherein the end product has a density range of thirty pounds to sixty-five pounds per cubic foot.

4. The process of producing a homogeneous hardboard product in thicknesses greater than one-half of an inch, which comprises producing partially dried lignocellulosic sheets, bonding two or more of such sheets by the use of a bonding agent in forming a laminated mat, then preheating the mat in a dielectric heater to a temperature of 400° F. to 430° F., and then applying pressure and heat at sufficient temperature to the laminated mat to form a dense end product having smooth opposed surfaces.

5. A process as defined in claim 4, wherein an emulsion of linseed oil is utilized as a bonding agent.

6. The process as defined in claim 4, wherein the end product has a density range between thirty-five pounds and fifty pounds per cubic foot.

7. The process of producing a homogeneous hardboard product in thicknesses greater than one-half of an inch, which comprises producing partially dried lignocellulosic sheets, bonding two or more of such sheets by the use of a bonding agent in forming a laminated mat, then preheating the mat in a dielectric heater at temperatures above 350° F. and below 430° F., and then applying

pressure and heat at sufficient temperature to the laminated mat to form a dense end product having smooth opposed surfaces.

8. A hardboard product comprising a homogeneous pressed lignocellulosic product of a thickness range between one-half inch and one inch, wherein said hardboard is formed by bonding two or more partially dried lignocellulosic sheets by the use of a bonding agent in forming a laminated mat, then drying the mat, then dielectrically pre-heating the dried mat to a temperature of 400° F. to 430° F., and finally pressing the pre-heated mat between smooth heated platens in forming an end product having smooth opposed surfaces.

9. A hardboard product comprising a homogeneous pressed lignocellulosic product of a thickness range between one-half inch and one inch, wherein said hardboard is formed by bonding two or more partially dried lignocellulosic sheets by the use of a bonding agent in forming a laminated mat, then drying the mat, then dielectrically pre-heating the dried mat to a temperature of 400° F. to 430° F., finally pressing the pre-heated mat between smooth heated platens in forming an end product having smooth opposed surfaces, and said end product having a density range of thirty pounds to sixty-five pounds per cubic foot.

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