

UNITED STATES PATENT OFFICE

2,633,429

METHOD OF AVOIDING EXPLOSION
HAZARDS

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No Drawing. Application January 31, 1951,
Serial No. 208,847

4 Claims. (Cl. 117-57)

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This invention relates to methods of avoiding explosion hazards in industrial processes, and more particularly to avoiding such hazards incident to the vapor drying and preservative treatment of wood. This is a continuation-in-part of my copending application Serial No. 707,757, filed November 4, 1946 now abandoned.

In my copending application Serial No. 579,851, filed February 26, 1945, now U. S. Patent No. 2,435,218, a method of drying wood is disclosed which comprises treating the wood in a closed space with a highly heated organic vapor that is inert to the wood and that permeates the wood so as to flash off the moisture in the wood as vapor. This process is carried out by subjecting the wood to the drying treatment in the closed drying space with organic vapor maintained at a temperature sufficiently high to liberate rapidly the moisture in the wood while continuously removing liberated moisture vapor and spent organic vapor from the closed drying space. The organic vapor used in carrying out the process may be selected from a large group of hydrocarbons and hydrocarbon derivatives, as disclosed in the above noted copending application, all of which are characteristically potentially explosive.

After the vapor drying treatment has been completed, as disclosed in my above identified copending application, it is usually desirable to subject the wood to a suitable vacuum period in order to recover some of the vapor drying medium that has distilled into the wood and thus leave the wood free of excess drying medium in the outer layers. While this vacuum period will reduce the temperature of the atmosphere of organic vapor in the drying chamber somewhat from the characteristically high temperatures employed during the drying process, the temperature in the drying chamber at the end of the vacuum period will still ordinarily be of the order of 240° F. or more, although it may vary either upwardly or downwardly from this level depending upon the particular vapor drying agent used, for the final temperature will normally be about 50° F. below the boiling point of the drying agent.

When the dried wood is to be impregnated with preservatives following the vapor drying treatment, the preservative treatment is conveniently carried out in the same closed space used for vapor drying. And this involves introducing air under pressure to the closed space incident to the preservative treatment, as described in United States Patents No. 709,799, Reissue No. 12,707, and No. 1,008,864, covering the well known Rueping process. This introduction of compressed

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air, however, involves the danger of diluting the atmosphere of organic vapor in the closed space to such an extent as to bring it within the explosive range and induce an explosion.

According to the present invention I have found that this danger may be obviated by introducing steam to the closed drying space following the vacuum period and before introduction of compressed air to initiate the preservative treatment. If desired, the steam may be introduced to break the vacuum applied at the end of the drying process. However, under certain conditions, as where a relatively high degree of drying has been effected, this may result in sucking an undesirable amount of water vapor into the wood. In such a case, the vacuum may be broken by opening the closed drying space to the atmosphere, after which the steam may then be introduced.

While the manner in which steam operates to modify the atmosphere of organic vapor in the closed drying space according to the present invention to avoid explosion hazards is not entirely clear, and I do not wish to be limited to any particular theory, it appears that this effect results from the high heat capacity of steam or water vapor. Because of this high heat capacity, it appears that the steam is capable of absorbing ignition heat and thus dampening the propagation of the ignition heat to an explosive degree. In any event it should be noted that the use of steam according to the present invention is clearly not as a diluent to preclude the presence of air in amounts that will support combustion, but as a modifying agent for a potentially explosive organic vapor atmosphere to avoid explosion hazards when air in amounts that will support combustion are added to this atmosphere. The use of inert vapors or gases as diluents for avoiding explosion hazards is of course old. As a matter of fact, air itself may be used as a diluent, for if air is present in either too small or too great a percentage combustion cannot take place, although the use of air in this manner is not a practical expedient for it requires the handling of disproportionately large amounts of air. The same disadvantage is encountered with the more commonly used inert diluents, such as carbon dioxide and nitrogen, which must likewise be handled in relatively large volumes in order to avoid explosion hazards, and this fact provides a basis for illustrating very strikingly the different manner in which steam is employed according to the present invention.

Quantitative data on the use of carbon dioxide

and nitrogen as diluents to render non-inflammable various combustible gases and vapors are given in a report of the Bureau of Mines, of the U. S. Department of Interior, entitled "Prevention of Benzene-Air Explosions by Addition of Nitrogen and Carbon Dioxide" (R. I. 3787, December, 1944). Although no data are given in this report, or are available in the literature otherwise, with regard to the vapor drying agents, such as toluene and xylene, more usually employed for drying wood in accordance with the vapor drying process of my above noted prior patent with which the present invention is particularly adapted for use, still benzene is one of the drying agents that may be employed as disclosed in that patent, so that the data for benzene from the above noted Bureau of Mines report forms a good basis of comparison, which should follow similarly for other drying agents as well, to show that the steam used as a modifying agent against explosions according to the present invention would have to be used in amounts many times greater if its action were merely as a diluent.

According to the data from the Bureau of Mines report in order to render 1 volume of benzene non-inflammable under all conditions of dilution with air, it is necessary to add 12.9 volumes of carbon dioxide, or 21.2 volumes of nitrogen. Now at the end of the vapor drying process of my above noted prior patent, it is usual to impose a final vacuum period to recover vapor drying medium that has distilled into the wood. After this final vacuum period the drying chamber will characteristically be under about a 20" Hg vacuum. If a preservative impregnation is to follow the drying process, then compressed air must first be admitted to the treating chamber, while if the dried wood is to be removed for use otherwise, air from the atmosphere must necessarily be admitted in removing the wood.

If protection from explosion hazards were to be obtained under these circumstances by first adding carbon dioxide or nitrogen to the organic vapor atmosphere before admitting air, the conditions that would have to be established may be calculated from the above noted Bureau of Mines data as follows:

20" Hg vacuum=252 mm. pressure
Volume of carbon dioxide required per volume of benzene=12.9

Volume of nitrogen required per volume of benzene=21.2

Pressure necessary to add 12.9 volumes of carbon dioxide per volume of benzene=

$$252 \div \frac{1}{12.9} = 3252 \text{ mm.}$$

$$= 63 \text{ p. s. i. (absolute) or about } 48 \text{ p. s. i. (gauge)}$$

Pressure necessary to add 21.2 volumes of nitrogen per volume of benzene=

$$252 \div \frac{1}{21.2} = 5345 \text{ mm.}$$

$$= 103 \text{ p. s. i. (absolute) or about } 88 \text{ p. s. i. (gauge)}$$

According to the present invention, however, steam at a pressure of the order of only 5 to 10, or at the most 20, p. s. i., is used to avoid explosion hazards, while the indications are that steam would be even less effective than carbon dioxide because its heat capacity is lower, which is a clear indication that the effect of the steam is not one of dilution, but of modification. The

introduction of steam to the closed drying space, however, does not lower the temperature in the closed space, and the steam does not condense to form water so that the dried wood is not wet or hydrolyzed by the method of the present invention.

In a typical vapor drying treatment carried out according to the process disclosed in my above identified copending application, wood was dried at about 325° F. for twelve hours followed by a vacuum period of two and one-half hours at 25 inches of mercury. At the end of the vacuum period the temperature of the atmosphere of organic vapor in the closed drying space was 247° F. This temperature is above the level at which it would normally be considered safe to admit air to the evacuated drying space. The vacuum was accordingly broken with steam, the steam being admitted to the closed drying space until a pressure of 10 p. s. i. was obtained. Air at 100 p. s. i. was then introduced to initiate a preservative treatment, and the pressure rise in the closed space was regular and normal as the air was admitted.

The same procedure has been employed where the temperature at the end of the vacuum period was as high as 270° F. Where a subsequent preservative treatment is to be carried out, I find it convenient to regulate the introduction of steam so that a pressure of not more than about 5 to 10 p. s. i. is established in the closed drying space, and the introduction of air incident to the preservative is consequently not hampered. In any case, the steam pressure used should at the least be such as to obtain a partial pressure of steam in the drying chamber equal to the partial pressure of the organic vapor so as to insure the presence of steam in a volume at least equal to the volume of organic vapor; while the steam pressure should in no event be allowed to exceed 20 p. s. i., because above this pressure the wood is adversely affected in the presence of steam as evidenced by the specification of this pressure by the American Wood Preservers Association as a maximum in the use of steam for preliminary softening of wood prior to preservative treatment. Within these limits it is recommended that this maximum limit of 20 p. s. i. be approached as nearly as possible or convenient in particular circumstances so that the modifying effect of the steam may be employed with the greatest practical factor of safety. As the air under pressure is introduced, the pressure in the closed drying space may then be watched carefully, and if an undue rise is noted the air supply may be cut off and additional steam admitted. When the pressure ceases to rise, the steam supply may then be cut off and after blowing the pressure in the closed space down to 5 to 10 p. s. i. or other starting pressure again, the introduction of air for the preservative treatment may be repeated.

The method of the present invention has been described above in connection with the procedure for effecting a preservative treatment following a vapor drying treatment because the introduction of air under pressure incident to the preservative treatment results in a marked dilution of the atmosphere of organic vapor in the closed drying space so that the consequent explosion hazards must be dealt with. Where it is merely desired to open the closed space to the atmosphere it will not usually be found necessary to use a steam pressure of more than about 5 p. s. i., because the degree of dilution with air

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in such a case is not usually sufficient to bring the atmosphere of organic vapor immediately within the explosive range unless the temperature in the closed space is very high or a very high vacuum has been employed following the drying treatment. It will be understood, however, that this will also depend on the particular organic vapor being employed, and that the method of the present invention is applicable for modifying the atmosphere in the closed drying space whenever an explosion hazard is encountered.

I claim:

1. In the vapor drying and preservative treatment of wood comprising subjecting the wood to a drying treatment in a closed space with a potentially explosive organic vapor at elevated temperatures and then effecting a preservative impregnation of the dried wood in the same closed space under air pressure, the amount of air present during the impregnation being sufficient to render the organic vapor normally explosive, the method of avoiding explosion hazards which comprises modifying the atmosphere of organic vapor in said closed space upon completion of the drying treatment by establishing therein an initial pressure with steam so that a partial pressure of steam is obtained at the temperature existing in the closed space that is at least equal to the partial pressure of the organic vapor, but so that said initial pressure is not more than 20 pounds per square inch, before establishing the air pressure in said closed space for the subsequent preservative treatment.

2. In the process of vapor drying wood which comprises subjecting the wood to a vapor drying treatment in a closed space with a potentially explosive organic vapor at elevated temperatures, the method of avoiding explosion hazards upon subsequent admission of air to said closed space in an amount sufficient to render the organic vapor normally explosive which comprises modifying the atmosphere of organic vapor remaining in said closed space after completion of the drying treatment by introducing steam to said closed space before admitting air thereto

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until a pressure is established therein of not more than 20 pounds per square inch and not less than that at which the partial pressure of the steam at the temperature existing in said closed space is equal to the partial pressure of the organic vapor.

3. In the vapor drying and preservative treatment of wood comprising subjecting the wood to a drying treatment in a closed space with a potentially explosive organic vapor at elevated temperatures followed by a vacuum period to recover vapor drying medium that has distilled into the wood, and then subsequently treating the wood in the presence of air under pressure with preservatives, the amount of air present during said subsequent treatment being sufficient to render the organic vapor normally explosive, the method of avoiding explosion hazards which comprises introducing steam until an initial pressure up to 20 pounds per square inch, and not less than that at which the partial pressure of the steam at the temperature existing in said closed space is equal to the partial pressure of the organic vapor, is established in said closed space after said vacuum period before admitting air under pressure to the closed space for the preservative treatment.

4. In the vapor drying and preservative treatment of wood, the method of avoiding explosion hazards as defined in claim 3 and further characterized in that the steam is introduced until said initial pressure is of the order of 5 to 10 pounds per square inch.

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REFERENCES CITED

The following references are of record in the file of this patent:

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