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PROCESS OF IMPREGNATING AND DRYING WOOD AND COMPOSITION THEREFOR

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This invention relates to wood treatment. More particularly, the invention relates to a composition and method for treating wood to reduce the volumetric shrinkage of the wood when the moisture content thereof is lowered. The invention is particularly applicable to reduce the shrinkage of wood in the form of thin sheets such as are obtained by the slicing or cutting of wood to produce veneer.

In conventional drying processes the normal shrinkage of wood, particularly in the radial direction, reduces the dimensions of the wood by 6 to 9% or more. In many applications it is particularly desirable to reduce this shrinkage as much as possible. It is particularly important to reduce shrinkage when the species of wood treated or the method of manufacture commands a high price and where tight fitting assemblies are required to keep their dimensions under varying conditions of service.

Various attempts have been made by the prior art to limit the amount of shrinkage which wood undergoes on drying. Impregnation or other treatment by chemicals is one of the methods heretofore suggested. Chemicals suitable for the treatment of wood to reduce the shrinkage thereof when subjected to drying operations must be characterized by chemical stability in the wood. Furthermore, such materials must not be hydroscopic or demonstrate a tendency to crystallize on the surface of the wood. Additionally, such materials must have a high efficiency in relatively low concentration. Additionally, such materials must be available at low cost. The various salts, carbohydrates, polyalcohols, and the like which have heretofore been suggested for stabilizing wood with regard to dimensional changes caused by drying have not satisfactorily met the above-defined prerequisites.

It is a primary object of this invention to provide a composition which may be employed to treat wood whereby the volumetric shrinkage of the wood when the moisture content thereof is reduced is limited.

It is an additional primary object of the invention to provide a method for treating wood to limit the volumetric shrinkage of the wood when the moisture content thereof is lowered.

In accordance with this invention wood is treated with a mixture of urea and a material selected from the group consisting of hydroxyacetic acid and the alkali metal and ammonium salts of hydroxyacetic acid to reduce the volumetric shrinkage of the wood when the moisture content thereof is lowered. The aforementioned mixtures of urea and hydroxyacetic acid and hydroxyacetic salts are effective in low concentration to limit the volumetric shrinkage of the wood

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when the moisture content of the wood is lowered. Furthermore, such mixtures are not hydroscopic to any appreciable extent and do not impart hydroscopic properties to the wood. Additionally, the mixtures of this invention are stable in the wood and are available at low cost in large quantity.

Hydroxyacetic acid and the alkali metal and ammonium salts thereof including specifically sodium, potassium, lithium, and ammonium salts, are contemplated for utilization in conjunction with urea in this invention. Such salts may desirably be obtained by forming first an aqueous solution of urea and hydroxyacetic acid and thereafter adding an alkali metal hydroxide or carbonate, such as ammonium, potassium, or lithium hydroxide or carbonate or bicarbonate to the solution so formed in an amount requisite to raise the pH to from about 5 to about 7.

Mixtures in all relative proportions of urea and hydroxyacetic acid and the ammonium and alkali metal salts of hydroxyacetic acid are contemplated by this invention. Especially suitable mixtures contain from about 0.08 to about 0.30 parts by weight of hydroxyacetic acid or the alkali metal or ammonium salts of hydroxyacetic acid per part by weight of urea. A preferred range is from about 0.16 to about 0.20 parts by weight of hydroxyacetic acid or ammonium or alkali metal salts of hydroxyacetic acid per part by weight of urea.

The compositions of this invention may be utilized in the form of solutions, such as aqueous solutions, as substantially dry crystals, and as a mixture of crystals and water, and applied to the wood by brushing, dipping, immersion, or any other method suitable to effect contact of the wood with the compositions of the invention.

Appropriate solutions useful for treating wood in accordance with this invention comprise aqueous solutions containing from about 10% to about 45% by weight, preferably from about 25% to about 35% by weight, of the mixture of urea and hydroxyacetic acid and the ammonium or alkali metal salts of hydroxyacetic acid, as above-defined. Such solutions may be appropriately utilized by dipping the wood to be treated therein for a period of from about 3 to about 30 minutes with the solution maintained at a temperature of from about 15 to about 80° C. Greater or lesser temperatures may be utilized when circumstances indicate that such modifications may be expedient.

In many instances, particularly when it is desirable to preclude absorption by the wood treated of substantial quantities of water from the compositions of this invention it is advantageous to apply the compositions of the invention in

more highly concentrated form than hereinbefore described. In such cases there may be utilized fully saturated aqueous solutions of the mixtures of urea and hydroxyacetic acid or ammonium or alkali metal salts of hydroxyacetic acid contemplated by this invention. Concentrated aqueous solutions containing from about 45% to about 70% by weight are particularly suitable. Solutions containing from about 60% to about 70% by weight of the urea-hydroxyacetic acid mixtures of this invention are preferably employed.

When concentrated solutions as above-defined are utilized the treatment of the wood may be effected by immersion for a period of from about 3 to about 30 minutes with the solutions maintained at a temperature of about 15 to about 80° C., in like manner to that described with reference to the more dilute solutions. Alternatively, the concentrated solutions may be brushed on the wood to be treated and the wood thereafter stacked or otherwise stored to permit penetration of the solution in the wood. Like treatment may be effected with the more dilute solutions previously described.

The amount of moisture present in the compositions of this invention may still further be reduced by utilizing as the composition to treat the wood a moist mixture of salts. Such salt mixtures may be prepared by mixing crystalline urea with a technical 70% solution of hydroxyacetic acid or a like solution of the alkali metal or ammonium salts of hydroxyacetic acid. Preferably crystalline urea is mixed in the proportion of from about 4 to about 7 parts of crystalline urea with from about 0.6 to about 1.2 parts of hydroxyacetic acid or an alkali metal or ammonium salt thereof and about 0.4 to about 0.2 parts of water by weight. An almost dry mixture of chemicals is thereby obtained which can be spread on the thin surface of the sheets of moist wood to permit the moisture of the wood to dissolve and distribute the same through the wood. In like maner, mere physical mixtures of dry urea and dry hydroxyacetic acid or ammonium or alkali metal salts of hydroxyacetic acid may be utilized.

When such crystalline mixtures of dry salts are utilized it is preferable that the sheets of wood having the crystals of the salts spread thereover be stacked together and left for a period of from about 1 to 24 hours, at atmospheric temperature, i. e., a temperature of from about 5 to about 30° C.

Veneer sheets or like other materials treated are thereafter subjected to conventional drying operations of the type heretofore practiced in the art. Such drying operations normally embrace oven drying of the wood at a temperature of from about 200 to 240° F., for a time period requisite to reduce the moisture content of the wood to about 5% by weight.

Substantially all species of wood may be treated in accordance with this invention, specific reference being made to oak, walnut, gum, poplar, beech, fir, mahogany, and the like. When the invention is particularly adapted to the wood in the form of thin sheets such as are utilized in the production of veneer, it may also be applied to wood in any physical configuration which it is desired to treat. Thus railroad ties, and other bulky wood articles may also be treated by this invention. It will be appreciated by those skilled in the art that the time of treatment may of necessity be extended somewhat when other wood articles of substantial thickness are treated in accordance with the method of this invention.

Generally speaking, while the invention is applicable to the treatment of wood having any relative moisture content, the wood treated will be characterized by a moisture content of 30% to 50% by weight.

It is preferred that the compositions of this invention be utilized in the method of the invention with a pH not greater than about 7 when the alkali metal and ammonium salts of hydroxyacetic acid are utilized. A pH range of 5 to 7 is particularly suitable.

EXAMPLE 1

An aqueous solution is prepared containing 6 parts of urea and one part of hydroxyacetic acid and 15 parts of water, all parts being by weight. Walnut veneer having the dimensions of 10.58'' wide, 1/28'' thick and a moisture content of about 45% by weight was dipped in this solution maintained at a temperature of 60 to 70° C., for a period of about 30 minutes. The walnut veneer was thereafter removed from the treating solution and the solution was allowed to drain off. The veneer was then dried in a conventional drying oven maintained at a temperature of about 105° C., for a period of about 25 minutes. The moisture content thereof was reduced to about 6% by weight. The width of this walnut veneer sheet was about 10.49 inches, thus indicating a shrinkage of less than about 1%. A control walnut veneer sheet identical with that above-described, which was not treated in the compositions of this invention but which was dried in precisely the same manner as that above-described to a moisture content of about 6% showed a shrinkage of about 7 to 8%.

A third walnut veneer panel identical with that panel first-described but treated in aqueous solution containing 30% by weight of urea for a period of 30 minutes while the solution was maintained at a temperature of 60 to 70° C. and thereafter dried in the same manner as the first-described sheet to a moisture content of about 6%, was measured and found to have a width of about 10.30 inches, thereby demonstrating a shrinkage of about 2.7%.

A veneer sheet identical with the one first-described was immersed for about 30 minutes in a solution containing about 30% by weight of acetic acid, at a temperature of about 60 to 70° C. and thereafter dried to a moisture content of about 6%. The width of this sheet, after drying, was about 10.26 inches, thus indicating a shrinkage of about 3%. This experiment was repeated with lactic acid and the dried veneer sheet had a width of about 10.24 inches, thus also indicating a shrinkage of about 3%.

The percents of shrinkage above-noted are determined by comparing the width of the original veneer sheet of high moisture content with the width of the dry sheet and expressing the difference as percentages of the original width.

EXAMPLE 2

This example illustrates the practice of the invention utilizing a more concentrated form of the hydroxyacetic acid-urea mixtures contemplated by the invention.

An aqueous solution was prepared containing 6 parts of urea, 0.70 parts of hydroxyacetic acid, and 4 parts of water, all parts being by weight. This concentrated solution was applied by brushing to the surfaces of thin sheets of moist walnut

wood, containing about 40% by weight of water, having the dimensions of 8.31" wide, 1/28" thick. The so-treated sheets were stacked and left in a stack at a temperature of about 20 to 25° C., for a period of about 120 minutes.

The so-treated sheets were thereafter dried in the manner described in Example 1 to a moisture content of about 5%. The width of the sheets after drying was about 8.09 inches, thereby indicating a shrinkage of about 2.6%.

Control sheets dried in like manner but not treated with the compositions of this invention demonstrated a shrinkage of about 7.86%.

EXAMPLE 3

Six parts of crystalline urea were mixed with 1 part of technical hydroxyacetic acid containing 70 parts of hydroxyacetic acid and 30 parts of water by weight. Crystals obtained in this manner were spread over the surfaces of 10 sheets of walnut wood, having a moisture content of about 59%. The total width of the wood sheets upon which the crystals were placed was 82.2". The so-treated sheets were then stacked together and left for a period of about 24 hours in an atmosphere having a temperature from about 20 to 25° C. The so-treated sheets were thereafter dried in accordance with the method described in Example 1. The total width of the sheets after drying was about 81.3", thus indicating a shrinkage of only about 1.1%.

EXAMPLE 4

This example embraces the results of a series of comparative pilot plant runs.

After slicing, veneer sheets from 3 poplar and 3 gum flitches were separated into two stacks. The veneer sheets were 6 feet in length. The width varied from about 6" to 16". The poplar veneer sheets contained about 50% by weight of moisture and the gum sheets contained about 55% by weight of moisture.

Some of each of the two stacks of sheets were used as a control and the other was treated with one of the compositions of this invention in the manner indicated in the table.

Table

Species	Treatment	Total Width After Drying		Veneer Saved By Treatment, Sq. ft. per m. sq. ft.
		Untreated, Feet	Treated, Feet	
Poplar	Immersion [1]	41.0	43.3	56
Gum	do	49.9	53.0	62
Poplar	Brushed on [2]	53.6	56.3	50
Gum	do	28.0	28.9	32
Poplar	Crystals [3]	18.8	20.4	85
Gum	do	48.2	51.4	66

[1] The sheets were immersed in a solution of urea and hydroxyacetic acid identical with that described in Example 1 in the same manner and for the same period of time and under the same temperature conditions as described in Example 1 and thereafter dried for a period of about five minutes in an industrial veneer drying machine, the temperature at the inlet end of which was about 240° F., the temperature at the outlet end of which was about 155° F., to a final moisture content of about 3 to about 6% by weight.

[2] The sheets were brushed with a solution of urea and hydroxyacetic acid identical with that described in Example 2 in the same manner and for the same period of time and under the same temperature conditions as described in Example 2 and thereafter dried for a period of about five minutes in an industrial veneer drying machine, the temperature at the inlet end of which was about 240° F., the temperature at the outlet end of which was about 155° F., to a final moisture content of about 3 to about 6% by weight.

[3] The veneer sheets were treated with crystals obtained in the same manner and under the same conditions as those described in Example 3, and thereafter dried for a period of about five minutes in an industrial veneer drying machine, the temperature at the inlet end of which was about 240° F., the temperature at the outlet end of which was about 155° F., to a final moisture content of about 3 to about 6% by weight.

The remarkable utility of the methods and compositions of this invention in effecting saving in veneer is obvious from the table.

EXAMPLE 5

Six walnut veener sheets of the same type as those described in Example 1 were treated in the same manner as that described in Example 1, with an aqueous solution of hydroxyacetic acid and urea identical with that described in Example 1 and under the same conditions of time and temperature as those described in Example 1. Subsequent to the drying operation it was found that the average thickness of the treated sheets was about 0.0334 inch.

Six control sheets identical with the six sheets as above-described in this example were not treated with the composition of this invention but were dried in precisely the same manner as the treated sheets. The average thickness of the control sheets subsequent to drying was about 0.0326 inch.

It is obvious from the foregoing that the sheets treated in accordance with this invention demonstrated, subsequent to drying, an average thickness about 0.002 inch greater than that of the untreated control sheets. Assuming a conventional veneer thickness of about 0.033 inch, an extra veneer sheet is obtained through the practice of this invention for every 16 or 17 sheets produced and treated. The economic significance of the invention is thus readily apparent.

EXAMPLE 6

A group of 12 sheets of poplar having dimensions of about 10" x 24" and a like group of sheets of gum both having a thickness of 1/20 of an inch were treated with the aqueous solution of Example 2. Subsequent to treatment the veneer sheets contained urea and hydroxyacetic acid in an amount equal to about 18% by weight of the sheets. The sheets contained about 50% by weight of water before treatment. The so-treated sheets were thereafter dried in a veneer dryer to a moisture content of about 5%. Simultaneously, substantially identical groups of untreated control sheets of poplar and gum were dried.

After storage of both the treated and untreated dried sheets in a chamber in which the relative humidity was maintained at about 30% at about 26° C. for a period of about 3 days, constant weight was reached and both the control and the treated sheets were exposed to air of 80% relative humidity at 38° C. for a period of about 3 days. The treated gum sheets averaged 7.47% increase in weight whereas the untreated sheets averaged 7.59% increase in weight. The treated poplar sheets averaged 7.43% increase in weight whereas the untreated poplar sheets averaged 7.34% increase in weight.

This example clearly demonstrates that the compositions of this invention do not substantially increase the hydroscopicity of the wood treated.

EXAMPLE 7

Example 2 was repeated with the exception that the urea-hydroxyacetic acid solution utilized was neutralized by adding ammonium hydroxide in an amount requisite to raise the pH to about 6 or 7, thereby forming a mixture of urea, hydroxyacetic acid, and the ammonium salts of hydroxyacetic acid.

The results obtained are substantially identical with those described in Example 2.

Like results are obtained when alkali metal hydroxides, including sodium, potassium, lithium hydroxides and carbonates, are utilized.

In some industrial drying operations the wood sheets may be carried by metallic members which contact the wood to be dried. Under some circumstances, this may give rise to some discoloration of the wood surfaces. This problem may be obviated by predrying the surfaces only of the wood with a stream of warm air prior to placing the wood in contact with the metallic members of the drying apparatus.

I claim:

1. A composition for treating wood to reduce the volumetric shrinkage of the wood when the moisture content thereof is lowered, consisting essentially of urea and a material selected from the group consisting of hydroxyacetic acid and the alkali metal and ammonium salts of hydroxyacetic acid, said composition containing from about 0.08 to about 0.30 parts by weight of said material per part of urea.

2. The composition of claim 1 containing from about 0.16 to about 0.20 part by weight of said material per part by weight of urea.

3. An aqueous solution containing from about 10% to about 70% by weight of the composition of claim 1, said solution having a pH not greater than about 7.

4. An aqueous solution containing from about 10% to about 45% by weight of the composition of claim 1, said solution having a pH not greater than about 7.

5. An aqueous solution containing from about 25% to about 35% by weight of the composition of claim 1, said solution having a pH not greater than about 7.

6. An aqueous solution containing from about 45% to about 75% by weight of the composition of claim 1, said solution having a pH not greater than about 7.

7. A composition for treating wood to reduce the volumetric shrinkage of the wood when the moisture content thereof is lowered, consisting essentially of from about 4 to about 7 parts by weight of crystalline urea, about 0.6 to about 1.2 parts by weight of a material selected from the group consisting of hydroxyacetic acid and the alkali metal and ammonium salts of hydroxyacetic acid, and from about 0.4 to about 0.2 part of water by weight, said composition having a pH not greater than about 7.

8. A composition for treating wood to reduce the volumetric shrinkage of the wood when the moisture content thereof is lowered comprising a mixture of urea and a material selected from the group consisting of the alkali metal and ammonium salts of hydroxyacetic acid, said composition being characterized, when in aqueous solution, by a pH not greater than about 7, and containing from about 0.08 to about 0.30 part of said material per part of urea.

9. The method which comprises impregnating a substantial portion of the wood with the composition of claim 1, thereafter drying the surface only of the so-treated wood, and subsequently completing the drying of the wood.

10. The composition of claim 1 wherein said material is hydroxyacetic acid.

11. The composition of claim 1 wherein said material is the ammonium salt of hydroxyacetic acid.

12. A process for reducing the volumetric shrinkage of wood when the moisture content thereof is lowered which comprises impregnating a substantial portion of the wood, the shrinkage of which is to be reduced, with the composition of claim 1 and thereafter lowering the moisture content of the impregnated wood.

13. A process for reducing the volumetric shrinkage of wood when the moisture content thereof is lowered which comprises impregnating a substantial portion of the wood, the shrinkage of which is to be reduced, with the composition of claim 2 and thereafter lowering the moisture content of the impregnated wood.

14. A process for reducing the volumetric shrinkage of wood when the moisture content thereof is lowered which comprises impregnating a substantial portion of the wood, the shrinkage of which is to be reduced, with the composition of claim 5 and thereafter lowering the moisture content of the impregnated wood.

15. A process for reducing the volumetric shrinkage of wood when the moisture content thereof is lowered which comprises impregnating a substantial portion of the wood, the shrinkage of which is to be reduced, with the composition of claim 6 and thereafter lowering the moisture content of the impregnated wood.

16. A process for reducing the volumetric shrinkage of wood when the moisture content thereof is lowered which comprises impregnating a substantial portion of the wood, the shrinkage of which is to be reduced, with the composition of claim 7 and thereafter lowering the moisture content of the impregnated wood.

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