HIGH TEMPERATURE STEAM TREATMENT OF WOOD CHIPS

REDUCE WOOD CHIPS SUBSTANTIALLY TO FIBERS

FORM WET MAT OF FIBERS ON SCREEN

SQUEEZE-PRESS TO REDUCE MOISTURE CONTENT

DRY IN HOT AIR CONTINUOUS DRYER

INSTANTANEOUS SURFACE HEAT TREATMENT

HOT PRESS TO CONSOLIDATE INTO HARDBOARD
This invention relates to the manufacture of heat and pressure consolidated wood-fiber hardboard. More particularly, it is directed to a process for the preparation of a dried, wet-formed mat of wood-fiber prior to the consolidation thereof by combined heat and pressure.

The manufacture of wood-fiber hardboard consists of the formation of a relatively porous mat of woody material and the consolidation of the mat by combined heat and pressure. A high-pressure steam treatment of the woody material prior to forming, providing to some degree a conversion of the lignins and the cellulose, is commonly preferred in order to obtain, when subsequently formed and consolidated, a superior hardboard, and it is with regard to this method of hardboard manufacture that the present invention is concerned.

Of particular concern, one result of the steam treatment of woody material is the formation of water-soluble sugary material. Following the mat formation and drying, the water-solubles are, in large part, ultimately deposited on the wood fibers of the mat. The usual manner of drying, whether or not it is preceded by passing the mat through squeeze rolls to substantially reduce the water content, will include the subjection of the mat to circulating, relatively dry, heated air, as in a kiln. The mat is reduced in moisture content to a bone-dry condition or at least to a moisture content of less than 10%, preparatory to consolidation, by heat and pressure, to a relatively thinner hardboard of a specific gravity ordinarily about 1.0 or higher.

In prior processes, generally as described above, it has been considered essential to remove, in some manner, a substantial proportion of the water-solubles at some point in the process prior to the final drying, since it is known that their presence creates a problem of the surface sticking to the high temperature and pressure consolidating means, resulting in delaminated, unacceptable end products. This has been accomplished heretofore by additional washing steps prior to drying, wherein the solubles are carried away in the wash water. The washing steps are unduly costly, and, of greater significance, create a very serious problem of waste disposal.

It is an object of the present invention to provide a process for making hardboard generally in accordance with the above described preferred steps, wherein the sticking caused by the solubles is avoided, without requiring the costly and undesirable additional washing steps for their removal, and further permitting a more rapid high-temperature consolidation.

A further object of the invention is to provide a process of making hardboard wherein a high percentage of all of the natural woody material is retained and employed within the final product.

A still further object of the invention is the avoidance in the manufacture of any substantial amount of waste disposal and the consequent stream pollution problems, and providing instead a recovery of sludge and solubles in a form readily adaptable for further advantageous use.

A still further object of the invention is to provide a process of hardboard manufacture wherein a highly impervious-surfaced hardboard is produced, of improved bending strength and abrasion resistance.

These and other objects and advantages will appear more fully when considered in connection with the following detailed description of a preferred embodiment of the invention and the accompanying drawing in which a flow sheet of the process of the invention is set forth.

A preferred form of the process of the present invention, as shown in the drawing, consists of reducing raw wood to chips of a size in the order of 3/4" x 3/4" across the grain and 3/4" with the grain. The chips are then subjected to a high-temperature steam treatment, to chemically convert some of the ingredients therein, principally the lignins, into a form whereby they will subsequently provide a binder material in the consolidated board, this being in accordance with many similar prior processes. As is known, there is also produced by this treatment, a certain amount of water-soluble material, such as wood sugars, which have long been recognized as undesirable, but unavoidable.

The steam-treated chips are then reduced in size substantially to fibers by any known means such as by defibrators having closely opposed, oppositely rotating discs. The fibrous material, dispersed in an aqueous slurry, is then formed into mats by known screen forming means, such as a Fourdriner machine.

The mats, still consisting of considerable water, are then squeezed, such as by press rolls, to substantially reduce the water content, and are then dried, as in a hot air continuous dryer, to a water content of from 0% to 10%, preferably as close to 0% as practical.

In accordance with the present invention, the surfaces of the mats are then dried, heated by conduction, convection or radiation, to temperatures in excess of 400° F., preferably to in the order of 400° F. to 500° F., for very short intervals of time. The time period is preferably in the order of one second, however, it is more properly defined in accordance with the invention, as substantially the amount of time required to convert a surface-migrated layer of wood sugar from an "A" stage wherein the material is liquid when hot, solid when cold, and generally soluble in a variety of solvents, to a "B" stage wherein the material softens when heated but does not melt, will swell in solvents, but is substantially insoluble in water. The minimum temperature of 400° F. is directed at producing the above described surface treatment with a minimum of heating of the mat inward of the said surface-migrated layer of wood sugar.

In a preferred form of the invention, the dry mat is passed between rolls, such as calender rolls, which are heated to a sufficient temperature in excess of 400° F. to provide the above described surface material conversion, using roller speeds and sufficient pressure on the rolls to effect rapid heat transfer without producing a permanent densification of the mat to a specific gravity above approximately 0.2 less than the ultimate density of hardboard desired.

The above instantaneous high temperature and pressure surface treatment has been found to be capable of performance without a harmful degree of sticking occurring, still resulting in providing a surface-treated mat which may be consolidated, by the usual relatively lengthy high temperature, and pressure process, again without encountering a harmful degree of sticking.

The dry mats may alternatively be pressed between heated platens, of sufficient temperature to substantially
instantaneously heat the mat surfaces to an excess of 400° F. The mat is compressed to effect rapid heat transfer, avoiding a densification of the mat to a specific gravity in excess of approximately 0.2 less than the ultimate density desired. The platens are held under compression for only a sufficient time to convert the surface wood sugar material from the "A" stage to the "B" stage, in the order of one second.

The surface treated mat is then consolidated by the usual relatively lengthy high temperature and pressure consolidation.

Example III

Dry mats, wherein a relatively high percentage of water solubles are present at the surface, are more satisfactorily surface treated in accordance with the invention by altering the methods of Examples I and II to include a plurality of repeated surface heating steps. Thus, in Example I, rather than decreasing the speed of the high temperature rollers excessively to obtain additional time for completion of conversion of a suitable degree of "A" stage material to "B" stage material, there is performed a plurality of passes of the mat between one set or successive sets of heated rollers. Similarly, in Example II, repeated "bumps" of the high temperature press platens may be employed to provide the desired surface material conversion. The surface treated mats are then consolidated by suitable high temperature and pressure.

Example IV

To employ radiated heat in accordance with the invention, the dry mats are passed between gas-fired, infrared heaters of sufficient temperature, and using suitable speeds, to raise the mat surface temperature to an excess of 400° F., without heating substantially the mat material inward of the surface. Repeated passes may be employed if necessary to convert the wood-sugar, surface-migrated material to the "B" stage without substantial inward heating of the mat. Following surface treatment, the mat is consolidated by suitable high temperature and pressure.

Example V

Surface treatment of mats by heat convection, is possible in accordance with the invention, by passing the dry mats rapidly through a high temperature hot air oven, raising the mat surface temperature to an excess of 400° F., without heating substantially the mat material inward of the surface, converting the "A" stage surface material to the "B" stage. The mat is then consolidated by suitable high temperature and pressure.

The economic element will usually dictate, in large part, the method most advantageous for any given manufacturing facility.

As stated, the amount of water-solubles present may vary and require variation in the preferred conditions in practicing the invention. The amount of water or other forms of moisture present will further effect the necessary conditions. The presence of other naturally-occurring or added material or variation in the pH may also speed up or slow down the change from the "A" stage to the "B" stage.

Under most all conditions which may reasonably be encountered, a conversion of the water-solubles, which have been found to migrate in very high percentage to the mat surface, may be successfully, simply and economically obtained in accordance with the above methods, whereby the high temperature and pressure consolidation, to produce hardboard, may be carried out with greater facility than was common heretofore. As a further result, an improved hardboard is produced for equal or less cost, having substantially all of the natural woody material remaining and beneficially employed, providing greater strength and cohesiveness, imperviousness and resistance to abrasion.

Having completed a detailed disclosure of the preferred embodiments of my invention so that those skilled in the art may practice the same, I contemplate that variations may be made without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In the manufacture of heat and pressure consolidated wood fiber hardboard, wherein wood has been reduced substantially to fibers and said fibers have been subjected to an aqueous digestion wherein a substantial quantity of water soluble derivatives thereof are produced, the further steps comprising wet felting said fibers to form a porous wood-fiber mat containing a substantial proportion of said water soluble derivatives, drying the mat to a moisture content of less than 10%, effecting said drying of said mat in a manner whereby a substantial proportion of said water soluble derivatives are caused to move to a thin outer skin on each face of said mat, heating said thin outer skin of each face sufficiently to cause said water solubles adjacent said face to be converted to a substantially water insoluble state without substantially heating the mat inward from said skin, without consolidating said mat to a specific gravity greater than approximately 0.2 less than the specific gravity of the ultimate hardboard, and then consolidating said mat by suitable heat and pressure.

2. The method of claim 1 wherein said thin outer skin is heated to a temperature in excess of 400° F.

3. The method of claim 2 wherein said heating is for a period in the order of one second.

4. The method of claim 2 wherein said heating is performed by contacting said skin with a heated external element.

5. The method of claim 4 wherein a plurality of said contacting steps are included.

6. The method of claim 2 wherein said heating is accompanied with a compression of said mat without producing a permanent densification of said mat to a specific gravity above approximately 0.2 less than the ultimate density of hardboard to be produced.

7. The method of claim 6 wherein said heating and compression is performed by heated rollers.

8. The method of claim 6 wherein said heating and compression is performed by radiation of heat from a heating source.

9. The method of claim 2 wherein said heating is performed by radiation of heat from a heating source.

10. The method of claim 2 wherein said heating is performed by convection of heat in a hot air oven.

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