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METHOD OF MAKING PLYWOOD

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This invention relates to a method of making hot-pressed weatherproof plywood in which a solution of a thermosetting binder is applied in a single coating on the core ply of wood and is so adjusted as to avoid the necessity for drying the coated core before the hot pressing operation.

More specifically the invention relates to a process of making hot-pressed plywood involving only a single coating of the core ply with a solution of a meta-cresylic acid-formaldehyde resin having its water content so adjusted as to produce in the coated core ply a total moisture content of 40 to 150% based on the weight of the dry resin.

This application is a continuation-in-part of my copending application entitled: "Method of making plywood," U. S. Serial No. 206,833, filed May 9, 1938.

In my U. S. Patent No. 2,068,759, dated January 26, 1937, I have described and claimed a method of making plywood involving a plurality of resin-solution coating and drying operations followed by a humidification of the multi-coated core sheets. The multi-coated and humidified cores are then laid up between uncoated veneer sheets and the resulting stack is hot-pressed to unite the veneers and cores. This hot-pressing operation thermally sets the resin coating on the cores to weld the veneer sheets thereto, while the humidifying step imparts a desired moisture content along the glue lines during the hot-pressing operation.

According to this invention, the heretofore-required plurality of coating, drying and humidifying steps prior to the hot-pressing operation are eliminated.

I have now found that, by proper control of the solid content in the resin or binder solution and the total moisture content in the coated core, the total coating can be effected in a single application of a solution of the partial condensation product or binder to be used in uniting the wood plies. By such control of the solid content in the resin solution and the total moisture content in the coated core the heretofore-necessary drying and humidifying operations are eliminated and the coated cores can be laid up between veneer sheets and directly pressed. The saving thus encountered both in labor and equipment represents a considerable item in the cost of plywood manufacture.

In carrying out the invention, an aqueous solution of a meta-cresylic acid-formaldehyde partial condensation product is prepared with a water content determined by the moisture con-

tent of the core sheets to be coated so as to produce in the coated cores a total moisture content of 40 to 150% based on the weight of the dry condensation product.

Since the core sheets or center sheets are usually dried to a moisture content of from 2½ to 3½%, and preferably not over 4%, the aqueous solution of the thermosetting binder is prepared with a high solid content so that the total moisture content of the coated core or center sheet lies within the range of 40 to 150% based on the dry weight of the binder in the coating. Thus, part of the moisture within this range may be present in the wood itself while the remainder of the moisture is present in the coating itself as a vehicle for the binder.

The high solid content of the binder solution may produce a viscous mass that must be heated to reduce its viscosity in order to insure an even coating on the core sheets. However, the high viscosity of the binder has a desired function in preventing deep penetration of the binder into the wood. The binder, however, will bite into the wood for a sufficient depth to insure an excellent bond without, however, penetrating sufficiently inward from the surface of the wood to become ineffective for a surface bonding. Thus the binder is maintained where it is needed at the glue line of the plywood panel.

When highly viscous binder solutions are used, the same are preferably heated in the coating apparatus to temperatures between 87 to 100° F. When the heated binder has been applied to the core sheets, it will congeal somewhat upon cooling to room temperatures. The amount of binder solution spread on the core veneer is regulated so that from 15 to 50 pounds of dry binder will be spread on each 2,000 square feet of coated surface or 1,000 square feet of core sheets having a coating on both broad faces thereof.

It is, then, an object of this invention to prepare hot pressed plywood with a thermosetting resin binder having a water content regulated to produce in the binder-coated core sheet a total moisture content of from 40 to 150% based on the weight of the dry binder.

Another object of the invention is to regulate the moisture content of an aqueous solution of a thermosetting binder in accordance with the moisture content of a core or center ply of wood used in the making of plywood panels so that the coated plies can be directly laid up between veneers and hot pressed without heretofore necessary drying and humidifying operations.

A further object of the invention is to effect

the total coating operation of core sheets for plywood panels in a single application of a binder solution to produce, in the coated cores, a moisture content that will insure a good bond during a subsequent hot pressing operation.

A specific object of the invention is to provide coated core sheets for plywood panels having single films of thermosetting binder on the broad faces thereof containing from 15 to 50 pounds of a thermosetting cresylic acid-formaldehyde condensation product per 2,000 square feet of coated area and having a total moisture content of from 50 to 150% based on the weight of the dry condensation product.

Other and further objects of the invention will become apparent from the following detailed description of the process.

A solution of a cresylic acid-formaldehyde partial condensation product is prepared by exothermically reacting, in a water jacketed digester, 400 parts by weight of commercial meta-cresylic acid (consisting mainly of meta-cresol and higher phenols) and 432 parts by weight of a 37 to 40% formaldehyde solution in the presence of an alkali condensing agent such as sodium hydroxide. This alkali condensing agent can be used in the form of an aqueous solution with the amount of water in the solution regulating the solid resin content of the partial condensation product. Preferably not less than 10% by weight of sodium hydroxide or equivalent weight of other alkali, based on the weight of the cresylic acid, is used.

The ingredients are preferably initially regulated to temperatures around 62° F. and the reaction is allowed to proceed exothermically until somewhat constant temperatures are reached, usually in about from 30 to 50 minutes. A resinous partial condensation product is thus obtained.

The reaction is arrested by the circulation of cold water through the jacket of the digester in which the ingredients have been reacted until the syrupy liquid product reaches a temperature of around 100° F.

If desired, smaller amounts of water can be used in the alkali condensing agent solution and an additional amount of a water solution of sodium hydroxide can be added to the reaction mass when the temperature thereof becomes constant. This added solution will serve to arrest the reaction.

A moisture analysis of core sheets or center sheets on which the condensation product solution is to be spread, is obtained, and the water content of the binder solution is adjusted so that the coated cores or center sheets will have a total moisture content of from 40 to 150% based on the dry weight of the condensation product coated thereon.

In plants where the cores and veneers have been dried to a moisture content of not more than 4% and preferably between 2 to 3½%, the binder solution can be adjusted to have a 45 to 50% solid content. This solid content of the binder solution produces in the final coated cores a total moisture content well within the operative range.

For producing a binder solution having a solid content of 45% about 450 parts by weight of water are used in the amounts of the reacting proportions given in the above specific example. This water may be added to form the solution of the sodium hydroxide condensing agent or can

be partially added with the sodium hydroxide solution used as an arresting agent after the reaction is completed.

The binder solutions obtained having a solid content of 45 to 50% have been found to possess a viscosity of from 900 to 1,000 centipoises at 87° to 90° F. if the viscosity is determined immediately after the reaction is completed. However, the viscosity of the binder gradually increases upon standing, and at the end of 48 hours, the viscosity of the binder may rise to from 1,600 to 2,000 centipoises at 87° to 90° F.

Due to the high solid content and high viscosity of the binder the same is preferably heated in a glue spreader to temperatures between 87 to 100° F. The binder can be circulated through a glue spreader preferably having top and bottom rubber covered coating rolls. The core veneers or center sheets are passed between the rubber coating rolls to receive a coating on the broad faces thereof. The pressure of the rollers on the cores or center sheets is adjusted so as to obtain a spread on the broad faces thereof equivalent to 15 to 50 pounds of dry binder per 1,000 square feet of core or center sheet. This is equivalent to 2,000 square feet of coated surface. When the coatings have been applied to the core sheets or center sheets the same will congeal somewhat upon cooling to room temperatures.

The coated cores or center sheets are next placed between uncoated veneers in the usual manner with the grains of adjoining veneers running at right angles to each other to build up a stack of the desired number of plies for producing a plywood panel. No drying of the coating is required. However, the stack is preferably allowed to stand for a period of 30 minutes to 1 hour to permit the coatings on the core sheets to penetrate into the adjacent wood surfaces and thereby obtain a good bite into the wood. This penetration serves to dissipate some of the moisture from the wood surfaces by absorption of moisture into the wood. The moisture that penetrates into the wood acts somewhat as a plasticizer during the subsequent hot pressing operation. This aids in the transfer of some of the binder to the uncoated veneers at the time of the hot pressing operation. At the same time, however, the binder has a sufficiently high viscosity so that it will not be absorbed throughout the wood and thereby result in a wasting of binder and a possible staining of the surfaces of the panel.

If desired, small amounts of wetting agents such as thiethanolamine or "Areskap" can be incorporated into the reaction mass at the time of preparing the binder so that it will have an increased penetrating action on the wood. The wetting agent need only be used in very small amounts, for example, from .1 to .5% based on the weight of the dry condensation product.

After the stack of plies has been allowed to stand a sufficient time for penetration of the binder into the wood, the stack is placed between the platens of a heated platen press where it is heated to temperatures around 330° F. to set the resin binder into a hard, infusible and insoluble mass permanently welding the veneers together.

After the hot pressing operation, the plywood panels are immediately inserted in a humidifier before they cool down. The humidifier will impart a desired moisture content into the panels

of between 6 to 12%. This prevents subsequent warping of the panel.

Pressures of about 175 pounds per square inch of panel surface are used in the hot press when the veneers are formed of Douglas fir. If the veneers are formed of Redwood, lower pressures of around 130 pounds per square inch of panel surface are used.

Tests made on plywood panels prepared according to this process show panel shear strengths from 227 to 272 pounds per square inch with an average wood failure of 95 to 99%. Even after boiling the plywood panels in hot water for 48 hours, shear strengths averaging 196 pounds per square inch with 97% wood failure were obtained. The high wood failure indicates that the resin bond is stronger than the shear strength of the wood veneers. The strength of the product therefore is limited only by the strength of the wood.

From the above description it should be understood that the process of this invention includes the single coating of wood core veneers or crossbanding with a high solid content and high viscosity solution of a thermo-setting resin such as a cresylic acid-formaldehyde resin in an aqueous solution. The total moisture content of the coated core or crossband is regulated by the regulation of moisture in the wood and the percentage of water in the resin solution so that the total moisture content of the coated core is from 40 to 150% based on the weight of the dry resin in the coating. This total moisture content eliminates steam pockets and check formation during the hot pressing operation and the coatings on the veneers do not have to be pre-dried.

The coating is regulated so that from 15 to 50 pounds of dry resin are spread on each 1,000 square feet of core. Since both broad faces of the cores are coated, the corresponding coated area is thus 2,000 square feet.

I am aware that numerous details of the method may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not propose limiting the patent granted hereon otherwise than necessitated by the prior art.

I claim as my invention:

1. In the method of making plywood including the coating of a core ply of wood with a thermosetting binder, the covering of the coated surface with a veneer and the uniting of the core and the veneer by the application of heat and pressure to set the binder, the improvements which comprise effecting the total coating in a single application of an aqueous solution of a partial condensation product of cresylic acid and formaldehyde at temperatures of from 87 to 100° F., said solution having a viscosity of from 900 to 2,000 centipoises at 87 to 90° F., and a solid content of from 45 to 50%, allowing the heated coating to cool on the core for thickening the solution, and directly hot pressing the core and veneer together whereby sufficient moisture is present along the glue line to plasticize the condensation product without forming steam pockets and the high viscosity of the condensation product prevents deep penetration of the binder into the wood and away from the glue line.

2. The method of making plywood which comprises heating a viscous aqueous solution of a

thermosetting binder to temperatures around 100° F. to produce a flowable liquid, coating said heated flowable liquid on core veneer, adjusting the thickness of the coating to apply from 15 to 50 pounds of dry binder over 2,000 square feet of coated area, allowing the heated coating to cool for thickening the solution on the surface of the core for eliminating deep penetration of the binder into the wood and away from the plywood glue line, covering the thickened coating with veneer and hot pressing the veneer and core together for setting the binder whereby moisture from the thickened aqueous coating will plasticize the binder during the hot pressing operation.

3. In the method of making plywood including the coating of a core ply of wood with a flowable thermosetting binder in a water vehicle, the covering of the coated core with a wood veneer ply and the hot pressing of the core and veneer together to set the binder for permanently uniting the plies, the steps which comprise determining the moisture content of the core, spreading in a single application an amount of binder in a water vehicle to yield 15 to 50 pounds of dry binder over each 2000 square feet of coated surface, and adjusting the water content of said binder in accordance with the two variables of the determined moisture content of the core and the selected weight of the dry binder to produce a total moisture content of 40 to 150% in the coated core based on the weight of the dry binder in the coating.

4. In the method of making plywood including the coating of a core ply of wood with a flowable thermosetting binder in a water vehicle, the covering of the coated core with a wood veneer ply and the hot pressing of the core and veneer together to set the binder for permanently uniting the plies, the steps which comprise determining the moisture content of the core, heating the binder in a water vehicle to render the same readily flowable, spreading in a single application an amount of the heated binder in the water vehicle to yield from 15 to 50 pounds of dry binder over each 2000 square feet of coated surface, adjusting the water content of said binder in accordance with the two variables of the determined moisture content of the core and the selected weight of the dry binder to produce a total moisture content of 40 to 150% in the coated core based on the weight of the dry binder in the coating, and allowing the coating to cool on the core to thicken the binder for preventing deep penetration thereof into the wood.

5. In the method of making hot pressed plywood including the coating of a core ply of wood with a thermo-setting binder in a water vehicle, the covering of the coated surface with a veneer containing not more than 4% moisture, and the uniting of the coated core with the veneer by the application of heat and pressure to set the binder, the improvement which comprises effecting the total coating in a single application of the binder in the water vehicle with said coating containing from 15 to 50 pounds of binder on a dry basis per 2000 square feet of coated area to produce in the coated core a total moisture content of 40 to 150% based on the selected weight of the dry binder whereby said moisture content will plasticize the binder during the hot pressing operation without forming steam pockets.

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