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STABILIZING THE COLOR OF WOOD

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ABSTRACT OF THE DISCLOSURE

A low concentrate aqueous solution of an oxidizing agent selected from the group comprising potassium permanganate, the water soluble chromates and dichromates and chromic acid is applied in a quantity small enough so that drying takes place rapidly. Ammonium dichromate gives preferred results. Concentration of oxidizing agent is such that available oxygen lies in the range from about 0.025% to about 0.30% of the total aqueous solution and varies with wood species in accordance with darkness of natural color.

This invention relates generally to the art of finishing wood and pertains more especially to a method of treating wood to produce in it a coloration that remains substantially unchanged after prolonged exposure to light.

It is well known in the wood finishing art that most of the woods commonly used for furniture, wall paneling and other ornamental purposes change color with exposure to light. This color change phenomenon is perhaps most frequently noticed in wall paneling, which is likely to be installed while fairly new; but it is not uncommon with furniture. Thus a housewive may find that behind every picture hanging on a paneled wall of a relatively new home there is an area that is apparently either bleached or darkened, depending upon the species of paneling.

In most cases dark woods become lighter after prolonged exposure to light and light woods darken in color. So far as is known, color change in a particular species of wood terminates after the wood has been exposed to a certain amount of light, its color then being stabilized.

It is to be understood that the color change here discussed is in the wood itself and not in any finish on the surface of the wood. Certain types of wood finishes are known to change color with exposure to light, or with mere lapse of time, but wood finishes that are substantially stable in color are known and are usually used, and therefore the more serious color instability is that of the natural wood itself.

It has been recognized for some time that color instability in wood must be due to the presence of photoresponsive materials in the wood, and on this basis attempts have heretofore been made to prevent color change by incorporating ultraviolet absorbers in the materials used for final coats in wood finishing. However, color change occurs in wood that is indoors, where window glass normally screens it from most ultraviolet radiation, and even occurs in wood located in rooms having only a northern exposure. As might be expected, therefore, the use of ultraviolet absorbers in wood finishes was of little value in preventing color change, since the photosensitive materials responsible for the phenomenon seem to respond to a broad spectrum of actinic radiation.

With the foregoing observations in mind, it is a general object of this invention to provide a method for rapidly stabilizing the color of wood in a manner that is compatible with any of the usual finishing operations, and

by which the wood is given a stable color that is compatible with any coloration that might be imparted to it by coloring materials in the nature of stains and the like that are commonly used in such finishing operations.

Another object of this invention is to provide a method of stabilizing the color of wood without interfering with finishing operations normally performed on the wood, and which method can in fact be practiced concurrently with the performance of a normal finishing procedure such as the application of a glue size.

Another and very important object of this invention is to provide a method of stabilizing the color of wood so that its color will undergo no substantial change as a result of prolonged exposure to actinic light, which method can be performed with great rapidity as a step in normal surface finishing procedures and requires no substantial drying or aging time that might delay the performance of subsequent surface finishing operations.

With these observations and objects in mind, the manner in which the invention achieves its purpose will be appreciated from the following description and examples. This disclosure is intended merely to exemplify the invention. The invention is not limited to the particular details disclosed, and changes can be made therein which lie within the scope of the appended claims without departing from the invention.

In general, the present invention is premised upon the theory that the photoresponsive materials in wood that cause it to change color with prolonged exposure to actinic light do so as a result of their being oxidized by such irradiation.

The invention therefore provides a procedure for effecting the rapid oxidation of these unidentified components of wood, to cause the wood to assume substantially the color that it would normally acquire after prolonged exposure to actinic light. The coloration thus imparted to the wood will naturally be a substantially stable one, since it represents the completion of the oxidation process that would otherwise be fully effected only by prolonged irradition of these unidentified components.

I have discovered that the oxidizing agents that are useful for this purpose are, in general, potassium permanganate, the water soluble chromates and dichromates and chromic acid, and that the oxidizing agent must be in the form of a low-concentrate aqueous solution which can be applied to the surface of unfinished wood in any suitable manner.

Particular oxidizing agents that have been successfully employed in the performance of the method of this invention are: potassium permanganate, sodium chromate, potassium chromate, ammonium chromate, sodium dichromate, potassium dichromate, ammonium dichromate and chromic acid.

While chromic acid has been found effective on some species of woods, notably walnut, birch and cherry, its use is not recommended because of its acidity, which may affect the wood itself, and because of the fire hazard inherent in its use with organic compounds. Furthermore, other oxidizing agents have been found to be at least as effective as chromic acid, so that there seems to be no need for using chromic acid in practicing the method of this invention.

As between the chromates and dichromates, I prefer the dichromates inasmuch as they are the more powerful oxidizing agents.

Among the dichromates, ammonium dichromate will probably be the most suitable for the majority of woods from the standpoint of color results. To the extent that ammonium dichromate imparts some coloration of its

own to wood treated by the method of this invention, as distinct from the color that the same wood would naturally acquire after prolonged exposure to light, such artificial coloration is in the nature of a light tan cast which is in no wise objectionable and which in fact tends to enhance the appearance of the wood by intensifying its natural coloration and grain contrast.

Sodium dichromate, when used in the practice of the method of this invention, tends to impart a slight yellowish cast to the treated wood. This is not objectionable on some of the light colored woods and may even be desirable in some cases.

Potassium dichromate, when used in the method of this invention, tends to impart to the wood a reddish cast. While this might be objectionable on light colored woods, it may be desirable on rosewood, mahogany and the like.

Potassium permanganate produces a color that is more brown and less yellowish than that imparted by the chromates and dichromates, and has given especially good results on red oak, walnut, birch and teak.

The level of concentration of the oxidizing agent in the aqueous solution is fairly critical, and, moreover, is different for different woods. However, I have discovered a general pattern of correlation between natural wood color and concentration level of the oxidizing agent in the aqueous solution, which is explained hereinafter, so that on the basis of this disclosure those skilled in the art will have no difficulty achieving complete success in stabilizing the color of any particular species of wood in accordance with the method of this invention.

In practicing the method, the aqueous solution of the selected oxidizing agent, at the proper level of concentration, is applied to the surface of the wood in any suitable manner that will effect complete coverage of the surface, preferably without leaving liquid standing on the surface. Thus the solution can be brushed on, sprayed on, or applied by roller coating or dipping. A gallon of the solution will cover about 1,000 square feet of wood surface.

If desired, the aqueous solution can include a water reduceable glue size or gum arabic, or water soluble dies or pigments.

After application of the aqueous solution the wood can be allowed to air dry slowly, or it can be flash dried with heated air or infrared radiation to enable further processing to take place immediately. If desired, pieces of wood being treated by this method can be stacked immediately after the aqueous solution is applied and allowed to dry in the stack, in which case adequate drying to permit further processing will take place in 3 to 4 hours.

Color change in the wood is noticeable immediately upon its drying.

After it has dried, the wood is ready for any desired further processing such as the conventional application of sizing, filler, stain, sealer and the like.

As pointed out above, the degree of concentration of oxidizing agent in the aqueous solution is critical, and varies with the natural coloration of the wood, being lowest for light colored species and highest for those of naturally dark coloration. In general, the concentration of the oxidizing agent solution should be such that the available oxygen in the oxidizing agent represents between about 0.025% and about 0.30% of the total solution.

About 19% of ammonium dichromate is available oxygen. Solution concentrations of ammonium dichromate will therefore range from about 0.15% to about 1.50% potassium permanganate.

In the case of the chromates, dichromates and chromic acid, the solution concentration can be based upon the percentage concentration of the chromium trioxide radical, and should be such that the solution contains not less than about 0.12% of the CrO_3 radical nor more than about 1.2% of that radical.

The concentration ranges for some of the other materials mentioned hereinabove are as follows:

	Percent
Sodium chromate	0.19 to 1.93
Sodium dichromate (anhydrous basis)	0.17 to 1.77
Potassium chromate	0.23 to 2.31
Potassium dichromate	0.17 to 1.75
Ammonium chromate	0.18 to 1.80

The concentration value of potassium permanganate has been found to be substantially equivalent, in each case, to that of ammonium dichromate, hence the concentrathion range for potassium permanganate is from about 0.15% to about 1.50%.

The following information is based upon ammonium dichromate solutions, and can be used in the practice of the method with potassium permanganate on the basis of directly equivalent concentrations, and with the chromates and dichromates by calculation of equivalent solution concentrations in terms of percentage content of available oxygen.

When the invention is to be practiced with many different species of woods, it is desirable to prepare solutions with four different degrees of concentrations of the oxidizing agent, each having twice the concentration of the solution of next lower concentration. Thus, it has been found very practical to prepare four different ammonium dichromate solutions which respectively have these percentages of ammonium dichromate: 0.16%, 0.33% 0.66% and 1.33%.

The 0.16% solution is intended for the lightest colored woods, and has given excellent results in the practice of the method of this invention on: maple, ash and beech.

The 0.33% solution is intended for moderately light colored woods and has given excellent results on: birch, red oak and elm.

The 0.66% solution is intended for moderately dark colored woods and has given excellent results on: white oak, pecan, teak and hickory.

The 1.33% solution is intended for the darkest colored woods and has given excellent results on cherry, mahogany, African cherry and paldao.

These four values of solution concentration are useful for many applications, as indicated above, and are in all cases useful for purposes of preliminary classification as explained below. However, there are some woods which required slightly different values of solution concentration than those mentioned above; as for example, the 1.33% ammonium dichromate solution has been found slightly too strong for walnut and rosewood, which require a 1.15% solution. In correspondence with the results a 1.33% solution of potassium permanganate has been found slightly too strong for these same woods, while a 1.15% potassium permanganate solution has been found highly satisfactory with them.

It has been noted that the region in which a species of wood is grown may affect the value of solution concentration which produces best results, and the solution concentration for each species in the above tabulation may have to be modified to some extent to compensate for such regional differences.

In practicing the method of this invention upon a species of wood not mentioned in the foregoing tabulation, the natural coloration of the wood should be compared with those listed above. A fresh piece of wood of that species should be tested with a solution of the degree of concentration that has been found satisfactory for the most nearly similar group of woods in the above list. After the aqueous solution has been applied and has dried, any desired clear finish can be applied to the treated surface of the test specimen, following the procedure normal for such finish. The test specimen is then exposed in a window having a southern or western exposure with a part of its surface masked or covered. Exposure is for the time usually required for substantial natural color change to occur in the wood, and the test specimen is then examined.

If there is only a very slight difference in coloration, or none, between the masked and the exposed portions

of its treated surface, a solution of the correct concentration has been applied, and that concentration value will be correct for all wood of the same species and regional origin.

If the unmasked portion of the treated surface has been bleached or faded by its exposure to light, the solution used on the test specimen was too concentrated for the species of wood represented by it, and use of a lower degree of concentration is indicated for wood of that species. This is true of both the naturally dark colored woods and the light colored ones, because the use of an excessive concentration causes the wood to acquire a coloration which is initially much darker than that of the wood in its natural state.

If the unmasked portion of the test specimen has been darkened by its exposure to light, use of a higher solution concentration is indicated. Again, this is true of the dark woods as well as the light ones, at least on cases where the concentration is not extremely weak for the particular wood; and in the case of the dark woods such darkening is due to a deepening of the color imparted by the process.

Even in cases where a species of wood may require a solution concentration intermediate a pair of the values set forth above, it should rarely be necessary to make tests with more than three different concentrations of a particular oxidizing agent to arrive at the correct value for the particular species.

When too low a concentration of oxidizing agent is used for the aprticular wood species being treated, the method of this invention partially completes the oxidizing process that would normally be effected by prolonged exposure to light, and it has been observed in such cases that the color change which occurs in the wood takes place during the first few days of exposure to light, the color of the wood being stable thereafter.

Further details of the method of this invention will be apparent from the following examples:

EXAMPLE 1

Twelve unfinished 4' x 8' plywood panels were taken from a production line for standard interior wall paneling. On six of these face veneer was of red oak, and on the other six it was elm.

The panels were passed rapidly under a roller coater which coated their faces with a 0.33% solution of ammonium dichromate in tap water. They were then stacked flatwise and allowed to dry overnight. The next day they were sanded with a belt sander and then finished, in the manner usual for wall peneling, with a seal coat, colored filler and finish coat. The panels were then exposed to daylight through a window, with a part of each panel covered with an opaque mask to enable comparison. After two weeks of such exposure only a very slight difference in coloration was noticeable as between the covered and uncovered portions of each panel.

EXAMPLE 2

Six unfinished 4' x 8' panels similar to those of Example 1 but having a birch face veneer were taken from the production line and passed rapidly under a roller coater which coated their faces with a 0.33% solution of ammonium dichromate in tap water. Immediately thereafter the panels were dried with impinging hot air followed by infrared lamps, and as soon as they were observed to be dry (drying required less than a minute) they were finished according to standard practice as described in Example 1. After a two-week's exposure to direct daylight through a window, with a portion of each panel covered, very little difference in coloration could be detected between the covered and uncovered portions of each panel.

EXAMPLE 3

Six panels like those of Examples 1 and 2, but having a hickory face veneer, were subjected to the same procedure as the panels of Example 1, except that the solution applied was a 0.66% ammonium dichromate solution in tap water. Again, two weeks of exposure to direct window light developed very little difference in coloration between covered and uncovered portions.

EXAMPLE 4

Twelve panels like those of Examples 1 and 2, but with six having a cherry face veneer and six having a walnut face veneer were subjected to the same procedure as the panels of Example 1, except that in this case the oxidizing agent was a 1.33% ammonium dichromate solution in tap water.

After two weeks of exposure to direct window light, little difference in coloration was noticeable between covered and uncovered areas of the cherry panels.

On the walnut panels, however, the uncovered areas were found to be noticeably lighter, after the same exposure, than the covered areas. This bleaching upon exposure to light indicated that too strong a solution of ammonium dichromate had been used on the walnut panels, but the degree of bleaching was not such as to indicate a step-down all the way to a 0.66% solution.

A 1.15% solution of ammonium dichromate in tap water was therefore brushed onto a test panel having a walnut face veneer, and after the solution had dried the face of the panel was finished in the usual manner. The color of this test panel was found to be substantially stable under prolonged exposure to light.

In connection with the tests described in the above examples, two panels each of cherry, walnut and birch were treated in general accordance with the method of Example 1 but with ammonium dichromate solutions known to be too concentrated for those woods. The cheery and walnut panels were treated with a 2.0% solution of ammonium dichromate in tap water and the birch panels with a 0.66% solution. In addition, two panels each of cherry and walnut were similarly processed but with the use of a 0.66% ammonium dichromate tap water solution, which was known to be too weak for those woods. As expected, the panels treated with the excessively high ammonium dichromate solution all became noticeably lighter in color after prolonged exposure to light. As was also expected, the panels treated with solution known to be too weak all showed noticeable color darkening upon prolonged exposure to light, although the color change was not as great as it would have been with the same woods not treated by the method of this invention; and the color stabilized after a few days of exposure.

From the foregoing description it will be apparent that this invention provides a simple, expeditious and easily practiced method for producing a stable, light insensitive coloration in wood; and it will be further apparent that the method of this invention is entirely compartible with normal methods for finishing wood surfaces, and that such coloration as it imparts to the wood is compatible with the coloration commonly imparted by stains and the like that are used in such finishing processes.

What is claimed as my invention is:

1. The method of stabilizing the color of ornamental wood which consists essentially of applying to the wood while it is in unfinished condition an aqueous solution of an oxidizing agent selected from the group consisting of potassium permanganate, the water soluble chromates and dichromates and chromic acid, the concentration of said oxidizing agent in the solution being such that not less than about 0.03% of the total aqueous solution nor more than about 0.30% thereof consists of available oxygen of the oxidizing agent.

2. The method of claim 1, further characterized by:

(A) the oxidizing agent being selected from the class consisting of the dichromates of sodium, potassium and ammonia; and

(B) the percentage of the chromium trioxide radical

of the selected oxidizing agent in the total aqueous solution being between about 0.12 and about 1.2.

3. The method of claim 1 wherein the oxidizing agent is ammonium dichromate, further characterized by: the percentage of ammonium dichromate in the aqueous solution being about 1.33 for woods of the class consisting of cherry, mahogany, African cherry, rosewood and paldao.

4. The method of claim 1 wherein the oxidizing agent is ammonium dichromate, further characterized by: the percentage of ammonium dichromate in the aqueous solution being about 1.15 for woods of the class consisting of walnut and teak.

5. The method of claim 4, further characterized by: the step of drying the wood, effected by applying heat to the wetted surface of the wood, to permit further finishing steps to be performed upon the wood without undue delay.

6. The method of claim 1 wherein the oxidizing agent is ammonium dichromate, further characterized by: the percentage of ammonium dichromate in the aqueous solution being about 0.66 for woods of the class consisting of red oak, pecan and hickory.

7. The method of claim 1 wherein the oxidizing agent is ammonium dichromate, further characterized by: the percentage of ammonium dichromate in the aqueous solution being about 0.33 for woods of the class consisting of birch and elm.

8. The method of claim 1 wherein the oxidizing agent is ammonium dichromate, further characterized by: the percentage of ammonium dichromate in the aqueous solution being about 0.16 for woods of the class consisting of ash, beech and maple.

9. The method of claim 1 wherein the oxidizing agent is potassium permanganate, further characterized by: the

percentage of potassium permanganate in the aqueous solution being about 1.33 for woods of the class consisting of cherry, mahogany, African cherry, rosewood and paldao.

10. The method of claim 1 wherein the oxidizing agent is potassium permanganate, further characterized by: the percentage of potassium permanganate in the aqueous solution being about 1.15 for woods of the class consisting of walnut and teak.

11. The method of claim 1 wherein the oxidizing agent is potasium permanganate further characterized by: the percentage of potassium permanganate in the aqueous solution being about 0.66 for woods of the class consisting of red oak, pecan and hickory.

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