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PROCESS OF MANUFACTURING BOARD-LIKE ARTICLES

Hugh R. Rogers, Savannah, Ga.

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The present invention relates to the manufacture of a class of composite board-like products, from wood or other lignocellulosic materials, known to the industry as re-aggregated wood or chip-boards. It relates more particularly to a novel and improved method for the production of boards by the re-aggregation of raw wood particles. Even more particularly it relates to the production of such products characterized by their outstanding dimensional stability. The board products are of important commercial desirability in the manufacture of furniture and the like articles as well as in the building industry, and as core materials in the manufacture of a variety of articles.

In the production of re-aggregated wood boards, relatively small particles, i. e. chips, splinters, or shavings of natural wood, hereafter referred to as chipped wood particles in contradistinction to separated lignocellulose fibers, are dried to their equilibrium moisture content or lower and the dried particles are mixed with an aqueous resin binder and consolidated under heat and pressure. The wood particles are ordinarily obtained by mechanical reduction carried out in chippers, hammermills, shredders, hogs, planers, lathes, and the like means. While sawdust and finer wood particles may be employed, their use is not usually desirable because of the lack of fiber strength in the particles. The resin has ordinarily been applied by tumbling the wood particles while, at the same time, spraying them with a resin solution or adding the resin solution by other means. Inasmuch as the wood particles are quite dry, they naturally absorb a considerable amount of the resinous material and thus leave less of the resin on the surfaces of the particles. This sorption of the resin by the particles results in a consolidated board product characterized by its brittleness and by the relatively weak glue bond between the individual wood particles. Efforts have been made to overcome this sorption of the resin by the wood particles by the use of extenders or fillers such as wheat and rye flour, rice hulls, pecan and walnut shell flour, wood flour, and the like materials. This means of treatment prevents, at least to some extent, the sorption of the resin by the wood particles. However, it also requires that the resin treated particles be consolidated substantially immediately to prevent loss of moisture and further absorption of the resin. In any event, much of the resin is still sorbed by the wood particles and also by the material employed as an extender. Obviously, since this sorbed resin is not available for binding the wood particles together during consolidation thereof, the resin requirements are high. Moreover, when these resin treated wood particles having a relatively high moisture content are consolidated under heat and pressure, the products are characterized by relatively high densities when they are consolidated under sufficient pressure to produce a satisfactory bond between the individual particles.

It is an object of this invention to provide a method whereby the above described disadvantages are overcome in the manufacture of board products by the re-aggregation of raw lignocellulose particles.

It is another object of the invention to provide a method of applying resin uniformly over the surfaces of raw wood particles, or other lignocellulose materials, while at the same time preventing any appreciable sorption of

resin by the particles. Thus, substantially all of the resin employed will be available for binding together the individual particles into a composite product.

A further object of the invention resides in the provision of board products characterized by densities approximating that of natural wood, by their natural beauty, and by their strength and greatly improved dimensional stability under all conditions. Other objects of the invention will be apparent from the following detailed description thereof.

Briefly, the invention comprises adjusting the moisture content of the raw material, i. e. of relatively small particles of raw wood or other lignocellulosic materials such as cane, bagasse, corn stalks and the like materials, to a degree immediately below the saturation point thereof; the moisture-containing particles are then mixed with a resinous composition for a period of time sufficient to insure uniform distribution of the resin over the surfaces of the lignocellulose particles. Due to the relatively great moisture content of the particles, the resin is prevented from becoming sorbed and substantially all of it is therefore available for bonding the particles together.

The resin treated raw material may, if desired, be immediately converted into board products. On the other hand, the resin treated material may be stored for a considerable period of time prior to consolidation without any substantial alteration or deterioration thereof. In either event, prior to consolidation of the resin treated raw material, the moisture content thereof is reduced to about 6–20% and preferably to the equilibrium moisture content of the material, normally in the range of about 6–12%. The moisture removal may be effected by any means which will avoid advancement of the resin. For example, the treated particles may be subjected to vacuum drying or forced air drying at room or slightly elevated temperatures. The use of large volumes of warm air removes the moisture from the surfaces of the particles and allows the excess moisture within the particles to migrate to the surface and be removed. Inasmuch as the moisture always moves from within to the surfaces of the particles, it is thereby readily removed therefrom without disturbing the resin deposited on the surfaces. This drying procedure is advisable in order to prevent blistering of the product or, even more seriously, the blowing out from the press of the material during the consolidation treatment unless extended pressing periods are employed or perforated platens used. Furthermore, this drying treatment permits the use of shorter pressing cycles and higher pressures and results in the production of a relatively low density product characterized by its great strength and stability.

In carrying out the novel method of the invention, the selected particles are wet out, if necessary, with water as by tumbling in a revolving container while spraying water thereon or by adding the water to the particles in a continuous type mixer-conveyer. Other moistening methods may be employed as, for example, stirring the particles in a carefully measured quantity of water to be absorbed thereby. In any event, sufficient water should be employed to bring the moisture content of the particles to a point above the equilibrium moisture content of the material. For raw wood, this equilibrium point is normally in the range of about 6–12% depending on the type wood and the surrounding climatic conditions. In the novel method of the invention, therefore, the moisture content of the wood particles is adjusted to at least about 15% before addition of the resinous binder. It has been found that an even more preferable moisture content is within the range of from about 25% to about 90% of the amount required for complete saturation of the wood particles. For relatively large particles, i. e.

those which will pass a 3.5 mesh screen and be retained on a 12 mesh screen, saturation will usually be reached when there is about 100%–125% of moisture present based on the dry weight of the particles. In the case of smaller particles and flakes or shavings, saturation is obtained when there is about 200% of moisture present based on the dry weight of the particles. Within this preferred range, the subsequent addition of resin results in substantially all of the resin being deposited and retained on the surfaces of the wood particles.

In selecting the size wood particles to be employed there is a particularly critical limit since it has been found that the most commercially desirable products are obtained by the use of three distinct wood fractions. The first two classes or fractions of wood particles are obtained from wood which has been reduced mechanically as by means of a hog or shredder. The first fraction is that portion of the wood particles which will pass a 3.5 mesh screen, i. e. one having a 0.223 inch opening and be retained on a 7 mesh screen having about a 0.111 inch opening. The second fraction comprises that portion of the wood particles which will pass a 7 mesh screen and be retained on a 12 mesh screen having about a 0.05 inch opening. These two fractions can be combined and employed as a mixture but the most desirable products are obtained when the wood particles are separated into these two fractions and employed individually. The third class of wood particles found to be desirable in the manufacture of board products according to the method of this invention comprises the relatively thin flakes of wood obtained from surface type planers or the extremely thin veneer as produced by a lathe. This class of wood particles has been found to be of outstanding desirability as a surfacing material over the above described fractions of wood particles. Although relatively thick flakes or shavings may be employed as surfacing material and the finished surface planed or sanded, it is preferred that the thickness of the flakes does not exceed about 6–8 mils. In surfacing the chip board products with flakes, shavings, and the like, an additional advantage of the invention is presented. The shavings, suitably treated with one of the hereinbefore mentioned resins, are spread over the wood particles prior to the pressing treatment and consolidation is effected in one operation. Furthermore, the use of such relatively thin flakes or shavings results in a product having a smooth and attractive surface requiring no further finishing of any sort. However, it is to be understood that, while the above discussion has been directed to the three types of wood particles which are most desirable, other natural wood particles may also be employed in the novel process of the invention.

The resins which may be employed as binding agents for the selected wood particles depend entirely on the ultimate use for which the board product is manufactured. Where complete waterproof characteristics are desired, commercially accepted exterior glues such as resorcinol, phenolic, melamine, polyester, furan, and the like resin glues are employed. For interior use where only a moderate degree of resistance to water is required, the urea-formaldehyde type resins are preferred. Modification of these resins with the exterior type resin glues hereinbefore mentioned permits the attainment of any desired degree of water resistance in the final product. It is not necessary that the selected resin be soluble in water. For instance, suspensions of resins in water are entirely suitable as are aqueous resin emulsions. For the purposes of this description, therefore, the term "aqueous resin mixture" will be understood to include aqueous resin solutions, dispersions, emulsions, and the like. It will be appreciated from the foregoing discussion that the novel method of the invention may be employed to produce improved board products in any type of platen press under heat and pressure thereby presenting to the art a desirable advantage over prior methods.

One of the outstanding advantages of the present invention resides in the above described method of applying the resinous binder in such manner that substantially all of the resin is retained on the surfaces of the wood particles and is thus available for binding the particles together. This represents a decided saving since the amount of resin required is much less than that heretofore necessary. For example, good results are obtained by employing 3–10% of resin solids based on the weight of wood chips. On the other hand, it may sometimes be desirable to use as much as 40–50% of resin for achieving particular results. Such large quantities of resin may also be employed in the method of this invention without danger of loss of resin.

Having mixed together the moisture-containing wood chips and resin mixture, the mixture is next subjected to a drying procedure, as hereinbefore described, to adjust the moisture content to about 6–20% and even more preferably from about 6% to about 12%. The treated mixture may then be stored or immediately converted to the final board product. The resin treated chips are contained by any desired means between the platens of a press and consolidated under pressure and elevated temperature. For most of the uses to which the boards are best adapted, the desired density is about that of natural wood, i. e. from about 0.4 to about 0.8 for thicknesses greater than ⅜ inch. For thinner boards it is desirable to obtain a density of about 0.6 to 1.0. Within this range, the board products are easily fabricated, exhibit the required physical characteristics, and are sufficiently light to be easily handled. The pressures necessary for consolidation may range from about 50 p. s. i. to about 600 p. s. i. but, of themselves, constitute no part of this invention.

The invention will be further illustrated by the following specific examples. It is to be understood, however, that the examples are given for illustrative purposes only, and modifications thereof within the scope of the appended claims are included in the invention.

Example 1

1000 parts by weight of wood particles (passed through 0.111 inch screen opening and retained on 0.055 inch screen) at their equilibrium moisture content of 11%, e. g. 900 parts of wood and 100 parts of moisture, were wet out with 150 parts of a water solution containing the hardening agents for a urea-formaldehyde resin. 150 parts of a 60% aqueous resin mixture of a commercial urea-formaldehyde resin was added to the wet out wood particles and thoroughly distributed on the chips by mixing. After the resin was thoroughly distributed on the chips, they were subjected to forced air drying with hot air until the moisture content had been reduced to 10% based on the weight of the wood chip-resin components. The mixture was then placed in a tray and pressed for 7 minutes between the heated plates of a hydraulic press at a pressure of 200 p. s. i. and a temperature of 305° F. The finished board had a thickness of ⅜" and a density of 0.6 and after being allowed to condition under room conditions for three days was subjected to the following tests: the board was submerged in water at room temperature for 4 hours and then allowed to dry at room temperature for 20 hours. The product of this example withstood six of these cycles before its physical properties were substantially altered. By comparison, a board made and pressed under these same conditions, but without first wetting out the wood particles, deteriorated beyond commercial usefulness after one such cycle.

Example 2

To 1000 parts of wood particles of the same size as those of Example 1, at 10% moisture content, was added 800 parts of water containing 1.5 parts of a gray water-soluble wood stain and thoroughly mixed. To these dyed

chips was then added 150 parts of a catalyzed urea-formaldehyde resin of 60% solids content and thoroughly distributed over the wood particles. The treated chips were then dried and converted into a board as in Example 1. This 3/8" board had a density of 0.62 and satisfactorily withstood six cycles of soaking and drying as outlined in Example 1.

Example 3

The procedure of Example 1 was repeated using wood particles which had passed a 0.223 screen opening. 200 parts of the wood shavings of a thickness up to five mils were then wet out and strained gray with 200 parts of water containing the dye. To these stained and wet shavings was added 40 parts of a commercial melamine resin as a 50% aqueous solution. After thoroughly distributing the resin over the dyed shavings, the material was dried under hot air to a moisture content of about 15%.

A board product was then made from these two classes of raw material as follows: first, a sheet of resin impregnated Kraft was placed in the bottom of a shallow tray. Over this sheet of paper the wood particles were evenly distributed and then over the wood particles the dyed and resin-treated shavings were placed and evenly distributed. This assembly was then placed in a press and consolidated under 200 p. s. i. at 305° F. for ten minutes. The product had a density of 0.65, good dimensional stability, and a smooth surface from the resin treated dyed shavings. This resin treated shavings surface was found to be wash-proof and needed no further finishing of any kind.

Example 4

The procedure of Example 1 was repeated except that the moisture content of the chips, prior to the resin addition, was adjusted to approximately 15% by weight. The product was essentially the same as that of Example 1 except it withstood only three of the soaking and drying cycles before showing deterioration.

Example 5

500 parts of the raw material of Example 1 at 10% moisture content was wet out with 300 parts of water. To these wood particles were then added 60 parts of a 50% phenol-formaldehyde resin solution and the resin evenly distributed over the wet particles. The wood particles were then dried to a moisture content of 20% by means of hot air. This resin treated material was pressed for six minutes at 350 p. s. i. and 320° F. The product was 1/4" thick and had a density of 0.90. This thin board showed good strength and water resistance.

Example 6

1500 parts of wood particles of the same size as those of Example 3, at a moisture content of 8%, was wet out with 200 parts of water. To the wet chips was then added 220 parts of a catalyzed 50% solution of a urea-formaldehyde resin and mixed thoroughly. This treated material was dried to a moisture content of 15% with warm air and pressed for 12 minutes at 200 p. s. i. and 300° F. The product was 3/4" thick and had a density of 0.60. This board was then planed on both surfaces and used as a core material by placing a veneer cross-band and face on each side and consolidating under heat and pressure. This gave a product which exhibited superior dimensional stability over conventional plywood construction.

Example 7

The procedure of Example 6 was repeated except that the veneer cross-bands and face and back were applied to the core and consolidated in one pressing operation with essentially the same results as Example 6.

Example 8

The procedure of Example 2 was repeated in exactly the same manner and the treated and dyed chips dried to a moisture content of 12%. These dyed and resin treated chips were then placed in a tray for containment. In contact with the chips was placed a metal platen machined to contain parallel grooves of varying depth and length. This material was pressed for eight minutes at 200 p. s. i. and 310° F. with the machined side of the plate in contact with the chips. This procedure gave a very attractive board product, the surface of which had the same imprint design as the machined face of the platen.

Example 9

The procedure of Example 3 was repeated in exactly the same manner but pressed with the grooved platen used in Example 8 in contact with the resin treated and dyed shavings. This procedure gave a very attractive product with an embossed surface which required no further surface treatment of any kind.

Example 10

1000 parts of wood particles of the same size as those of Example 1 which had been obtained by mechanically reducing and screening wet wood were taken at a moisture content of 30%, and 120 parts of a 60% aqueous mixture of a urea-formaldehyde resin containing the catalyst was added directly and mixed therewith to thoroughly distribute the resin. The resin treated chips were then dried and pressed exactly as in Example 1 to give a product essentially the same as obtained in Example 1. It will thus be seen that green or wet wood may be employed in the present invention without the necessity for drying the wood particles to a low moisture content.

From the foregoing description of the invention it will be appreciated that the novel process described provides a desirable means of producing board products of reaggregated wood. It presents the outstanding advantage of permitting the use of smaller amounts of resin than have hereinbefore been possible. The novel process also presents a method of board production in which all of the resin employed serves to bind the wood particles together. In addition to these advantages, the method of the invention also permits the addition of any desired agent to the wood particles while they are being conditioned to the desired moisture content. For example, agents such as dyes, fire proofing materials, vermin proofing compositions and the like materials may be added to the wood particles. Where, as in the case of urea-formaldehyde resins, a hardening agent or catalyst is required, this material may advantageously be added to the water which is used in treating the wood particles and eliminates the necessity of adding the catalyst to the resin. Other commercially desirable advantages stem from the fact that press plates having any desired design may be employed to produce decorative board products.

I claim:

1. A method of preparing an improved board-like product comprising mixing together chipped lignocellulose particles and an aqueous resin mixture, said particles having a moisture content prior to admixture with the aqueous resin of from about 15% to about 200%, based on the dry weight of particles, continuing the mixing procedure until the resin has been substantially uniformly distributed over the surfaces of the lignocellulose particles, reducing the moisture content of the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage to from about 6% to about 20% based on the dry weight of the particles and resin solids, and then consolidating the mixture under heat and pressure whereby there is obtained a product characterized by a density of from about 0.4 to about 1.0 and by its greatly improved dimensional stability.

2. A method of preparing an improved board-like product comprising mixing together chipped wood particles and an aqueous resin mixture, said wood having an average particle size such that all of the particles will pass

through a 3.5 mesh screen and will be retained on a 12 mesh screen and said particles having a moisture content of from about 15% to about 125% based on the dry weight of the chipped wood particles prior to the completion of the mixing together of the chipped wood particles and the aqueous resin mixture, continuing the mixing procedure until the resin has been substantially uniformly distributed over the surfaces of the particles, reducing the moisture content of the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage to from about 6% to about 20% based on the dry weight of particles and resin solids, and then consolidating the mixture under heat and pressure whereby there is obtained a product characterized by a density of from about 0.4 to about 1.0 and by its greatly improved dimensional stability.

3. In the preparation of an improved board-like product and wherein chipped wood particles, in heterogeneous relationship, are bound together with a resinous composition under heat and pressure, the improvement which comprises wetting the wood particles to provide therein a moisture content of from about 15% to about 200%, based on the dry weight of the chips, admixing therewith an aqueous resin mixture, continuing the mixing procedure until the resin is substantially uniformly distributed over the chips, drying the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage within the range of from about 6% to about 20% by weight, and thereafter consolidating the mixture under heat and pressure whereby there is obtained a chip-board product characterized by its density approximating that of natural wood, by its improved appearance and general physical properties, and by its improved dimensional stability.

4. A method of preparing an improved board-like product comprising mixing together chipped wood particles and an aqueous resin mixture, said wood having an average particle size range such that all of the particles will pass through a 3.5 mesh screen and will be retained on a 12 mesh screen and said particles having an initial moisture content of from about 25% to about 100% based on the dry weight of the particles, continuing the mixing procedure until the resin has been substantially uniformly distributed over the surfaces of the particles, reducing the moisture content of the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage to from about 6% to about 20% based on the dry weight of the particles and resin solids, and then consolidating the mixture under heat and pressure whereby there is obtained a product characterized by a density of substantially that of natural wood and by its greatly improved dimensional stability.

5. A method of preparing an improved lignocellulose board-like product comprising mixing together wood particles and an aqueous resin mixture, said wood having a particle size range such that all of the particles will pass through a 3.5 mesh screen and be retained on a 12 mesh screen and said particles having an initial moisture content of from about 25% to about 100% based on the dry weight of the particles, continuing the mixing procedure until the resin has been substantially uniformly distributed over the surfaces of the particles, reducing the moisture content of the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage to from about 10% to about 12% based on the dry weight of the particles and resin solids, and then consolidating the mixture under heat and pressure whereby there is obtained a product characterized by a density of substantially that of natural wood and by its greatly improved dimensional stability.

6. A method of preparing an improved lignocellulose board-like product comprising mixing together wood particles and an aqueous thermosetting resin mixture, said wood having a particle size range such that all of the particles will pass through a 3.5 mesh screen and be retained on a 12 mesh screen and said particles having an initial moisture content of from about 25% to about 100% based on the dry weight of the particles, continuing the mixing procedure until the resin has been substantially uniformly distributed over the surfaces of the particles, reducing the moisture content of the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage to from about 6% to about 20% based on the dry weight of particles and resin solids, and then consolidating the mixture under heat and pressure whereby there is obtained a product characterized by a density of substantially that of natural wood and by its greatly improved dimensional stability.

7. A method of preparing an improved lignocellulose board-like product comprising mixing together wood particles and an aqueous thermosetting resin mixture, said wood having a particle size range such that all of the particles will pass through a 3.5 mesh screen and will be retained on a 12 mesh screen and said particles having an initial moisture content of from about 25% to about 100% based on the dry weight of the particles, continuing the mixing procedure until the resin has been substantially uniformly distributed over the surfaces of the particles, reducing the moisture content of the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage to from about 10% to about 12% based on the dry weight of particles and resin solids, and then consolidating the mixture under heat and pressure whereby there is obtained a product characterized by a density of substantially that of natural wood and by its greatly improved dimensional stability.

8. A method of preparing an improved board-like product comprising mixing together wood particles and an aqueous resin mixture, said wood having an average particle size range such that all of the particles will pass through a 3.5 mesh screen and will be retained on a 12 mesh screen and said particles having a moisture content of from about 15% to about 200% of the dry weight of the wood particles prior to the completion of the mixing together of the wood particles and the aqueous resin mixture, continuing the mixing procedure until the resin has been substantially uniformly distributed over the surfaces of the particles, reducing the moisture content of the mixture by an appreciable amount substantially in excess of 5% by dry weight of the wood particles, bringing the moisture percentage to from about 6% to about 20% based on the dry weight of particles and resin solids, spreading the resin-treated particles to the desired depth in a mold, spreading over the top surface of said wood particles a relatively thin layer of resin treated wood flakes having a maximum thickness of about 6 mils, and then consolidating the mixture and surfacing flakes under heat and pressure whereby there is obtained a smooth surfaced product characterized by its improved appearance, a density of from about 0.6 to about 1.0, and by its greatly improved dimensional stability.

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