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PROCESS OF IMPREGNATING CAPILLARY MATERIALS SUCH AS
WOOD, UNDER PRESSURE IN A CLOSED VESSEL
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FIG. 1

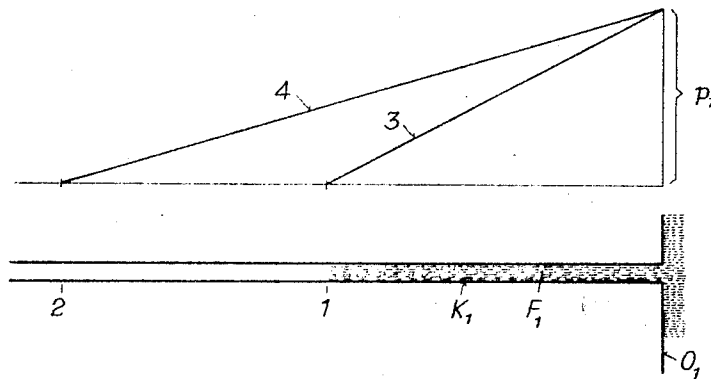
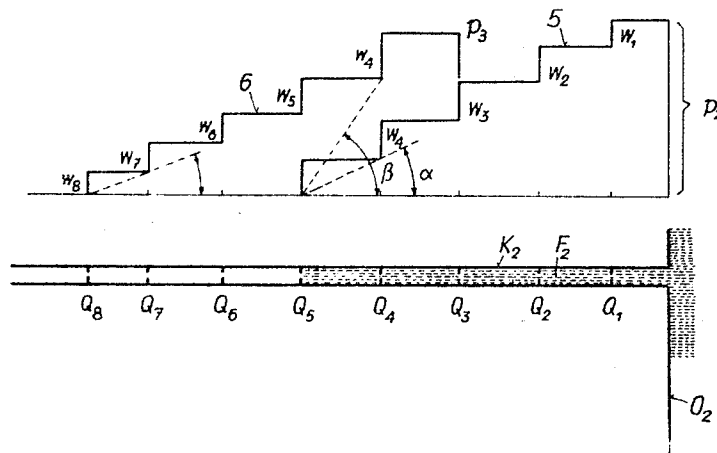


FIG. 2



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PROCESS OF IMPREGNATING CAPILLARY MATERIALS SUCH AS WOOD, UNDER PRESSURE IN A CLOSED VESSEL

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10 Claims

ABSTRACT OF THE DISCLOSURE

A process is disclosed for the impregnation of a capillary material, such as wood, under pressure in a closed vessel. While the contents of the vessel are maintained at a superatmospheric pressure, a gas is evolved within the capillaries which forces the impregnating liquid deeper into the article. The gas is produced by providing in the article a thermally gasifiable substance and when the impregnating liquid and gasifiable material are in contact within the capillaries the temperature is raised to thereby evolve the gas with the resultant increase in pressure.

This invention relates to a process of impregnating capillary materials, such as wood, under pressure in a closed vessel. The invention relates particularly to the impregnation of materials which cannot be impregnated economically or cannot be impregnated at all by known methods.

A known process involves the application of vacuum and pressure. A previous vacuum or a liquid pressure is utilized to produce a pressure gradient between the surface and the interior of the material to be impregnated, so that the liquid penetrates into the interior in the form of capillary filaments. With the depth of penetration, the length of the filament increases and the pressure gradient drops. As a result, the rate of liquid penetration decreases progressively so that a complete impregnation takes a long time.

FIG. 1 of the accompanying drawing represents a general case. A liquid filament F_1 has entered a capillary K_1 , which extends from the surface O_1 of the material. In spite of the following references to one liquid filament, it is understood that a multiplicity of liquid filaments penetrate a capillary material. The filament is at the surface O_1 under the superatmospheric pressure p_1 and at its tip 1 is under atmospheric pressure at the time of observation. Curve 3 represents the pressure gradient. When the tip of the liquid filament has proceeded to 2 and the superatmospheric pressure p_1 at the surface O_1 has still the same value, a smaller pressure gradient is now obtained, which is represented by curve 4. Owing to the decreasing pressure gradient, the speed of the penetration of the filament F_1 will progressively decrease.

If a material to be impregnated, such as wood, comprises capillaries which are interrupted and have portions that are connected by minute passages or perforations, these minute passages present a high resistance to the flow of the penetrating liquid filament so that a considerable pressure loss results at each of these passages. The penetration of the filament ceases when the pressure of the filament is no longer sufficient to overcome this resistance. Such a case is shown in FIG. 2.

FIG. 2 shows a capillary K_2 , which extends from the surface O_2 and is interrupted by perforated transverse walls Q_1 , Q_2 , Q_3 etc. As long as the liquid filament F_2

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flows under the influence of a superatmospheric external pressure p_2 , there will be a pressure gradient as represented by curve 5. Pressure losses W_1 , W_2 , W_3 etc. will be caused by the resistances at the transverse walls Q_1 , Q_2 , Q_3 . The losses due to friction may be neglected. The flow virtually ceases when the superatmospheric pressure p_2 has been consumed by the resistances to the flow, particularly by the resistances which are due to the transverse walls Q_1 to Q_5 . The stepped pressure-gradient curve 5 includes generally an angle (or slope) α relative to the horizontal.

The penetration of the impregnating agent having a high viscosity can be promoted by an addition of solvents to impregnating agents or by heating the impregnating agents. These measures reduce the viscosity of the impregnating agent. Owing to their low viscosity, gases and vapors can easily be introduced and can be deposited inside the capillaries. These processes, however, do not involve a change of the pressure in the liquid filament.

There have been only few attempts so far to change the pressure in the advancing liquid filament. In the hot-cold process, the hot wood is placed into a cold liquid and a vacuum is obtained ahead of the liquid filament because the air, vapor or gas which is found there is reduced in volume and sucks the liquid inwardly. A vacuum at the tip of the filament will increase the pressure gradient so that the process is successful. It has limitations, however, because it is not possible to preheat the material to be impregnated to temperatures which are so high that a high vacuum is obtained in the interior of the material.

The process according to the invention is characterized in that vapor is produced in the preceding liquid filament while the impregnating liquid is being forced into the material to be impregnated, said production of vapor being effected with the aid of a highly volatile substance and by heating and the vapor being produced in such an amount that the pressure in the liquid filament is increased to a value which does not exceed the external pressure, or a gas is produced with the aid of a substance which evolves a gas together with the impregnating liquid and in such an amount that the pressure in the liquid filament is increased to a value which does not exceed the external pressure.

The basic concept of the invention will now be explained with reference to FIG. 2. When the liquid pressure is increased to p_3 , e.g., between the transverse walls Q_3 and Q_4 , a pressure gradient corresponding to an angle β is obtained at Q_5 . Owing to the increase of the pressure and of the pressure gradient, the liquid filament will penetrate, e.g., to Q_8 . The resulting new pressure gradient curve is designated 6. The pressure gradient to the tip of the liquid at Q_8 will again have approximately the angle α . It would not be desirable to increase the pressure p_3 to a value in excess of p_2 because the liquid would then flow outwardly until the pressures have been equalized.

The increase of pressure which has been described for the region between the transverse walls Q_3 and Q_4 is obtained throughout the material to be impregnated in any section of the liquid filaments between two transverse walls. It begins on the outside and proceeds inwardly and is effected, e.g., by a transformation of a liquid into vapor by heating, or by an evolution of gas in a chemical reaction. This may result in an increase of the pressure in the capillary, e.g., at Q_8 in FIG. 2, to the value of the external pressure.

In one embodiment of the invention, a low-boiling substance is dissolved in the impregnating liquid, e.g., methylene chloride in tar oil, or carbon dioxide in an aqueous solution, the capillary substance is subjected to the pressure of this impregnating liquid, and the impregnating liquid is heated so that the pressure in the liquid filament is in-

creased to a value not exceeding the external pressure, while the superatmospheric external pressure is maintained.

It is known to dissolve impregnating agents in low-boiling liquids, e.g., in liquefied gases, and to introduce this solution under pressure into the material to be impregnated. In these known processes, the solution is heated toward the end of the impregnation and the vapor is withdrawn by a vacuum to recover the solvent. This known process differs from that according to the invention in that in the former the solvent must be added in large quantities and the superatmospheric external pressure is reduced rather than maintained during the heating so that an increase of the pressure in the liquid filaments is not obtained.

In another embodiment of the process according to the invention, a low-boiling substance, such as methylene chloride vapor or carbon dioxide, is introduced into the capillaries so that the methylene chloride is condensed and the carbon dioxide is dissolved in the water contained in the capillary material, whereafter the impregnating liquid is introduced under pressure and is subsequently heated while the external superatmospheric pressure is maintained, whereby the pressure in the liquid filament is increased to a value which is not in excess of the external pressure.

The German patent specification No. 138,933 (Wassermann) discloses a process in which the material to be impregnated is subjected to a high air or gas pressure before it is treated with the impregnating liquid and this air or gas pressure is maintained or even increased during the subsequent treatment with the impregnating liquid.

The process according to the invention differs from this known process in that a vapor which has been introduced into the material to be impregnated must condense or a gas which has been introduced must be dissolved in the water contained in the capillary substance, the vapor or gas pressure need not be maintained during the subsequent treatment with the impregnating liquid, when such vapor or gas pressure would even have an obstructing effect, and the impregnating liquid must be heated in order to activate the condensed vapor or the dissolved gas so that the vapor or gas can become effective to increase the pressure of the liquid filament. As the temperature rise proceeds inwardly, the pressure in the filament is continually increased close to the tip of the filament. In the abovementioned process of the Wassermann patent, the counterpressure is maintained or even increased so that the pressure gradient, which equals the pressure value at a point of the liquid filament divided by the length of the liquid filament ahead of this point, will be progressively reduced. This is different from the invention.

Capillary materials tend to absorb or discharge moisture in response to a temperature change and for this reason always contain moisture. Some capillary materials, such as wood, contain natural moisture. Although wood must be dried before it is impregnated, it contains 25-30% moisture after such drying. This moisture is sufficient for dissolving an adequate amount of carbon dioxide.

In another modification of the process according to the invention, the impregnating liquid and an auxiliary liquid are separately introduced into the capillaries of the material, and said two liquids react to evolve a gas so that an increase of pressure in the capillaries is obtained while the superatmospheric external pressure is maintained. This increase of pressure may be assisted by heating.

For instance, an acid and subsequently an aqueous impregnating liquid which is capable of causing an evolution of a gas upon contact with the acid may be introduced into the capillaries of the wood, the impregnating liquid being introduced under pressure. The impregnating liquid may be, e.g. an NaF solution containing an addition of alkali bicarbonate or alkali carbonate. The reaction of the acid with the impregnating liquid will result in the evolution of a certain amount of gas so that the pressure in the liquid filament is increased to a value which does not ex-

ceed the external pressure while a predetermined temperature and the superatmospheric external pressure are maintained.

It is known to introduce solutions of different substances in succession into the wood in order to cause said substances to interact in the wood so that a protective substance is deposited or the wood is petrified. No process has been disclosed so far, however, in which a gas is evolved in the liquid filament while the superatmospheric external pressure is maintained.

Alternatively, an acid, aqueous impregnating liquid, e.g., an acidulated NaF solution, may be initially introduced into the capillaries of the material and this may be followed by the introduction of an auxiliary substance, the contact of which with the acid results in an evolution of a gas. This auxiliary substance may consist of a solution of alkali bicarbonate or alkali carbonate. The reaction of the impregnating liquid with the auxiliary material will result in an evolution of a certain amount of gas so that the pressure in the liquid filament is increased to a value not exceeding the external pressure, while a predetermined temperature and the superatmospheric external pressure are maintained.

A process in which a gas is evolved in the liquid filament while a superatmospheric external pressure is maintained is not known.

The process according to the invention will be described more in detail in the following examples, to which the invention is not restricted.

Example 1

2% by weight methylene chloride was added to an impregnating liquid consisting of a tar oil at a temperature of 30° C. Under a pressure of 10 kg./sq. cm. above atmospheric pressure, the mixture was forced into the capillaries of the material to be impregnated. An hour later, the solution was heated to 90° C. while the superatmospheric external pressure was maintained until the absorption of liquid had virtually ceased. The residual liquid was drained. The methylene chloride was removed from the capillaries by the application of a vacuum.

Example 2

Carbon dioxide was dissolved in an aqueous 4% solution of NaF at 20° C. The resulting impregnating solution was forced under a pressure of 10 kg./sq. cm. above atmospheric pressure into the material to be impregnated and an hour later was heated to 50° C. while the superatmospheric external pressure was maintained. This resulted in a liberation of the carbon dioxide from the impregnating solution so that the pressure in the capillaries was increased. When the absorption of liquid had virtually ceased, the residual liquid was drained and carbon dioxide was removed from the capillaries by evacuating.

To dissolve the carbon dioxide in the aqueous impregnating solution, the material to be impregnated was initially treated with carbon dioxide under a pressure of 1 kg./sq. cm. above atmospheric pressure. The impregnating cylinder was then filled with the impregnating liquid under a higher pressure and the pressure was then reduced to the atmospheric pressure. This caused the carbon dioxide to flow in tiny bubbles through the impregnating liquid, in which part of the carbon dioxide becomes dissolved.

Example 3

The pressure was reduced by 600 millimeters mercury and methylene chloride was sucked into the capillaries until the partial vacuum had been eliminated. Methylene chloride condensed on the walls of the capillaries. Tar oil at 40° C. was then forced under a pressure of 10 kg./sq. cm. above atmospheric pressure into the capillaries of the material to be impregnated. After an hour, the tar oil was heated to 90° C. while the superatmospheric external pressure was maintained until the

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absorption of liquid had virtually ceased. As in Example 1, the capillaries contained tar oil with an admixture of methylene chloride. When the superatmospheric pressure had been removed, the residual liquid was drained and the methylene chloride was removed from the capillaries by evacuating.

Example 4

Wood was treated with carbon dioxide under a pressure of 4 kg./sq. cm. above atmospheric pressure. After 15 minutes, a 4% solution of NaF was forced into the wood under a pressure of 10 kg./sq. cm. above atmospheric pressure. After one hour, the system was heated to 50° C. while the external liquid pressure was maintained until the absorption of liquid had virtually ceased. The surplus liquid and the carbon dioxide were then withdrawn by evacuating.

Example 5

After a reduction of pressure by 600 millimeters mercury, formic acid fumes were sucked into the capillaries until the partial vacuum had been eliminated. A neutral 4% NaF solution was mixed with a 4% sodium bicarbonate solution and was forced into the wood under a pressure of 10 kg./sq. cm. above atmospheric pressure. This pressure was maintained until the absorption of liquid had virtually ceased. Part of the liquid and the carbon dioxide gas which had been formed were then removed by evacuating.

Example 6

Wood was subjected to an air pressure of 4 kg./sq. cm. above atmospheric pressure. The superatmospheric external pressure was then increased to 10 kg./sq. cm. above atmospheric pressure and the wood was impregnated under this pressure with a 4% sodium bicarbonate solution. This pressure was maintained until the adsorption of liquid had virtually ceased. When the solution had been drained off, a solution of an acid impregnation salt, namely, a 4% solution of UA salt (pH=2) was introduced, also under a superatmospheric external pressure of 10 kg./sq. cm. above atmospheric pressure, which superatmospheric pressure was maintained until the absorption of liquid had virtually ceased.

Example 7

Wood was impregnated under a pressure of 10 kg./sq. cm. above atmospheric pressure with an acidulated 4% NaF solution (pH=2) until the absorption had virtually ceased. When the solution had been drained, a 4% solution of alkali bicarbonate was forced into the wood under a pressure of 15 kg./sq. cm. superatmospheric pressure until the absorption of the solution had ceased.

What is claimed is:

1. A process of impregnating wood having impregnable capillary channels, which comprises the steps of maintaining an impregnating liquid consisting at least in part of a wood preservative in contact with the wood and applying thereto a superatmospheric pressure sufficient to cause said impregnating liquid to penetrate into said wood, providing in said wood a nongaseous thermally gasifiable auxiliary substance which is capable of evolving a gas at a predetermined temperature, the impregnation of said wood being carried out at a temperature below said predetermined temperature, heating said wood to said predetermined temperature only after at least partial penetration of said liquid into the wood and when said auxiliary substance and said impregnating liquid are in contact with each other within said wood to evolve said gas and increase the pressure of said impregnating

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liquid in said wood, and maintaining said impregnating liquid outside said wood and in contact therewith under a superatmospheric pressure which is at least as high as the pressure of said impregnating liquid in said wood during the heating step.

2. A process as set forth in claim 1, in which said auxiliary substance is a liquid which is easily evaporable by heating and said auxiliary substance and said impregnating liquid are heated in contact with each other within said wood to evaporate at least part of said auxiliary substance.

3. A process as set forth in claim 1, in which said auxiliary substance is capable of causing said evolution of a gas upon contact with said impregnating liquid and said auxiliary substance and said impregnating substance are contacted only inside said wood.

4. A process as set forth in claim 1, in which said superatmospheric pressure is maintained substantially constant and the heating is controlled so that the pressure of said impregnating liquid in said gas is increased to a value which is not in excess of said superatmospheric pressure.

5. A process as set forth in claim 1, in which said auxiliary substance is a low-boiling liquid which is soluble in said impregnating liquid and introduced into said wood as a solute in said impregnating liquid, said impregnating liquid containing said solute being heated within said wood to evaporate at least part of said solute.

6. A process as set forth in claim 5, in which said impregnating liquid is tar oil and said auxiliary substance is methylene chloride.

7. A process as set forth in claim 1, in which said impregnating liquid is an aqueous solution and which comprises introducing carbon dioxide as said auxiliary substance as a solute in said impregnating liquid into said wood, and heating said impregnating liquid containing said solute within said material to evolve carbon dioxide.

8. A process as set forth in claim 1, in which said auxiliary substance is a low-boiling liquid and is introduced as a gas into said wood and caused to condense therein, whereafter the impregnating liquid is caused to penetrate into said material under said superatmospheric pressure to contact said condensed auxiliary substance, and at least part of said auxiliary substance is thereafter evaporated by said heating within said wood.

9. A process as set forth in claim 8, in which said auxiliary substance is methylene chloride.

10. A process as set forth in claim 1, in which said wood contains moisture and carbon dioxide is introduced into said wood and dissolved in said moisture to form said auxiliary substance, whereafter said impregnating liquid is caused to penetrate into said wood under said superatmospheric pressure to contact said auxiliary substance, and said auxiliary substance is thereafter heated to evolve carbon dioxide.

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