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METHOD OF DEODORIZING AND STERILIZING AIR IN ENCLOSED SPACES

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1 Claim. (Cl. 21—53)

The present invention relates to improvements in the method of deodorizing and sterilizing air in enclosed spaces. It is particularly applicable to the deodorization and sterilization of the air circulated in air conditioning systems in accordance with the method described in the Kuehner Patent No. 2,683,074, issued July 6, 1954, to one of the present applicants. As disclosed in said patent, an effective method of producing such a sterilization and deodorization consists in spraying the circulated air with a circulating aqueous alkaline solution of potassium permanganate. Such a solution has been found to be highly effective in removing odors, molds, and bacteria from the circulating air. It is the object of this invention to improve the operation of this method so as to overcome certain drawbacks which have manifested themselves in the practical operation of the system. More particularly, it is the object of this invention

(a) To eliminate the evaporation of the water component of the spray, and

(b) To eliminate the necessity for a chemical charging device, sometimes referred to as a dispenser.

With regard to the first of the above objects, it will be recognized that, as in the case of a plain aqueous spray, the air passing through a treating unit in which it is sprayed with an aqueous solution of potassium permanganate is brought nearly to the saturation point; hence, in the absence of refrigeration or heating means in the unit, the air would issue from the unit in a state close to saturation at the air wet bulb temperature. That is, the relative humidity in the room is increased beyond the comfort zone. Obviously, this imposes severe limitations in the use of the treating unit. More particularly, it limits the percentage of room air which can be circulated through the treating unit in contrast to the total air going to the air conditioner, and even with this limitation, there is bound to be some rise in relative humidity. Another drawback resulting from the evaporation lies in the necessity of providing a water make-up line to supply the equivalent of the water evaporated, and drain lines to guard against accidental overflow. Obviously, this limits the mobility of the unit and increases appreciably the installation costs.

Regarding the second object of the invention referred to above, it will be appreciated that, since the deodorant and disinfectant effect of the permanganate treating solution is dependent upon a chemical reaction between the smoke, etc. in the air and the dissolved chemicals in the solution, the chemicals are gradually consumed and, hence, must be replaced. Moreover, in actual practice, it is found desirable to maintain the concentration of the solution at a strength less than saturation in order to obviate any tendency of the chemicals to crystallize on the equipment and form deposits leading to the corrosion of the metallic surfaces, stopping of flow lines, etc.

Accordingly, in order to maintain the concentration of the treating solution at an optimum predetermined value less than saturation, it was necessary heretofore to pro-

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vide a suitable dispenser for automatically feeding at a retarded rate the chemicals into the treating solution, as the chemicals dissolved therein became consumed by the treatment.

Applicants have discovered a practical and effective means for overcoming all of the drawbacks enumerated above, namely, undesired rise in the humidity, necessity for a water-make-up line, and necessity for a dispenser.

The nature and advantages of the present invention will be better understood by reference to the accompanying drawings, in which

Fig. 1 is a diagrammatic view of a typical washer adapted for carrying out applicants' invention;

Fig. 2 is a chart illustrative of the vapor pressure conditions obtaining with the use of the present invention.

Referring to Fig. 1: The unit has the usual spray devices 10 for spraying the aqueous treating solution. These are interposed in the path of the air stream which enters the compartment 11 at one end 12 and leaves at the other end 13. The solution circulating means is indicated at 14, the solution accumulating in the bottom of the compartment to the level indicated at 15.

In initially preparing the treating solution, the chemicals may be added to the treating water in the compartment, or the water may be preliminarily prepared by adding the chemicals thereto and introducing the same to the circulating system. The chemicals may be introduced to the treating water individually or as mixtures in the form of dry powders, concentrated aqueous solutions or as pills or tablets, whichever is considered most convenient.

The numeral 16 indicates a suitable receptacle or retaining basket for replenishing the chemicals in the solution, as they are consumed in the course of the operation of the unit, in order to maintain the desired concentration thereof. This receptacle can consist of a perforated basket containing a supply of chemicals submerged in the treating solution so that the latter has access to the chemicals. As will be explained below, it is a feature of the present invention that there will take place but a limited solution of the chemicals in the treating solution.

In accordance with the present invention, applicants add a controlled proportion of another salt, specifically lithium chloride, to the aqueous solution of potassium permanganate. Applicants have established that when this salt is present in the permanganate solution, it is possible to operate at room temperature without humidifying the air in the room. By reason of the presence of lithium chloride in controlled amounts, the vapor pressure of the aqueous spray solution becomes such that, under all ordinary temperature and humidity conditions, water will not evaporate from the solution beyond a certain point and there will be no necessity for a water make-up line.

As an aid in understanding the operation of an air treating system using applicants' invention, reference is had to Fig. 2 which represents a lithium chloride vapor pressure chart, reproduced from Chemical and Metallurgical Engineering 47 (5), page 303, May 1940. The several curves in this chart show the relationship between dry bulb temperature and the vapor pressure of lithium chloride solutions of various concentrations.

As is readily apparent from the chart, the vapor pressure of an aqueous solution containing lithium chloride is less than the vapor pressure of pure water at the same temperature (0% LiCl curve). The lithium chloride depresses the vapor pressure to a degree dependent upon the percentage of this salt in the water solution. As an example, let us assume that the air deodorizing system is to be operated under conditions of 80° dry bulb tem-

perature and 50% relative humidity of the room air entering the treating unit. From available psychrometric data set out on the chart of Figure 2, it is found that the corresponding partial pressure of this air is 13.1 mm. mercury. By reference to the chart of Figure 2, it will also be seen that the 80° dry bulb temperature line (on the abscissa) intersects the 13.1 mm. mercury vapor pressure line (on the ordinate) at a point which lies on a lithium chloride line corresponding to a solution concentration of 29% lithium chloride by weight. Hence, if 29% of lithium chloride be added to the treating solution, then, the system would stabilize at this condition and, thereafter, water vapor would neither be evaporated from the solution nor condensed from the air stream.

Of course, changing conditions whether of temperature or humidity, or both, of the air entering the unit would bring about a new equilibrium condition with the lithium chloride water spray to balance out at a new concentration in the spray solution. For example, let us assume that the air supplied to the unit changes from 80° dry bulb, 50% relative humidity—i. e. the conditions of the air in the example discussed above—to 80° dry bulb and 30% relative humidity. In that case, the vapor pressure of water in the entering air would drop to 7.8 mm. Referring again to Fig. 2, it will be seen that this corresponds to a lithium chloride solution concentration of about 37%. This means, that the spray solution would change from a condition of 30% concentration to a condition of 37% concentration, corresponding to the above specified change in the condition of the entering air. Such a change from 30% to 37% concentration would take place by a temporary evaporation of water from the spray water to the circulating air, with a resultant increase of the salt concentration in the spray unit, until the new condition has been obtained. Conversely, should the relative humidity in the entering air increase, then, there will take place a condensation from the air stream to reduce the concentration of the salts in the spray unit until the new equilibrium condition has been reached, and the unit then becomes stabilized at the new concentration. All the changes—evaporation or condensation, as the case may be—are automatic and require no control of any kind.

During a change of conditions as described above, the unit affects the relative humidity in the space. It is, however, a situation which exists in a limited way and for a very short period, and is hardly of any consequence even if the unit be handling 100% of the circulated air.

Applicants have further discovered that the addition of lithium chloride to the spray solution containing potassium permanganate also successfully accomplishes the second important object of this invention, namely, elimination of the use of a special dispenser to retard the mixing into the main solution of the make-up potassium permanganate for replenishing the consumed deodorant. Applicants have discovered that potassium permanganate in the form of crystals and sufficient for a year's supply, can simply be placed in the retaining basket 16, which is submerged in the solution in the lower part of the compartment 11, and that the lithium chloride in the solution acts to retard the solubility of the potassium permanganate in the solution so as to maintain the content of the potassium permanganate in the solution within the desirable concentration limit, even in the presence of an excess of crystals in the basket.

Without limiting themselves to any special theory, applicants believe that the action here is a complex function of solubility, dissociation constants and water bound by LiCl; primarily, it probably involves the tying up of water molecules by the lithium chloride molecules, the major component, thereby reducing the water available for dissolving the KMnO_4 . Whatever be the explanation, applicants have conclusively established the reducing effect of lithium chloride solutions on the solubility of KMnO_4 in the following two ways:

(a) By beaker tests. Excess potassium permanganate (more than 6% by weight) was added to three beakers, containing respectively

- (1) Distilled water;
- (2) 30% LiCl by weight in distilled water, and
- (3) 40% LiCl by weight in distilled water at 80° F.

These were agitated at irregular intervals and held for periods varying from hours to days to insure equilibrium between the crystals and solute. KMnO_4 concentration determinations were made by colorimetric analysis and also, by a wet chemical method involving ferrous ammonium sulfate-ceric sulfate titration.

A number of these tests were made and representative results of the KMnO_4 concentration determinations were as follows:

Distilled H_2O : 2 N or 6.3% by weight KMnO_4
 30% LiCl: .125 N or .38% by weight KMnO_4
 40% LiCl: .09 N or .28% by weight KMnO_4

The reduction of solubility of KMnO_4 by reason of the presence of the lithium chloride is quite evident.

(b) In a "mobile washer" used to prove the air sanitation effectiveness of applicants' system, there were added 300 grams of crystalline KMnO_4 into a wire mesh basket. The system contained 10 liters of liquid; hence, if all the permanganate dissolved, the resultant normality would be 1 normal or 3% by weight of KMnO_4 . By chemical analysis, applicants have found the operating normalities over a week's time to range from .2 N—.18 N or .62%—.56% by weight of KMnO_4 . This system was run off and on for a year under similar conditions with no evidence of overcharging with KMnO_4 .

An additional test was equally striking. When LiCl crystals were added to a saturated (2 N or 6.2%) aqueous solution of KMnO_4 , the KMnO_4 crystals precipitated, indicating the reduced solubility. When more water was added, this precipitate redissolved.

Practical experience with the type of deodorizing system under consideration, i. e. one using a potassium permanganate solution, has shown that in order to prevent corrosion and scaling, etc. of the equipment, the normality of the solution should not exceed .5. It is apparent from the data set out above, that the lithium chloride solution will maintain the normality at a value not in excess of .2, i. e. well below this danger point.

From the foregoing, it will be seen that applicants have successfully accomplished the major objects of the present invention, namely

- (1) Inhibition of addition of moisture to the room air by the treating solution, and
- (2) The necessity for using a special dispenser or other mechanical control device for limiting the dissolution of the deodorant chemical in the treating solution, i. e. for controlling its concentration.

Applicants' invention can be applied in a simple manner. It is merely necessary to know the condition of the air to be treated, the dry bulb temperature and relative humidity; the concentration of the lithium chloride solution to be placed in the treating unit can then be determined in a simple manner by the use of the chart, as explained above.

By the use of a lithium chloride solution of a concentration as derived from the chart, and carrying dissolved potassium permanganate, it is possible to deodorize air at room temperature without increasing the relative humidity in the room beyond the comfort zone. Also, there is no waste of potassium permanganate as a result of excessive solution thereof, and since the lithium chloride does not vaporize, it is possible to operate the unit for long periods without adding either lithium chloride or potassium permanganate to the initial charge, and without any regeneration treatment. Further, since the treating solution has been adjusted to the proper concentration for the predetermined design conditions of the sys-

tem—air temperature and humidity—the system will automatically stay in balance as far as the lithium chloride concentration is concerned.

While the operation of the present invention has been described with reference to the washer unit illustrated in Figure 1, it should be understood that the invention is not limited to the use of any specific system.

We claim:

In the process of deodorizing and sterilizing air circulated in occupied enclosures by bringing the air in intimate contact with an aqueous solution of potassium permanganate, the improvement of providing a substantially long life for the permanganate solution which comprises providing a saturated permanganate solution hav-

ing at least 6.2% permanganate by weight and having a normality of at least 2 N, and adding lithium chloride to the permanganate solution in an amount effective to reduce the normality of the permanganate solution to below about 0.5 to thereby bring the concentration of the permanganate solution to a strength less than saturation.

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