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# STABILIZATION AND PRESERVATION OF WOOD

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6 Claims. (Cl. 117—147)

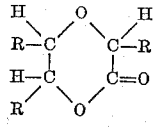
This invention relates to a process for the preservation of wood with 1,4-dioxan-2-one, derivatives of 1,4-dioxan-2-one and hydrolysis products of such dioxanone compounds.

It is well known that wood and wood products are attacked by certain microorganisms. For example, *Lenzites trabea* is a typical wood rot organism. Microorganisms such as fungas and bacteria not only tend to deteriorate the wood, but also are unsightly and produce objectionable odors. Numerous compounds and compositions such as organo-mercury compounds, organo-arsenic compounds, phenol and creosote mixtures have been used to preserve wood against attack by microorganisms. Many of these known preservatives, however, are highly toxic and must be handled carefully. Furthermore, many conventional wood-treating agents, although capable of inhibiting the growth of microorganisms, tend to swell the wood excessively or have other adverse effects (such as objectionable staining action) upon the appearance or physical structure of the wood fibers.

It has now been discovered that 1,4-dioxan-2-one (2-p-dioxanone) and its alkyl-substituted derivatives may be used as effective preservatives and stabilizers to prevent the growth of fungus and bacteria on and within wood without staining or breaking down the wood fibers. The 1,4-dioxan-2-one compounds (generically referred to as "1,4-dioxanones") have several other advantages over the known wood preservatives. For example, the 1,4-dioxanones are much less toxic than other preservatives (especially the organometallics) from the handling standpoint. Furthermore, the 1,4-dioxanones are more readily soluble in carriers such as water, acetone, alcohols and other common organic solvents. The 1,4-dioxan-2-ones may be used in the form of hydrolysis products or as equilibrium mixtures of 1,4-dioxan-2-ones and such hydrolysis products.

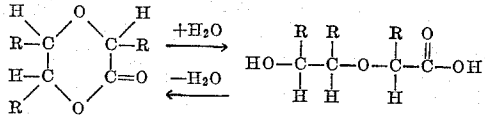
A preferred class of compounds which may be used as wood preservatives is represented by the formula

(I)



wherein each R is independently selected from the group consisting of the hydrogen atom and an alkyl group of from 1 to 2 carbon atoms (the methyl and ethyl groups). Examples of such compounds include 1,4-dioxan-2-one (2-p-dioxanone), 3,5-dimethyl-1,4-dioxan-2-one, 3-methyl-6-ethyl-1,4-dioxan-2-one, 3,5,6-trimethyl-1,4-dioxan-2-one, 5-ethyl-1,4-dioxan-2-one and 6-methyl-1,4-dioxan-2-one.

When water is used as a solvent, an equilibrium mixture is formed which contains predominantly 2-hydroxyalkoxyalkanoic acid along with some polymer




wherein each R is defined as in Formula I. In dilute solutions, an equilibrium mixture which is predominantly free acid is obtained. Both the 1,4-dioxanones and the hydrolysis products are useful as wood preservatives. For convenience, weights and percentages of preservatives used herein are based upon the amounts of 1,4-dioxanones in non-hydrolyzed form.



According to the process of the present invention, the wood or wood product is contacted with a solution containing about 1 percent to about 100 percent by weight (preferably from about 5 percent to 25 percent by weight) of the 1,4-dioxanone compound (or mixture of compounds and their hydrolysis products) by any conventional method of wood treatment. Typical methods include dipping, brushing or spraying the wood with the 1,4-dioxanone compound. Other methods which may be used to achieve better penetration of the 1,4-dioxanone compound into the wood fibers include forcing the 1,4-dioxanones into the fibers under pressure of obtaining penetration of the wood fibers by first subjecting the wood to a vacuum. Concentrations of 1,4-dioxanones of at least 5 percent by weight in the treating solution are most suitable from the standpoint of duration of the treatment. If the treatment is to last only for a short period, the wood can be treated with a solution containing as low as 3 percent by weight of the 1,4-dioxanone compound, usually in hydrolyzed form. The maximum amount of 1,4-dioxanone compound which the wood may absorb depends only upon the structure of the particular kind of wood and its saturation point. Amounts of up to 60 percent based upon the oven-dry weight of the treated wood may be absorbed by the wood and amounts of from 5 to 25 percent by weight are generally sufficient to achieve substantial preservation of the wood against geological attack, especially by mildew-producing fungi. While pure, undiluted 1,4-dioxanones may be used to treat the wood, it is generally more economical to employ dilute solutions (preferably aqueous) containing 1,4-dioxanones along with hydrolysis products (principally 2-(2-hydroxyalkoxy) acetic acids). Any suitable solvent, including nonaqueous solvents, may be used. Examples of such solvents include aromatic and aliphatic alcohols such as benzyl alcohol, methanol, ethanol, n-propanol, i-propanol, glycerine, ethylene glycol, diethylene glycol and tertiary butyl alcohol. Other solvents include ketones (such as acetone and methyl ethyl ketone) and ethers (including cyclic ethers such as tetrahydrofuran and dioxane as well as acyclic ethers such as diethyl ether). The 1,4-dioxanone preservatives of the present invention may be admixed with other known preservatives (including aldehydes, which may also function as solvents) without adversely affecting the preservative properties of the 1,4-dioxanones.

The following examples are submitted for the purpose of illustration only and are not to be construed as limiting the scope of the invention in any way.

## EXAMPLE I–V

White pine wood panels (1" x 3" x 4") were partially immersed in aqueous solutions containing different amounts (percent by weight) of 1,4-dioxan-2-one for a time period of 1 hour. The grain of the wood was parallel to the longest dimension of the wood, and the wood was immersed so that the grain was perpendicular to the surface of the impregnating fluid. The impregnated panels were air dried, the extent of immersion of the panels was marked on each panel (to delineate the treated portion from the untreated portion) and the panels were placed in a mildew chamber for observation. The mildew chamber contained representative samples of rotting and moldy wood rich in microorganisms responsible for wood decay and mildew in warm, humid regions. The temperature within the chamber varied from 23° to 25° C. during the tests. The relative humidity within the chamber was from 70 to 80 percent. The concentrations of 1,4-dioxan-2-one used in each of Examples I–V are recorded in Table 1.

After one year, the areas of the panels which were impregnated with dioxanone remained clear and free of fungus. The untreated portions of the wood panels had heavy growths. In addition, heavy growths appeared on a control panel receiving no treatment.

*Table 1*

| Example number: | Concentration of 1,4-dioxan-2-one (percent by weight of water solution) |
|---|---|
| I | 5. |
| II | 10. |
| III | 25. |
| IV | [1] 50. |
| V | [1] 100 (pure 1,4-dioxan-2-one). |

[1] Swelling of the wood occurred due to absorption of water. The treated portions of the wood were free of fungi.

## EXAMPLES VI–IX

In these examples, acetone was used in place of water and the panels were brushed with the preservative solution rather than dipped. The treatment was not as effective as the immersion technique but good control was obtained where the 1,4-dioxan-2-one soaked into the wood (such as at the ends). The concentration used in each of Examples VI–IX is recorded in Table 2. The white pine samples remained in the humidity chamber for 1 year along with the samples from Examples I–V.

*Table 2*

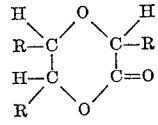
| Example number: | Concentration of 1,4-dioxan-2-one in acetone (percent by weight) |
|---|---|
| VI | 5 |
| VII | 10 |
| VIII | 25 |
| IX | 50 |

I claim as my invention:

**1.** A process for preserving wood which comprises impregnating the wood with a 1,4-dioxanone.



**2.** A process for preserving wood against biological deterioration which comprises incorporating into the wood an inhibiting amount of a composition containing a 1,4-dioxanone compound of the formula



wherein each R group is independently selected from the group consisting of a hydrogen atom and an alkyl group of from 1 to 2 carbon atoms.

**3.** The process of claim **2** wherein the 1,4-dioxanone compound is in an aqueous equilibrium mixture with its hydrolysis products.

**4.** A process for preserving wood against biological deterioration which comprises

(a) contacting the wood with a solution containing from 1 to 100 percent by weight of 1,4-dioxan-2-one to form an impregnated wood product, and

(b) evaporating excess solvent from said impregnated wood product.

**5.** The process of claim **4** wherein the 1,4-dioxan-2-one is in an aqueous equilibrium mixture with its hydrolysis products.

**6.** Wood containing a decay inhibiting amount of up to about 60% of the dry weight of the wood of a 1,4-dioxanone.

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