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## PRESERVATIVE IMPREGNATION OF WOOD

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3 Claims. (Cl. 117—63)

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This invention relates to the preservative impregnation of wood, and more particularly to the impregnation of wood with oil-borne toxic preservative compounds which are characteristically employed in solution for impregnation of wood. This is a continuation-in-part of my copending application Serial No. 122,857, filed October 21, 1949, which is in turn a continuation-in-part of my prior application Serial No. 602,687, filed June 30, 1945, and allowed September, 16, 1949, now abandoned in favor of the aforesaid continuation-in-part Serial No. 122,857.

In my above noted prior applications, there is disclosed a process that is particularly applicable for use in connection with the preservative impregnation of wood with creosote, and by which excess creosote can be removed effectively from wood impregnated therewith so that subsequent bleeding of the creosote onto the surface of the wood is avoided. The present invention is directed to the different problem of dealing with wood that has been impregnated with the solvent soluble toxic preservative compounds, as noted above, and which are often commonly referred to as "toxic salts."

The so-called toxic salts are in many cases preferred to creosote as a preservative impregnant, and this is particularly so in the treatment of lumber. Wood may be impregnated with these toxic salts in much the same way as creosote, for example, by the Rueping process as disclosed in U. S. Patents No. 709,799, granted September 23, 1902, Reissue No. 12,707, granted September 22, 1907, and No. 1,008,864, granted November 14, 1911. However, the toxic salts are characteristically used in solution for impregnation of wood as noted above, and this solution is usually employed cold rather than being heated as is customary with creosote.

The materials popularly referred to as "toxic salts" are, in fact, not all salts in the technical sense and are more accurately characterized as solvent soluble toxic preservative compounds, which are generally referred to as oil-borne preservatives. The word "oil," as used herein, refers to any organic solvent which will dissolve the preservative compound and which has the proper physical and chemical properties to permit its use as a vehicle for the preservative. Two important examples are copper naphthenate and pentachlorophenol, although there is a wide variety of other compounds of this type, such as:

*Metal organic compounds*

Copper resinate
Copper abietinate
Zinc naphthenate
Zinc resinate
Zinc abietinate
Ethyl mercuric acetate

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Ethyl mercuric chloride
Ethyl mercuric oleate
Phenyl mercuric acetate
Phenyl mercuric chloride
Phenyl mercuric oleate

*Chlorinated compounds*

2,4-dinitrochlorobenzene
Chloronaphthalene
1,-chlorobetanaphthol
2,4-chloroalphanaphthol
2,6-dichlor-4-nitrophenol
Trichlorobenzene
Tetrachlorophenol
2,4,5-trichlorophenol
2,4,6-trichlorophenol
Chloro-2-phenylphenol
2-chloro-4-phenylphenol

*Nitro compounds*

Orthonitrotoluene
Paranitrotoluene
Nitrobetanaphthol
Dinitrophenol

*Miscellaneous compounds*

Betanaphthol
Orthophenylphenol
Rosin amine
Rosin amine acetate

The impregnation of wood with these oil-borne preservative compounds has heretofore involved important difficulties, one of the most troublesome of which has resulted from the fact that these compounds are employed in solution for impregnation so that a substantial concentration of solvent is left in the impregnated wood, which, in the usual case, would be gradually lost to the atmosphere by evaporation, leaving heavy surface deposits of the preservative compound. Also, these solvents are relatively expensive, so that their dissipation in this manner represents a considerable economic loss, and, furthermore, the presence of these solvents in the impregnated wood creates a hazard that is particularly dangerous when the wood is to be used in closed spaces that might be heated, because of the possibility of building up sufficient concentrations of evaporated solvent to cause explosions or fires.

Another problem heretofore encountered in the impregnation of wood with these oil-borne preservative compounds has been the problem of preventing bleeding of the preservative compound in the outer layers of the wood, particularly over resinous areas, such as heartwood and knots. This leaves an undesirable deposit of preservative in addition to the initial surface deposits of the preservative compound left by evaporation of solvent. This condition not only

results in an undesirable surface discoloration of the wood, but it also prevents satisfactory painting of the wood.

In accordance with the present invention, I have discovered that these difficulties can be entirely eliminated by subjecting the wood after preservative impregnation to the heated vapors of an organic solvent. By treating the impregnated wood in this manner, I have found that the wood may be freed of the solvent employed in the preservative impregnating solution and also that the excess preservative compound in the outer layers of the wood can be removed to leave the wood with a substantially uniform concentration of preservative compound throughout its cross section. This treatment produces a clean outer surface free of discoloration from surface deposits of the preservative and also substantially free of natural wood resins and gums, so that the surface of the wood is rendered especially receptive to paint.

The method of treating the impregnated wood in accordance with the present invention may follow immediately after the last step in the above-mentioned Rueping process or any other suitable impregnation process; that is, when the impregnated wood is ready to be removed from the cylinder in which the impregnating treatment has been carried out. By suitable modifications of the treating cylinder, the impregnated wood may remain in that cylinder for treatment with organic vapors according to the present invention. However, this treatment with organic vapors may be carried out later, if desired, and in equipment separate from the impregnating apparatus.

Ordinarily, the wood will be dried before impregnation, since dry wood is substantially more receptive than wet wood to an impregnation treatment. This drying may be carried out by conventional methods, such as air seasoning or kiln drying, or by conditioning with steam, after it is placed in the treating cylinder, or by drying with organic vapors as disclosed in my prior Patents Nos. 2,273,039, 2,435,218, and 2,435,219. My above noted prior Patent 2,435,218 discloses an apparatus which is also suitable for carrying out the treatment of the present invention, and if the prior drying operation is carried out in this apparatus, the subsequent preservative impregnation and treatment following impregnation in accordance with the present invention may follow in the same equipment. An alternative procedure would be to impregnate the dried wood in one cylinder and then transfer the impregnated wood to the apparatus disclosed in my above noted prior patent for carrying out the treatment of the present invention.

The treatment of the impregnated wood according to the present invention involves heating the wood with organic vapor so that the solvent employed in the preservative compound solution is vaporized and substantially completely removed from the wood. In carrying out this treatment, the organic vapors used may be those of an organic solvent having a boiling point higher than that of the solvent employed in the preservative compound solution so that vaporization of the latter solvent will take place during heating of the impregnated wood with the organic vapors, or the organic vapors may be those of the same solvent employed as a vehicle for the preservative compound, or even a lower boiling solvent having a boiling point high enough to heat the wood sufficiently to give off a substantial amount of the impregnating solvent in a subsequent vacuum, the treatment being carried out with alternating periods of heating and vacuum in the latter two cases until the impregnated wood is freed of solvent. The use of organic vapors of the same solvent employed as the vehicle for the preservative compound will usually be preferred in carrying out the treatment of the present invention to avoid the necessity for separating mixed solvents.



The organic vapors used in carrying out the treatment of the present invention should also be those of a solvent for the preservative compound used in the impregnation treatment, so that the unique extraction of excess preservative will be obtained concomitantly with freeing of the wood of solvent. Otherwise, the term "organic vapors" is used herein to cover any and all vapors of organic compounds that will not deleteriously affect the wood as the treatment is being carried out. Principally, this means that the organic vapors should be those of a solvent having a boiling point substantially below the temperature at which thermal injury to the wood begins, namely, about 400° F. In usual commercial practice, solvents having initial boiling points not higher than about 320° F. are employed.

A lower temperature limit is determined in the usual case by the fact that with the lower boiling solvents, correspondingly low flash points are encountered, which beyond a certain point, render the process unduly hazardous. For this reason, it is recommended that the process not be operated with a solvent boiling below 240° F., unless the solvent used is of a non-inflammable type, such as, for example, perchlorethylene or trichlorethylene. A temperature of 240° F. indicates, according to the empirical rule developed by the petroleum industry, a flash point of about 50 to 55° F., which is a minimal value if proper safety precautions are observed in a processing operation of this sort.

Of course, if a non-inflammable type of solvent is used, the limitations imposed by these safety considerations are eliminated, and the lower temperature limit then becomes a matter simply of providing adequate heating of the impregnated wood. It should also be noted that the above-mentioned temperature limitations should be understood to correspond to atmospheric pressure, and would be modified accordingly under other pressure conditions.

Examples of the type of solvent that may be successfully employed according to the present invention are the aliphatic petroleum fractions, such as V M & P naphtha and Stoddard solvent; the aromatic coal tar fractions or petroleum derivatives, such as toluol and xylol; and the chlorinated hydrocarbons, such as trichlorethylene and perchlorethylene. Other similar solvents can be used if they possess vapor pressure characteristics that allow the necessary concentration of solvent vapors to exist in contact with the wood at an operable temperature, such as the solvents discolsed in my above patents 2,273,039, 2,435,218, and 2,435,219.

The present invention is further illustrated by the following description of actual test results:

These tests were carried out on Southern pine boards having an initial size of 2'' x 8" x 12' and having 100% sap wood content. These boards were surfaced on four sides and dried to 20% moisture content. For the tests, the 12' pieces were sawed in half and a 1'' section was removed at the center for moisture determination. One

6' section from each original piece was given the standard preservative impregnation treatment, while the other half of each piece was impregnated with the preservative solution exactly like the first half, but was subsequently subjected to the organic vapor treatment of the present invention. Impregnant solutions were made up of copper naphthenate dissolved in the specific solvents noted, using a concentration of copper naphthenate of about 0.75 weight percent calculated as metallic copper. Impregnation treatment was carried out according to the Rueping process, using 50 p. s. i. initial air and 150 p. s. i. preservative pressure, which was built up over a period of one-half hour and held at 150 p. s. i. for one hour, after which a 20" to 26" vacuum was impressed on the treating cylinder and maintained for one hour.

After the completion of the above-indicated treatment, each section was sawed at its midpoint and an appropriate number of one-inch sections were removed for testing. One section from each board was examined for preservative penetration. A second section was appropriately zoned for determining the preservative concentration at various depths. A third sample from each board was oven dried to determine the total volatile content. A fourth sample from each board was chipped into small pieces and extracted by boiling toluene to determine the residual water content.

Three types of solvents were employed in carrying out these tests, namely, aliphatic, aromatic and chlorinated hydrocarbons. Specifically, the aliphatic solvents were VM&P naphtha and Stoddard solvent; the aromatic solvents were toluene and xylene; and the chlorinated hydrocarbons were trichlorethylene and perchlorethylene. These solvents were used for dissolving the toxic compounds to produce the solution for impregnating the wood and also were used, in heated vapor form, for extracting the excess impregnant from the outer layers of the wood and recovering the impregnant solvent from the wood.

In cases where the solvent used for the vapor treatment step had a boiling point that was the same or lower than the boiling point of the solvent used in the impregnating solution, it was necessary to employ cycles in which periods of heating in vapor were alternated with vacuum periods, since vaporization of solvent from the wood occurs only during the vacuum cycle unless the wood is heated to a temperature above the boiling point of the impregnant solvent, such as occurs in vapor treating with an organic compound having a higher boiling point than the impregnant solvent.

As an example, toluene was used as the vapor treatment solvent to recover toluene that had been used as the impregnant solvent, in which case, the vapor treatment cycle consisted of intermittent periods of heating in toluene vapor, alternating with periods of vacuum. When solvents whose boiling points are higher than the impregnant solvent were used, it was possible to effect the vapor treatment in one cycle of heating in vapor followed by a short vacuum to recover the vapor treating solvent. As an example, toluene which boils at 231° F. was used as the impregnant solvent and was recovered by the use of xylene which boils at 282° F. In the latter case, the wood was exposed to the action of xylene vapor for a continuous period ranging from 4 to 6 hours, during which time most of the toluene was vaporized from the wood. At the end of this period of heating in vapor, the xylene that had condensed in the wood was recovered by a short vacuum. However, in this case, the material recovered was a mixture of toluene and xylene, the separation of which was accomplished by fractional distillation.

The data obtained in these tests are given in Table I which follows.

TABLE I

| Test | Solvent Employed | | Vapor Treatment Cycle In Hrs. | | Vapor Temperature, ° F. | Net Retention of Solvent, Lbs./Ft.[3] |
|---|---|---|---|---|---|---|
| | In Impregnant | In Vapor Treatment | Vapor | Vacuum | | |
| A | V | | (1) | (1) | | 5.30 |
| B | V | V | 3 | 3 (alt.) | 247 | 0.02 |
| C | V | S | 4 | 1 (str.) | 286 | 0.15 |
| D | S | | (1) | (1) | | 5.27 |
| E | S | S | 3 | 3 (alt.) | 197 | 0.02 |
| F | Tri | | (1) | (1) | | 11.06 |
| G | Tri | Tri | 2 | 2 (alt.) | 187 | 1.45 |
| H | Tri | Per | 4 | 1 (str.) | 229 | 0.93 |
| I | Per | | (1) | (1) | | 14.08 |
| J | Per | Per | 2 | 2 (alt.) | 253 | 0.34 |
| K | Tol | | (1) | (1) | | 6.45 |
| L | Tol | Tol | 3 | 3 (alt.) | 230 | 0.31 |
| M | Tol | Xyl | 4 | 1 (str.) | 266 | 0.31 |
| N | Xyl | | (1) | (1) | | 5.02 |
| O | Xyl | Xyl | 2 | 2 (alt.) | 268 | 0.16 |

V—VM&P naphtha.
S—Stoddard solvent.
Tri—Trichlorethylene.
Per—Perchlorethylene.
Tol—Toluene.
Xyl—Xylene.
Alt.—Alternating cycles of heating in vapor followed by vacuum.
Str.—One continuous or straight cycle of heating in vapor followed by a short vacuum cycle.
[1] No vapor treatment.

Under the heading "Vapor Treatment Cycle in Hours," the type of recovery procedure is shown. When the vapor agent was one having a higher boiling point than the impregnant solvent, the vapor recovery cycle comprised one long vapor contact period, followed by a vacuum period of one hour's duration. When the vapor agent was the same as the impregnant solvent, vapor contact periods of one hour's duration alternated with vacuum periods of one hour's duration. Thus, for Test B in Table I, the figures 3 and 3 appearing under this heading indicate that the impregnated wood was exposed to the solvent vapors for three intermittent one-hour heating

periods, alternating with three one-hour vacuum periods. In the last column of the Table I, it is seen from the net retention of solvent that the impregnant solvent was substantially completely removed by the vapor recovery treatment.

Samples from the tests listed in Table I were tested for copper content at various depths below the surface. To do this, the outer one-fourth inch of a given sample was removed and was ashed for analysis to determine the copper content. Likewise, the second one-fourth inch below the surface was removed and so tested. The copper content of the entire remaining portion of the sample, or core, was also determined. These results are shown in the accompanying Table II, along with the weighted average copper content for the cross section.

TABLE II

| Test | Solvent Employed | | Copper Content, Percent of Oven Dry Weights [2] | | | |
|---|---|---|---|---|---|---|
| | In Impregnant | In Vapor Treatment | Outer, ¼ In. | Second, ¼ In. | Core | Weighted Average |
| A | V | (1) | 0.36 | 0.15 | 0.14 | 0.23 |
| B | V | V (alt.) | 0.18 | 0.18 | 0.18 | 0.18 |
| C | V | S (str.) | 0.16 | 0.15 | 0.12 | 0.15 |
| D | S | (1) | 0.25 | 0.13 | 0.13 | 0.17 |
| E | S | S (alt.) | 0.18 | 0.12 | 0.12 | 0.14 |
| F | Tri | (1) | 0.55 | 0.32 | 0.24 | 0.38 |
| G | Tri | Tri (alt.) | 0.16 | 0.15 | 0.15 | 0.16 |
| H | Tri | Per (str.) | 0.15 | 0.10 | 0.11 | 0.12 |
| I | Per | (1) | 0.24 | 0.15 | 0.14 | 0.19 |
| J | Per | Per (alt.) | 0.19 | 0.15 | 0.14 | 0.17 |
| K | Tol | (1) | 0.23 | 0.15 | 0.14 | 0.18 |
| L | Tol | Tol (alt.) | 0.15 | 0.14 | 0.15 | 0.14 |
| M | Tol | Xyl (str.) | 0.23 | 0.15 | 0.13 | 0.17 |
| N | Xyl | (1) | 0.26 | 0.12 | 0.13 | 0.17 |
| O | Xyl | Xyl (alt.) | 0.12 | 0.12 | 0.09 | 0.11 |

(See footnotes for Table I for explanation of symbols.)
[1] No vapor treatment.
[2] These copper contents can be converted to copper naphthenate equivalents by multiplying by an appropriate factor, roughly 10.

These results show that for those specimens which were given the standard impregnation treatment only, the copper content in the outer one-fourth inch was materially higher than in the second one-fourth inch and in the remainder of the sample. On the other hand, for those specimens which were given the organic vapor treatment after impregnation, the copper concentration was very nearly uniform for all depths. In no case was the copper content in the outer one-fourth inch reduced by the organic vapor treatment to a value below that in the second one-fourth inch or in the core.

The total volatile content of the tests as shown in Table III below was determined by oven drying samples from each test. The moisture content was determined by the toluene extraction method and the solvent content was determined by subtracting the water recovered by toluene extraction from the total volatile. These determinations were made for the outer one-fourth inch of each sample, reported in the following table as the "Shell" and for the remaining portion, reported as the "Core."

TABLE III

| Test | Solvent Employed | | Volatile Content Based on Oven Dry Wt. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Shell | | | Core | | |
| | In Impregnant | In Vapor Treatment | Total Volatile | $H_2O$ | Solvent | Total Volatile | $H_2O$ | Solvent |
| A | V | (1) | 36.9 | 11.8 | 25.1 | 27.9 | 13.7 | 14.2 |
| B | V | V (alt.) | 2.4 | 2.2 | 0.2 | 2.4 | 2.2 | 0.2 |
| C | V | S (str.) | 14.7 | 4.6 | 10.1 | 5.7 | 1.7 | 4.0 |
| D | S | (1) | 37.1 | 11.2 | 25.9 | 25.5 | 10.9 | 14.6 |
| E | S | S (alt.) | 1.0 | 0.8 | 0.2 | 0.7 | 0.6 | 0.1 |
| F | Tri | (1) | 57.3 | 15.0 | 42.3 | 39.7 | 12.5 | 27.2 |
| G | Tri | Tri (alt.) | 8.9 | 4.6 | 4.3 | 13.8 | 8.9 | 4.9 |
| H | Tri | Per (str.) | 5.8 | 3.1 | 2.7 | 6.3 | 5.2 | 1.1 |
| I | Per | (1) | 53.6 | 10.5 | 43.1 | 37.2 | 11.5 | 25.7 |
| J | Per | Per (alt.) | 6.7 | 5.8 | 0.9 | 5.3 | 4.1 | 1.2 |
| K | Tol | (1) | 32.1 | 11.7 | 20.4 | 30.9 | 14.0 | 16.9 |
| L | Tol | Tol (alt.) | 5.6 | 4.7 | 0.8 | 3.8 | 1.0 | 2.8 |
| M | Tol | Xyl (str.) | 2.5 | 1.3 | 1.2 | 2.9 | 1.9 | 1.0 |
| N | Xyl | (1) | 29.0 | 10.5 | 18.5 | 23.6 | 10.9 | 12.7 |
| O | Xyl | Xyl (alt.) | 2.2 | 1.0 | 1.2 | 2.2 | 1.8 | 0.4 |

(See footnotes for Table I for explanation of symbols.)
[1] No vapor treatment.

These results show that for those specimens subjected to the vapor recovery treatment, the removal of solvent was substantially complete and also that a substantial reduction in the water content was effected. They further show that the removal of solvent and water was effective for the inner layers of the wood as well as for the outer layers.

Other tests on the organic vapor treated lumber indicated that penetration of preservative was good in all cases and retention of preservative was generally in excess of that proposed by current Federal Specifications for wood that is to be used in contact with the ground. A visual examination indicated that the lumber was not damaged by the treatment. The lumber that was impregnated only was found to have a very heavy coat of preservative compound deposited on the surface, and in certain areas, particularly

over heartwood and knots, there was heavy bleeding of preservative onto the surface, which left a sticky deposit. However, the lumber that had been subjected to the organic vapor treatment subsequent to the impregnation was clean and remarkably free from bleeding or any surface accumulation of preservative compound, and, in fact, its outer appearance was very nearly like the appearance of the inner layers.

Lumber subjected to the organic vapor treatment according to the present invention is extremely receptive to paint, and can, in fact, be more easily painted than lumber in its original state, because the treatment removes a considerable portion of the normally-present wood resins or gums from the surface layers. Panels were prepared and comparative painting tests conducted. These showed that the panels subjected to impregnation only quickly exhibited discoloration by bleed-through of excess preservative, whereas the panels subjected to organic vapor treatment showed no discoloration. Tests have also shown that no perceptible amount of case hardening of the organic vapor treated wood occurs.

It is obvious that the above-described vapor-treatment process can be also used for the recovery of solvent from impregnated products other than wood in its natural state, as, for example, fibrous compositions such as wall board and similar compositions made from comminuted wood.

I claim:

1. In the impregnation of wood with a normally liquid, oil-borne, preservative compound solution, the method of removing the solvent oil component of said solution from the impregnated wood, and of stripping excess preservative compound from the surface and outer layers of said wood to clean the surface thereof and to leave an effective concentration of preservative distributed substantially uniformly throughout the cross section thereof, which comprises heating the impregnated wood in a closed space by introducing into said closed space hot vapors of said solvent oil at a temperature corresponding to the boiling point of said solvent under the conditions in said closed space, continuing the introduction of said hot vapors so that said wood is heated in said closed space by the vapor atmosphere therein to an elevated temperature but not above about 320° F. so that said heating is carried out substantially below the temperature at which said wood would be damaged by heating, draining from said wood and then from said closed space condensate of said solvent oil as it is formed on the surface of the impregnated wood during the vapor heating of said wood and thereby carrying off excess preservative compound as an extract with said condensate from the surface and outer layers of the heated wood, discontinuing the introduction of said hot vapors and creating a vacuum in said closed space whereby the solvent oil component of said solution is vaporized from said heated wood and recovered from said closed space, and alternately repeating said vapor heating and vacuum treatments of said impregnated wood until the wood is substantially free of said solvent oil.

2. In the impregnation of wood with a normally liquid, oil-borne, preservative compound solution, the method of removing the solvent oil component of said solution from the impregnated wood, and of stripping excess preservative compound from the surface and outer layers of said wood to clean the surface thereof and to leave an effective concentration of preservative distributed substantially uniformly throughout the cross section thereof, which comprises heating the impregnated wood in a closed space by introducing into said closed space hot vapors of a normally liquid organic solvent for said preservative compound at a temperature corresponding to the boiling point of said solvent under the conditions in said closed space, said organic solvent having a boiling point under the conditions in said closed space above the boiling point of said solvent oil, continuing the introduction of said hot vapors so that said wood is heated in said closed space by the vapor atmosphere therein to an elevated temperature above the boiling point of said solvent oil but not above about 320° F. so that said heating is carried out substantially below the temperature at which said wood would be damaged by heating, draining from said wood and then from said closed space condensate of said organic solvent as it is formed on the surface of the impregnated wood during the vapor heating of said wood and thereby carrying off excess preservative compound as an extract with said condensate from the surface and outer layers of the heated wood, recovering from said closed space the solvent oil vaporized from the impregnated wood during the vapor heating of said wood, discontinuing the introduction of said hot vapors after said wood has been substantially freed of said solvent oil, and then creating a vacuum in said closed space whereby all condensate of said organic solvent remaining on said wood is vaporized and recovered from said closed space.

3. The method of removing solvent oil from wood impregnated with a normally liquid, oil-borne, preservative compound solution, and of stripping excess preservative compound from the surface and outer layers of said wood to clean the surface thereof and to leave an effective concentration of preservative distributed substantially uniformly throughout the cross section thereof, which comprises heating the impregnated wood in a closed space by introducing into said closed space the hot vapors of a normally liquid organic solvent for said preservative compound at a temperature corresponding to the boiling point of said solvent under the conditions in said closed space, said organic solvent having a boiling point under the conditions in said closed space that is sufficiently greater than the initial temperature of said impregnated wood for substantial heating of said wood, continuing the introduction of said hot vapors until said wood is heated in said closed space by the vapor atmosphere therein to an elevated temperature but not above about 320° F. so that said heating is carried out substantially below the temperature at which said wood would be damaged by heating, draining from said wood and then from said closed space condensate of said organic solvent as it is formed on the surface of the impregnated wood during the vapor heating of said wood and thereby carrying off excess preservative compound as an extract with said condensate from the surface and outer layers of the heated wood, recovering from said closed space any solvent oil vaporized from the impregnated wood during the vapor heating of said wood, discontinuing the introduction of said hot vapors and creating a vacuum in said closed space whereby any solvent oil remaining in and any condensate of said organic solvent remaining on said wood is

vaporized and recovered from said closed space, and alternately repeating said vapor heating and vacuum treatments as necessary until the wood is substantially free of said solvent oil and condensate of said organic solvent.

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