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METHOD OF MAKING PLYWOOD

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4 Claims. (Cl. 144—309)

This invention relates to a method of making plywood from natural wood veneer and core or cross-banding. The present is a continuation-in-part of my application entitled "Method of making plywood", Serial No. 741,745, filed August 27, 1934, wherein is disclosed a method of making plywood using an aqueous solution of a partial condensation product as the binder.

I have found that in the making of hot pressed plywood, it is very important to control the moisture content of the constituent laminations, and particularly the core or cross-banding, prior to the hot pressing operation. If the moisture content of the veneers going through the hot press is greater than about 4%, steam explosions and surface checks are very likely to occur on removing the plywood panels from the press. Furthermore, where the moisture content is above 4%, it is necessary for the veneers to remain in the press for a longer period of time to permit the excess of moisture to escape as steam through the edges of the veneer under the action of the heat of the presses.

It is also important to maintain a substantial percentage of moisture in the binder coating on the core, while keeping the moisture content of the body of the core at not over about 4% moisture, at the time of charging the veneers into the hot presses. I have found that this may be best accomplished by applying the aqueous solution of the binder material in successive steps, first applying a light coat and drying rapidly, and then applying a heavier final coat, drying the same and finally humidifying the surface coating to impart thereto a substantial moisture content. By the application of the aqueous binder material in successive steps, penetration of the binder material to the body of the core occurs only during the first coating operation and the second coating of binder material is thereby confined largely to the surface, where it can be most effectively used in the laminating operations.

It is therefore an important object of this invention to provide a method of making plywood that more effectively utilizes the binding qualities of an aqueous dispersion of a resin forming partial condensation product, and wherein moisture content of the coated core, or cross-banding, prior to the hot pressing operation is carefully controlled.

It is a further important object of this invention to provide an improved method for the manufacture of plywood, using an aqueous dispersion of a partial condensation product and by

careful control of the moisture content of the constituent veneers, eliminating the likelihood of steam explosions and surface checks, as well as warping of the finished plywood.

Other and further important objects of this invention will become apparent from the following description and appended claims.

The natural wood veneer to be used in the manufacture of the plywood of my invention is prepared in the usual way by peeling the wood on the lathe and then drying. I have found, however, that it is desirable to dry the veneer to a moisture content of from 2 to 3½%, and preferably not over 4%, and then use the veneer in the manufacture of plywood as soon as possible after it leaves the drier. Excess core or cross-banding should be stored in low humidity chambers to maintain as constant a moisture content as possible, since varying moisture contents in the veneers cause delay in the pressing operation. This is particularly true in plants located in areas where the climate offers a high humidity such that the dry core will take on enough moisture, if left around exposed to the air, to cause steam pockets in the plywood. Such steam pockets not only tend to produce checks in the finished veneers but make necessary a much longer period of time in the hot presses to counteract.

Where veneers having a higher moisture content than about 4% are used in the hot presses, there is not only a tendency for steam explosions and surface checks to occur, but the cell walls of the wood are rendered much more collapsible, so that when pressure is applied the thickness of the plywood panel is likely to be reduced in varying proportions. It is therefore important to use low moisture content veneers, both in order to reduce the period of time required in the pressing operation and also to secure a maximum and more uniform thickness of the final product at identical pressures.

In the preparation of the wood veneers for the pressing operation, I prefer to apply an aqueous dispersion of the binding material in successive coatings, drying the first applied coating prior to the application of the second coating in order to confine the second coating of the binder material as much as possible to the surface. If only one full coat is applied, it takes longer to dry and permits the binder to penetrate further into the core, resulting in a less effective use of the binder material. Moreover, where a roll type of spreader is used in applying the liquid binder

material, the pressure of the rolls tends to force the binder into the wood and leave dry spots.

I have found that by first spreading a light coat of the binder material and drying the coating rapidly, it acts as a filler to close up the pores and crevices of the core, so that when the second coat is applied, it will tend to stay on the surface. Areas not entirely covered by the first coat will be covered by the second coat of binder.

The coatings of binder material are preferably sprayed on to the surface of the core under pressure. Due to the roughness of the veneer in peeling on the lathe, especially in the case of the softer wood, and due to the natural defects, such as knots, pitch pockets, checks, and the like, it is very difficult to produce a uniform film of the binder material by the use of the roll type of spreader. In the spray system of spreading the binder over the core, however, the resulting film is practically uniform and can be dried in properly constructed humidity controlled driers to the correct moisture content.

After the application of the first light coating of aqueous binder solution, the coated core is dried, preferably at a temperature of between 90° and 150° F., to a low moisture content, say from 2 to 4%. The second coating of binder material is then sprayed on and the coated core again dried to a low moisture content and thereafter humidified. For this purpose the treated cores are placed in a humidifier at a temperature, preferably, of from 90° to 100° F., with a relative humidity of from 90% to 100%, and for a period of from 10 to 30 minutes, varying with the thickness of the binder film. Humidification of the treated cores in this manner makes it possible to obtain a low moisture content in the body of the core while at the same time securing a uniform and correct moisture content in the surface coating or film of the binder material. After the humidification, the body of the core should have a moisture content of preferably between 2 and 4% and the binder film or coating should contain from 15 to 40% moisture. This result is made possible through the use of a two step coating process, with the intermediate drying of the first coating to cause the second coating to be largely confined to the surface and not penetrate the body of the core. The substantial moisture content of the binder film or coating is desirable for the reason that it has a plasticizing effect in the hot pressing operation.

After the humidifying treatment is finished, the core should be laid up between the veneers and placed in the press as quickly as possible. There are three main factors to be controlled in hot pressing the cross-banded veneers, namely, temperature, pressure and time. The temperature range is preferably from 275° to 300° F. While it is advantageous to use temperatures in the lower range, this naturally means increasing the time of the pressing operation, so that for practical purposes, temperatures of between 315 and 335° F. will generally be found most expedient. The pressure ranges between 100 pounds per square inch and 250 pounds per square inch, depending upon the kind of wood from which the veneers are made.

On fir, for example, it has been found best to use between 135 and 175 lbs. per sq. in. of pressure on the presses, although the pressure may be increased to as high as 500 lbs. per sq. in. Time, of course, varies with the temperature used

and with the thickness of the plywood panel being made. At 330° F. a $\frac{1}{4}$ th inch construction requires 2½ minutes, a $\frac{13}{44}$ th inch construction about 20 minutes and an $\frac{1}{4}$ th inch construction about 36 minutes.

Upon leaving the press, the hot panels contain from 2 to 3½% of moisture and more moisture must be introduced into them to make the panels suitable for commercial use. Since thermal expansion has taken place in the panels while in the hot presses, sudden cooling would produce checks in the surface veneer. Consequently, the hot panels coming from the presses should be immediately taken to a humidifier, where the panels are stacked between racks and weighted to keep them flat and subjected to a relative humidity of from 80 to 90% and a temperature of about 190° F.

The time required for proper humidification of the plywood will, of course, depend upon the thickness, but in general varies between 6 and 12 hours. The humidification should be continued until the moisture content of the plywood is between 8 and 12%. This is the normal range for the moisture content of finished plywood, after delivery, for the range of relative humidity occurring in most localities where the plywood panels are used.

The aqueous dispersion of the binding material may be prepared from various ingredients capable of forming synthetic resins of a hard, infusible character. Examples of suitable synthetic resins are those of the phenolic-aldehyde and urea-aldehyde type, or mixtures of a urea and of a phenol with an aldehyde, or polymer of an aldehyde, as described in my copending application above referred to.

In addition to the examples of aqueous binder solutions given in the aforesaid application, the following will serve to illustrate methods of preparing suitable binder solutions:

Example 1

	Parts by weight
Cresylic acid.....	1000
Formaldehyde (40% aqueous solution).....	1000
Vegetable protein.....	200
Caustic soda.....	160
Soya bean oil.....	10
Triethanolamine.....	2½
Water.....	2400

The vegetable protein may be a dry extracted soya bean flour, peanut flour, or the like. Such flour is first added to the cresylic acid with constant stirring until a smooth homogeneous mass results. A 38° Bé. solution of caustic soda, containing about 100 parts of caustic soda, is added to the mixture of cresylic acid and soya bean or the vegetable flour. Then the soya bean oil and triethanolamine are added and the mixture agitated until a smooth homogeneous mass results. The mass is then cooled to 60° F., at which temperature the formaldehyde is added and the whole mixture agitated for 5 minutes. The heat of reaction between the various ingredients normally brings the mass up to about 70 to 85° C., where the mass is maintained for about 25 to 35 minutes. Next a cold, 10° Bé. solution of 60 parts of caustic soda in 2400 parts of water is added to the mass. If desired, the solution may be further diluted by the addition of water without causing a precipitation of the partial condensation product and will remain stable for a long period of time without any increase in viscosity.

Example 2

Parts by weight

Cresylic acid-----	600
Formaldehyde (40% aqueous solution)-----	600
Caustic soda-----	96
Triethanolamine-----	1.5
Soya bean oil-----	1.5
Water-----	1500

In making up this second formula, 60 parts of caustic soda are dissolved in order to form a 30° Bé. solution and this solution then added to the cresylic acid and mixed thoroughly therewith. The mixture is allowed to cool to 60° F., at which temperature the soya bean oil and triethanolamine are added. The formaldehyde is next added and the mixture agitated. The heat of reaction between the various ingredients brings the mass up to a temperature of normally from 70 to 90° C. After maintaining the mass at this temperature for about 25 to 35 minutes, the remaining portion of caustic soda, namely 36 parts, dissolved in 1500 parts of water and having a specific gravity of about 10° Bé., is added to the mixture with constant stirring until cold. As before, the solution may be diluted further by the addition of water without causing a precipitation of the partial condensation product. The final mixture is a clear amber colored solution and will remain stable for a long period of time without any increase in viscosity.

An improved binder solution may be prepared in accordance with the following example:

Example 3

After the reaction mixture has been prepared, but before its diluting with the additional water, the partial condensation product is precipitated by the addition of acidulated water, with constant stirring, and then allowed to settle. After decanting off the supernatant liquor, the soft resin material remaining is washed by the further addition of water until the mixture shows no acid reaction, after which the resinous mass is dissolved in the caustic soda solution with constant stirring.

By the method of Example 3, all the impurities are removed from the resin, so that when the resin is brought back into solution, the mixture is much lighter in color and holds for a much longer period of time without any increase in viscosity.

In Examples 1 and 2, soya bean flour or peanut flour are incorporated for the purpose of increasing the bonding strength of the synthetic resin resulting from the reaction between cresylic acid and formaldehyde. Other vegetable products rich in protein, cellulose and carbohydrates may be used.

It will be understood that the proportions of the various ingredients in the formulae of Examples 1 and 2 may be varied considerably and other ingredients substituted for those enumerated, as more fully explained in my copending application above referred to. The caustic soda used aids in increasing the solubility of the initial condensation product produced by the reaction between formaldehyde and cresylic acid, or sodium cresylate. The triethanolamine, which may be a commercial mixture of tri-, di- and mono-ethanolamine, acts as an emulsifying agent to prevent precipitation of the partial condensation product. It is important to note, how-

ever, that the final solution of the binder material is a true aqueous solution and not an emulsion or colloidal suspension. The reaction is not carried beyond the point at which the partial condensation product is still water soluble.

The amount of the aqueous binding solution to be applied to the veneer will depend upon the results desired. Excellent results have been obtained using 0.33 ounce of aqueous binding solution per sq. ft. for each glue line. In general, it is sufficient to use between 5 and 15 lbs. of resin forming ingredients, on a dry basis, per M sq. ft. of veneer surface being coated. The application of the binding solution in two steps by a pressure spray process, as described, makes it possible to use nearer the minimum amount of binding solution and still obtain a satisfactory bond.

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

I claim as my invention:

1. The method of making plywood which comprises applying successive coats of an aqueous solution of a resinous partial condensation product to a core surface, drying said core after each coating to a moisture content of not substantially over 4%, humidifying the final coating to impart to the coating itself a moisture content of from 15 to 40% and uniting said coated core with a veneer by the application of heat and pressure.

2. The method of making plywood which comprises applying a light coating of an aqueous solution of a resinous condensation product to a core surface, drying said coated core, applying a heavier coating of said aqueous solution to the surface only of said coated core, drying said coated core to a moisture content of between 2 and 4%, humidifying said coated core to impart a substantially increased moisture content to said coating but not to the body of the core and uniting said coated core with a veneer by the application of heat and pressure.

3. The method of making plywood which comprises applying a light coating of aqueous solution of a partial condensation product of cresylic acid and an aldehyde to a core surface, drying said coated core, applying a heavier coating of said aqueous solution to the surface only of said coated core, drying said coated core to a moisture content of between 2 and 4%, humidifying said coating on the core to impart a substantially increased moisture content to said coating, but not to the body of the core, uniting said coated core with a veneer by the application of heat and pressure and humidifying the resulting plywood to impart thereto a moisture content of between 8 and 12%.

4. In a method of making plywood, the steps of applying successive coatings of an aqueous dispersion of a resinous partial condensation product to a core of wood, drying the coated core after each coating to confine a subsequent coating to the previously coated surface of said core, humidifying the resulting coated core to impart to the surface coating thereof a moisture content of between 15 and 40% and uniting said coated core with a veneer by the application of heat and pressure.

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