TREATMENT OF MOISTURE-BEARING FIBROUS MATERIALS

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ABSTRACT OF THE DISCLOSURE

Method of stabilizing and preserving the strength and toughness of green wood by heating at elevated temperatures to remove moisture from the wood surface without damaging the surface or removing significant amounts of moisture from the interior of the wood, and then laminating a formed plastic film to the surface. For example, extruded polyethylene film is joined to green wood veneer pre-heated in an oven or by immersion in molten zinc.

This invention relates to processes for treatment of moisture-impregnated fibrous materials; more specifically, it relates to processes for removing humidity from moisture-laden fibrous materials such as green wood, and for coating such materials with a moisture-retaining plastic film. Still more specifically, this invention relates to processes for coating green wood veneer with a moisture-retaining plastic film.

This patent application is a continuation-in-part of my co-pending U.S. patent application Ser. No. 209,463, filed July 12, 1962, now abandoned.

Prior to this invention, it has already been demonstrated that solid materials may be dried by relatively slow and inefficient methods such as kiln-drying. Since molten metal conducts heat much faster than air and is easier to maintain at a high temperature, a molten metal drying process would seem to have definite advantages over the other processes. However, the expensive metal melting processes have not been widely used because of several problems encountered in their use.

One problem is that most metals oxidize when they are exposed to the atmosphere and held at temperatures high enough to keep them in a molten state. This is a serious problem because the metal oxidizes and forms an unwanted coating on the vessel holding the bath and on the material to be dried. Furthermore, the oxide hardens on the surface of the bath and traps steam arising beneath it from the metal being dried. When this trapped steam escapes it often causes an explosion and loss of valuable metal, and requires the use of fire protection and personnel safety devices.

Prior solutions to this problem include enclosing the bath in airtight housing filled with an inert gas. Although this prevents formation of the oxide, it increases the size and cost of the equipment used and reduces the speed and efficiency of the process by requiring entry to and exit from the bath very difficult.

Accordingly, an object of this invention is to provide a molten metal bath drying process in which the formation of an oxide coating on the surface of the bath is eliminated without enclosing the bath in an inert gases atmosphere and with a minimum of expense and effort.

In the process of this invention this object is met by using zinc (or a zinc-aluminum alloy as referred to hereinafter) as the bath metal and holding its temperature of around 950 degrees Fahrenheit. This avoids formation of the troublesome oxide coating on the bath's surface. Temperatures somewhat above 950 degrees may be used if desired, but the oxide coating forms more readily as this temperature is surpassed. Maintaining the bath temperature within the range from approximately 800 degrees to 950 degrees Fahrenheit has proved to be especially desirable since the minimum temperature (800 degrees) is sufficiently higher than the melting point of the bath metal to maintain it in a molten state when relatively cool objects are suddenly immersed in the bath.

Since this bath does not form an oxide coating when it is maintained in a molten state and exposed to the atmosphere for long periods of time, there is no need to enclose the bath in an inert gas atmosphere. This eliminates the previously existing need for costly enclosures and gases and provides a process which takes full advantage of the speed and efficiency advantage inherent in the use of a molten metal drying medium. As a result, the process is faster, more efficient and less expensive than any previously known.

Another problem present in prior molten metal processes is caused by the fact that molten metals often adhere to the surface of many materials such as wood. This gives the materials an undesired metallic coating and wastes metal. Accordingly, another object of this invention is to provide a molten metal bath which does not adhere readily to materials immersed in it for drying.

This object is met in the present process by adding a small amount of aluminum to the zinc bath to prevent adherence between the bath metal and the material being dried. Any amount of aluminum between zero and about 4 percent may be used, but the bath forms an oxide coating more readily as the amount is increased substantially above 4 percent.

Drying wood in a molten metal bath creates special problems in addition to those described above. In fact, it was previously considered impractical to use the process for drying combustible materials of any kind because of the undesirable charring or burning of the material would necessarily undergo. Hence, a further object of this invention is to provide a molten metal process capable of removing moisture from wood without damaging the wood to any substantial degree.

It has been discovered that wood can be dried by a molten metal process without charring if it is not held immersed in the bath for too long a time. The degree of drying can be controlled by the time of immersion and repeated immersions may be used where desired.

The molten metal process has proved to be especially useful in drying wood veneer. Since the veneer is relatively thin, interior moisture can get to the surface of the veneer easily and therefore can be evaporated quickly. The degree of drying attained can be controlled by varying the length of time the veneer is immersed in the bath.

The molten metal process has proved most useful in removing limited amounts of moisture from wood veneer and similar fibrous materials at a very rapid rate. This feature is very valuable in making any unique moisture-retaining plastic-coated wood veneer, which is made by applying to fresh wood veneer from which a relatively small amount of moisture has been removed a thin film of moisture-impervious plastic such as polyethylene. The resulting laminate has a moisture content of at least 25 percent of the dry weight of the wood. As is explained in my co-pending application Ser. No. 128,483, filed Aug. 1, 1961 and now abandoned, this veneer is stronger, tougher and less subject to warping than ordinary uncoated veneers because the moisture-impervious plastic coat prevents the wood from drying out, thus preserving the natural strength of the "green," moisture-laden veneer.

In making my unique moisture-retaining wood veneer, many special problems are met. First, it is believed that prior to the present invention, no truly successful method...
has been provided for bonding flexible plastic film to moisture-laden fibrous materials. Invariably, it is believed, the moisture in the materials has prevented long-lasting adherence between the film and the materials. This problem is especially severe in bonding plastic film to green wood veneer for use in making my unique laminated veneer product, since, as mentioned above, the wood has a relatively high moisture content when coated. The surfaces of the veneer should be dry or nearly so before the veneer is coated in order to promote proper adherence between the plastic and the wood, and yet most of the interior moisture of the wood should remain in order to give it strength and toughness.

It is essential to maintain the pliability and toughness of the coated veneer, and to keep its cost low, adhesives should not be used to bond the plastic to the veneer. This requirement makes the problem of providing a good bond all the more difficult.

Knots, splits, worm holes and other defects in the wood create the problem in that it is important to cover the wood surfaces exposed by the defects in order to prevent the wood from drying out around them and considerably weakening the wood at those already weak spots. Therefore, another object of the present invention is to provide a process for the treatment of moist fibrous materials to preserve their moisture strength and toughness.

Another object of the present invention is to provide a fast and inexpensive process for manufacturing moist wood veneer, by means of which the plastic is bonded rapidly and securely to the wood surface without the use of adhesives and is molded into crevices and holes in the wood.

In the drawings:

FIGURE 1 is a schematic drawing illustrating one embodiment of the present invention;

FIGURE 2 is a schematic diagram illustrating another embodiment of the present invention; and

FIGURE 3 is a cross-sectional view of wood veneer coated in accordance with the present invention.

In the process embodiment of FIGURE 1, wood veneer 10 is fed from a veneer supply 12, which may include a lathe which strips the veneer from a log and feeds it out continuously, a roll of veneer which has been cut previously, or a stack of separate sheets of veneer. This veneer is "green" i.e., it has a high moisture content. The veneer moves in the direction indicated by the arrows over a set of rollers 14 and into a molten zinc-aluminum bath 16 which is contained in a tank 18 and is maintained in a molten state at or below 930 degrees Fahrenheit by a suitable controlled heat supply 20. A curved guide-plate 22 feeds the veneer and keeps it immersed in the bath. The speed at which the veneer is fed into the bath is controlled so that each section of veneer remains immersed in the bath for from 2 to 3 seconds and emerges from the bath having relatively dry surfaces but still containing a relatively large amount of internal moisture.

The emerging veneer is then moved rapidly over a second set of rollers 24 and is fed substantially immediately into a plastic coater 26 which applies a coat of plastic to both surfaces of the veneer to produce the plastic-coated veneer described in my above-mentioned co-pending application Ser. No. 128,483.

Plastic coater 26 is described in detail in co-pending U.S. patent application Ser. No. 203,122, filed June 18, 1962, and now abandoned, and the description in that application is incorporated herein by reference. Some of the components of the coater 26 which are most pertinent to this invention are shown in FIGURE 2 for the sake of convenience.

Referring now to FIGURE 2, plastic coater 26 includes two extrusion dies 28 each of which is positioned on one side of the veneer 10 and extrudes a thin film of hot, moisture-impervious plastic material such as polyethylene onto both surfaces of the veneer. The temperature of the extruded plastic is within the approximate range of 500° to 625° F, as measured in the dies 28, and preferably has a temperature of approximately 575° to 590° F. The film applied to the veneer has a thickness of from 0.005 to 0.020 mil (thousandths of an inch) to 10 mils, and preferably between 0.03 and 0.1 mils.

Two "chill" rolls 32 press the hot polyethylene onto the wood and simultaneously cool the hot plastic. These rolls 32 are water-cooled and their temperature is maintained within a range of 74° to 85° F. They are capable of applying pressures of up to 600 pounds per linear inch to the veneer. Preferably, they compress the veneer by no more than about 25% of its original thickness. Since the veneer is moist and elastic, it regains substantially all of its original thickness after it has passed between the chill rolls 32.

The distance between the tip of each extrusion die 28 and the nip of chill rolls 32 is maintained within a range of approximately 3 to 7 inches, and preferably is set at 6 inches. At this latter distance, the temperature of the hot plastic drops to about 425° F. Just before it is applied to the veneer, it is cooled to approximately 425° F. This bonding process provides an extraordinarily good bond between the plastic and the veneer. The plastic-coated, moisture-laden veneer 34 emerging from the coater 26 is unique in that the plastic coats the surfaces of cracks, crevices, worm-holes and knot-holes, even to depths below which the surfaces of chill rolls 32 do not penetrate. Thus, the plastic is bonded quite firmly and protects the wood surfaces around defects in the wood so that drying of the wood in those areas is inhibited. This greatly retards weakening of the veneer in those defective areas.

This unique coated veneer 34 is shown in cross-section in FIGURE 3. This drawing shows how the plastic material 30 coats the surfaces of a worm-hole 36, a knot-hole 35, and two cracks 40.

It should be understood that the thickness of the film 30 is shown considerably enlarged for the sake of clarity. The external dimensions of the veneer sheet as it passes between chill rolls 32 are shown by dashed lines 42. It is evident from the drawing that the plastic is bonded to the surfaces of the defects at a depth far below the lines 42, thus indicating that the pressure of rolls 32 is not the only pressure bonding the plastic to the veneer.

It is believed that this highly unexpected deep bonding is accomplished by the following mechanism.

Because of the high moisture content of the veneer and the short time of contact between the veneer and the molten bath metal, the temperature of the veneer rises to only about the boiling temperature of the moisture in the veneer. Surface moisture is removed in the bath, and some of the internal moisture is converted into steam. Because the veneer is fed from the bath into the coater 26 substantially immediately, the interior of the veneer cools off very little before it is coated and a substantial portion of the internal steam still is present in the veneer when the plastic is applied. Then, when the wood cools, either by allowing the coated wood to cool in the air, or by rolling it with chill rollers 32, and internal steam condenses and creates an internal vacuum in the wood which draws the plastic film onto the wood's surface and into its cracks and crevices to depths below which the rollers 32 do not penetrate.

In order to insure good bonding, the fibrous material being coated should not be allowed to cool too slowly, since such moisture-laden internal moisture condenses before the plastic film is applied. The surface temperature to which the material can be cooled without condensing too much internal vapor varies with the type
of material, its thickness, the depth to which it is heated, etc.

Green wood veneer, due to its relatively high moisture content and the brevity of its heating in the molten bath, emerges from the bath having a surface temperature near the boiling temperature of water (212°F). It has been found that veneer having a thickness from 1/8 to 1/4 inch should not be allowed to cool in the air to surface temperatures substantially below 150°F, before application of the plastic film in order to maintain a quantity of internal vapor sufficient to give good vacuum bonding of the film. Air speeds up to 50 feet per minute have proved satisfactory. Faster air speeds are objectionable because the veneer should be coated substantially immediately after emerging from the bath. Thus, it has been found that the length of the travel path of the heated veneer from the bath to the coater ideally should be of the same order of magnitude as the length of the path taken by the veneer through the bath, as is shown in FIGURE 1. This results in a bath-to-coater travel time of the same order of magnitude as the immersion time in the bath, e.g., from 2 to 3 seconds, during which the surface and internal temperatures of the veneer drop only slightly. This travel time can be varied, but preferably is maintained within an approximate range of from 1 to 10 seconds.

It is believed that applying the hot film to the veneer in the coater results in some re-heating of the veneer and re-generation of internal vapor so that the film bond is further improved.

The veneer emerging from the coater is especially tough and flexible, due to its high moisture content, and is well suited for strenuous use in wireboard boxes and other applications. The fact that the surfaces of the veneer are substantially dry at the time the plastic films are applied further promotes good adherence of the film to the veneer.

The above manufacturing process is capable of producing plastic coated wood veneer at a high speed, velocities as high as 200 ft per minute being used and even higher speeds being practical. The molten metal bath apparatus is much smaller and much less expensive than the large kils used previously to achieve the same results. The fact that the temperature of the molten metal bath is substantially higher than temperatures which are practical in air-heating devices, and the further fact that molten metal conduct heat to the surface of the wood much faster than air, combine to make this manufacturing process much faster and efficient than any previously available.

Another embodiment of this fibrous material coating and preserving process is illustrated in FIGURE 2. This process is the same as that shown in FIGURE 1 except that a gas-fired oven 44 is used to heat the veneer prior to its entry into the coater 26, and the fresh veneer is fed first between a pair of rolls 46 which squeeze some of the moisture out of the veneer, and then through a vacuum cleaner 48 which removes any remaining surface moisture before the veneer enters the oven.

Operation of the process using the equipment as shown in FIGURE 2 is illustrated by the following example.

Sheets of green veneer 30 inches by 30 inches thick are produced by a venter lathe. These sheets contain moisture in an amount of from 65% to 120% of the dry weight of the sheet. The amount of moisture present depends upon the species of wood as well as other variable such as the moisture in the ground in which the tree grew before being cut down.

The veneer sheets are then fed between the rolls 46 at a speed of about 100 feet per minute. Rollers 46 apply pressures up to 600 pounds per linear inch to the veneer and squeeze from 4% to 22% of the moisture out of the wood, the amount removed depending again upon the species and moisture content of the wood. A feed speed of around 100 feet per minute is preferred, but higher speeds can be used.

The sheets then pass through the vacuum cleaner 48 which removes any excess surface moisture from the veneer, and then pass into the oven 44.

Oven 44 is gas-fired, but can be heated by other well-known means. An oven actually used is 62 inches long and has a rated output of 500,000 B.t.u. per hour, with air and steam used to heat the oven. In order to produce a 1% moisture content the oven is adjusted to at about 121°F. and it is higher than 1% of the moisture is removed from the veneer. As was explained above, it is believed that part of the internal moisture of the veneer is converted into steam.

The veneer is moved substantially immediately into the plastic coater 26 where the plastic is applied and bonded in the manner described above. The distance from the oven 44 to the coater 26 preferably is from 3 to 11 feet, resulting in an open-air travel time of from 1.5 to 6.6 seconds. In practice, it has been found that surface temperature loss of the veneer during this open-air travel is no more than 2° to 4°F.

The conventional oven 44 has the advantages of being readily available and relatively easy to operate. Also, the temperature of such a conventional oven is relatively easy to control.

The above description of the invention is intended to be illustrative and not in limitation thereof. Various changes or modifications in the embodiments described may occur to those skilled in the art and these can be made without departing from the spirit or scope of the invention as set forth in the claims.

I claim:

1. A process for stabilizing green wood and preserving its strength and toughness which comprises rapidly heating said green wood at a temperature above the boiling temperature of the moisture in said wood until moisture is vaporized from surface portions of the wood but no significant amount of moisture is removed from interior portions of the wood, laminating a formed plastic film onto at least one surface of the wood substantially immediately after said heating, and cooling said wood and plastic film.

2. A process as in claim 1 wherein said formed plastic film is mechanically pressed against the wood surface substantially immediately after application of the film.

3. A process as in claim 1 wherein said cooling is effected by contacting said wood and formed plastic film with a relatively cooler chill member substantially immediately after application of the film.

4. A process as in claim 1 wherein said formed plastic film is mechanically pressed against the wood surface substantially the same time said wood and plastic film are cooled.

5. A process as in claim 1 wherein said wood is heated in an ambient gas.

6. A process as in claim 1 wherein moisture is squeezed from said green wood prior to heating.

7. A process as in claim 6 wherein excess surface moisture is removed from said green wood by vacuum cleaning after squeezing and prior to heating.

8. A process for stabilizing wood veneer and preserving its natural strength and toughness, said process comprising the steps of: heating a sheet of said veneer in an oven for 1 to 10 seconds at a temperature above about 150°F, until moisture is vaporized from surface portions of said veneer but only while said surface portions remain undamaged and no significant amount of moisture is removed from interior portions of the veneer, then applying a thin formed film of moisture-impervious plastic material to each of the broad surfaces of said sheet while the surface temperature of said sheet is no lower than
150° F. and a substantial amount of vaporized moisture remains in said veneer, and then cooling said film and said veneer to condense said vaporized moisture in said veneer.

9. A process as in claim 8 in which said plastic material is polyethylene.

10. A process for manufacturing a laminated material comprising green wood veneer containing moisture in the amount of at least 25 percent of the dry weight of the wood and a thin film of moisture-impervious plastic material coated upon the broadest surfaces of said veneer, said process comprising the steps of: squeezing a portion of said moisture out of said veneer, passing said veneer through an oven at a temperature above about 1340° F. for from 1 to 5 seconds until moisture is vaporized from surface portions of said veneer but only while said surface portions remain undamaged and no significant amount of moisture is removed from interior portions of the veneer, applying a relatively thin extruded film of said plastic material to each of the two broad surfaces of said veneer, said plastic film having a thickness of from 1/2 to 10 mils and being extruded onto said surfaces at a temperature of from 500° to 625° F., and then passing said veneer between a pair of rollers which compress the laminate of film and veneer by no more than 25 percent of this thickness before passing between said rollers, the temperature of said rollers being maintained within the range of from 74° to 85° F.

11. A process for removing moisture from green wood which comprises immersing said green wood in a bath consisting principally of molten zinc, said bath having a temperature between about 800° F. and about 950° F., until moisture is vaporized from surface portions of the wood but only while said surface portions remain undamaged and no significant amount of moisture is removed from interior portions of the wood.

12. A process as in claim 11 wherein said bath comprises up to about 4 percent of molten aluminum.

13. A process for stabilizing green wood and preserving its strength and toughness which comprises immersing green wood in a bath consisting principally of molten zinc, said bath having a temperature between about 800° F. and about 950° F., until moisture is vaporized from surface portions of the wood but only while said surface portions remain undamaged and no significant amount of moisture is removed from interior portions of the wood, and then laminating a formed plastic film onto surface portions of the wood.

14. A process as in claim 13 wherein said wood is immersed in said bath for from two to three seconds.

15. A process as in claim 13 wherein said bath comprises up to about 4 percent of molten aluminum.

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