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METHOD AND COMPOSITION FOR CLEANING TOMBSTONES

Miles E. Barry, 124 Country Club, McHenry, Ill.

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This invention relates to a method of cleaning tombstones including a specific liquid cleaning composition for this purpose. In particular, the invention concerns a method and composition for cleaning tombstones whereby it will be possible to avoid damaging valuable vegetation such as grass, shrubs, bushes, trees, flowers and the like, which are located adjacent to or in the vicinity of the tombstones.

Many compositions are known which are suitable for cleaning stone materials or structures. The cleaning action of these known compositions is more or less satisfactory when used upon tombstones, markers, monuments, mausoleums and similar permanent memorial structures placed in cemeteries. With hard, non-porous types of stones, such as granite and marble, it is nevertheless often difficult to remove dirt, grime, soot and the like which has worked into the stone or to remove discoloration caused by chemical action within and near the surface of the stone. On the other hand, less durable or more porous stones such as concrete and limestone usually require more frequent cleaning, and there is a tendency to erode or disfigure such structures by excessive cleaning.

One of the most difficult problems in cleaning tombstones or the like is that they are placed in a location which is surrounded by valuable vegetation, and most cleaning compositions previously employed in this art have a general tendency to severely damage such vegetation. Thus, when cleaning tombstones, it has been necessary to apply the cleaning composition by hand with a brush, rag, or the like, while avoiding spillage or spattering of the composition upon nearby vegetation. Even then, it is almost impossible to avoid a run-off of the cleaning composition around the base of the tombstone, inhibiting or destroying plant growth in an area adjacent thereto. Furthermore, this area of damaged vegetation cannot be easily repaired, particularly if the cleaning composition is one which tends to remain in the soil with a herbicidal effect.

Prior cleaning compositions, if effective in their cleansing action, usually require safety precautions to prevent injury to the person handling the composition. Where the cleaning composition is weak and safe to handle, a considerably greater quantity must be applied to the stone. It will be recognized that the cleaning of tombstones and similar structures in cemeteries has been quite expensive because of the time consuming labor required and the safety precautions necessary to avoid various toxic effects.

One object of the present invention is to provide a method and composition for cleaning tombstones whereby a highly efficient cleaning action can be obtained while avoiding damage to surrounding valuable vegetation.

Another object of the invention is to provide a method and composition for cleaning tombstones whereby the cleaning composition is relatively safe to handle and requires only a minimum amount of labor.

Still another object of the invention is to provide a cleaning composition suitable for application to all types of stones or stone structures which are usually found in cemeteries. The composition of the invention is sufficiently strong in its cleansing action to remove practically all kinds of stains and discolorations produced by weathering, dirt or grime, chemical staining or the like, without unnecessary disfigurement or effacing of designs, lettering or other markings on the stone.

Yet another object of the invention is to provide an improved method of cleaning tombstones whereby a liquid cleaning composition can be rapidly and efficiently applied with readily available steam spraying equipment.

These and further objects and advantages of the invention will become more clearly apparent upon consideration of the following detailed description of the invention. The term "tombstone" is employed herein as being generally descriptive of all types of stone markers or other permanent memorials which are found in a cemetery. The term "vegetation" as employed herein relates to any form of plant growth including grass, ground cover, flowers, bushes, shrubs, trees and the like.

In accordance with the invention, an excellent method and composition for cleaning tombstones has now been found which combines a high cleaning action together with preservation of valuable vegetation located nearby. The cleaning composition consists essentially of a liquid aqueous mixture of orthophosphoric acid (H_3PO_4) and ammonium bifluoride (NH_4HF_2) and a small quantity of a non-ionic surface active agent. It has been necessary to carefully adjust the proportions of orthophosphoric acid and ammonium bifluoride in the mixture to obtain optimum results. Thus, it has been found that the aqueous mixture should contain at least about 1.25 to 1.8 parts by weight of orthophosphoric acid, calculated as H_3PO_4, to one part by weight of ammonium bifluoride. It is most preferable to employ 1.4 to 1.5 parts by weight of orthophosphoric acid to one part by weight of ammonium bifluoride. The non-ionic surface active agent is required in small quantities sufficient to provide a homogeneous aqueous mixture, usually not more than about 5% by weight with respect to the cleaning composition.

It is most convenient to prepare the liquid composition in a concentrated form, i.e. as a liquid concentrate, by mixing a concentrated solution of orthophosphoric acid with ammonium bifluoride in the presence of a compatible non-ionic surface active agent. When the composition is used for cleaning, it may then be further diluted with about 20 to 30 parts by volume, preferably about 25 parts by volume, of water. The dilute cleaning composition should have an acid pH of about 4 to 5.5, and optimum results are obtained at a pH of about 4.5 to 4.6.

If a 75% aqueous solution of orthophosphoric acid is employed to make up the concentrate, it should be used in a ratio of parts by weight of at least about 1.5:1 to 2.5:1 with respect to the quantity of ammonium bifluoride. Again, optimum results have only been obtained with a ratio of a 75% aqueous solution of orthophosphoric acid to ammonium bifluoride of about 1.85:1 to 2:1. Of course, a more dilute solution or mixture can be prepared in accordance with the foregoing proportions which are intended only as a prescription for the ratio of orthophosphoric acid to ammonium bifluoride.

While the cleaning composition can be applied to a tombstone by means of the usual brush or rag, it is particularly useful to incorporate the aqueous cleaning mixture in a hot wet steam jet directed against the tombstone. After application of the cleaning composition, fresh water or wet steam can be applied to rinse away the cleaning composition, and the stone can then be quickly dried by means of a jet of hot dry steam.

The orthophosphoric acid employed in the method and composition of the invention is most easily obtained in commercial quantities as an 85% aqueous solution. (Percentage is always by weight.) However, in order to avoid crystallization of the acid, it is preferable to prepare the liquid concentrate cleaning composition from about a 75% aqueous solution of orthophosphoric acid. The ingredients in the concentrate can be added in any order, but a stable homogeneous mixture is best prepared

by first mixing the 75% aqueous solution of orthophosphoric acid with a small quantity of a non-ionic surface active agent. Crystalline ammonium bifluoride is then added slowly with stirring or mixing until a homogeneous mixture has been obtained. The ammonium bifluoride dissolves only with difficulty, and fresh quantities should not be added until previous quantities have been thoroughly mixed into the solution.

Any compatible non-ionic surface active agent can be added to the composition in order to produce a stable homogeneous mixture. These materials are fully set forth in the literature, for example, "Surface Active Agents" by Schwartz and Perry, Interscience Publishers, Inc., New York, pages 202–214, and are usually water-soluble polyoxyalkylated aliphatic hydrocarbons. The polyoxyethylated alcohols have been found to be particularly useful. An excellent composition is provided by using Sterox AJ, which is a polyoxyethylated tridecyl alcohol containing about 9 to 10 mols of ethylene oxide per mol of tridecyl alcohol.

The surface active agent is essentially a water-soluble compound capable of producing emulsions or colloidal suspensions in water and further acts as a wetting agent in the application of the cleaning composition of the invention to a tombstone. The smallest possible quantity of surface active agent commensurate with a stable composition and action as a wetting agent is preferred.

The present cleaning composition was discovered after extensive testing of known compositions which were known to clean stone but which caused severe damage to vegetation. It was desirable to find a composition which would not only have a good cleaning action but which would have a synergistic effect of avoiding the inhibition or destruction of plant growth. Both orthophosphoric acid and ammonium bifluoride are acids which have been used in various cleaning compositions, and it was therefore surprising to find that these materials could be mixed together in a single composition which would not only clean stone but would also preserve vegetation. The exact reasons for this characteristic of the cleaning composition is not known. However, it is believed that the ammonium bifluoride probably acts as a cleaning agent by releasing hydrofluoric acid. The orthophosphoric acid, on the other hand, is believed to form phosphates which in the cleaning of the stone become incorporated in the soil to give a fertilizing effect, thereby counteracting any herbicidal effect of the acid composition. For example, it can be theorized that the orthophosphoric acid will react with the ammonium bifluoride according to the following equation:

$$H_3PO_4+NH_4HF_2\rightarrow NH_4H_2PO_4+2HF$$

The ammonium dihydrogen phosphate formed in this reaction is a known fertilizer and would be capable of reacting with further quantities of ammonium bifluoride to form the diammonium or triammonium phosphates. It is also conceivable that more complex compounds in the form of phosphates can be formed when applying the cleaning composition to the tombstone. The exact chemical reactions involved are not clearly understood, and the invention is not to be limited by such theoretical considerations. In general, it is much safer to work with orthophosphoric acid and ammonium bifluoride than with hydrofluoric acid which in its concentrated form can be very toxic.

The proportions of orthophosphoric acid to ammonium bifluoride should be carefully controlled to obtain optimum results. Ordinarily, the ammonium bifluoride should be present in a slight stoichiometric excess with respect to the above equation in which the end product is ammonium dihydrogen phosphate. A particularly effective liquid concentrate has been prepared by forming a homogeneous aqueous solution of 63.6% by weight of a 75% solution of orthophosphoric acid, about 33% by weight of ammonium bifluoride and about 3.4% by weight of a non-ionic surface active agent such as Sterox AJ. When this concentrate is diluted with about 25 parts by volume of water to one part of liquid concentrate, there is an excellent cleaning effect upon tombstones and substantially no damage whatsoever to surrounding vegetation. Poorer results are obtained when diverging from this optimum content of ingredients.

The invention is further illustrated by the following examples which set forth the preparation of the preferred composition and the preferred method of applying it to a tombstone. The examples are intended as being illustrative only and not exclusive.

Example 1

In a mixing device, 66.3 parts by weight of a 75% aqueous solution of orthophosphoric acid are first stirred with 3.4 parts by weight of Sterox AJ. Stirring is then continued while 33 parts by weight of ammonium bifluoride in crystalline form are slowly added to the liquid mixture. Only about one-tenth of the ammonium bifluoride is added at one time and completely dissolved before adding further quantities. The resulting concentrated mixture is quite stable and can be stored for future use. When applying to a tombstone, the concentrate is first diluted with about 25 parts by volume of water to one part by volume of the concentrate.

Example 2

A steam jet cleaner, sometimes referred to as a "steam jenny," is employed to apply the diluted cleaning composition of Example 1 to a tombstone. Steam is provided to the jet nozzle through one line while the cleaning composition is supplied through a different line. It was found that a wet steam should be employed to avoid drying out the stone when applying the cleaning composition. The moisture content of the steam can be provided by the water of the cleaning composiion or the steam itself may have a high moisture content. After application of the steam jet with the cleaning composition against the tombsone, the stone is then further treated with steam alone by shutting off the line which introduces the cleaning composition. After a thorough rinsing of the tombstone, a hot dry steam is applied thereto in order to quickly dry the stone.

A very effective cleansing action is obtained by the use of a steam jet, tombstones having been cleaned which had been very heavily stained with hydrochloric acid prior to cleaning. No visible damage or deterioration of vegetation could be found in a period of months after the cleaning operation. When using a steam jet, the steam spray generally will spread to an area of 20 or even 50 feet in all directions around the tombstone. Nevertheless, the vegetation in this area does not become damaged.

The invention is hereby claimed as follows:

1. A liquid composition for cleaning tombstones in the presence of valuable vegetation which consists essentially of an aqueous mixture of orthophosphoric acid and ammonium bifluoride in a ratio of about 1.25 to 1.8 parts by weight of orthophosphoric acid to 1 part by weight of ammonium bifluoride and a small quantity of a water-soluble non-ionic surface active agent sufficient to provide an homogeneous aqueous mixture.

2. A liquid composition for cleaning tombstones in the presence of valuable vegetation which consists essentially of an aqueous mixture of orthophosphoric acid and ammonium bifluoride in a ratio of about 1.4 to 1.5 parts by weight of orthophosphoric acid to 1 part by weight of ammonium bifluoride and a small quantity of a water-soluble polyoxyethylated aliphatic hydrocarbon as a non-ionic surface active agent sufficient to provide an homogeneous aqueous mixture.

3. A liquid composition for cleaning tombstones in the presence of valuable vegetation which consists essentially of an homogeneous mixure of (*a*) a 75% aqueous solution of orthophosphoric acid, (*b*) ammonium

bifluoride, (*c*) water and (*d*) a water-soluble polyoxyalkylated aliphatic hydrocarbon as a non-ionic surface active agent, the ratio of (*a*) to (*b*) in parts by weight being about 1.5:1 to 2.5:1 and the ratio of (*c*) to (*a*) and (*b*) combined in parts by volume being about 20:1 to 30:1, the non-ionic surface active agent being present in a quantity sufficient to provide a stable homogeneous mixture.

4. A liquid composition for cleaning tombstones in the presence of valuable vegetation which consists essentially of an homogeneous mixture of (*a*) a 75% aqueous solution of orthophosphoric acid, (*b*) ammonium bifluoride, (*c*) water and (*d*) a water-soluble polyoxyalkylated aliphatic hydrocarbon as a non-ionic surface active agent, the ratio of (*a*) to (*b*) in parts by weight being about 1.85:1 to 2:1 and the ratio of (*c*) to (*a*) and (*b*) combined in parts by volume being approximately 25:1, the non-ionic surface active agent being present in a quantity sufficient to provide a stable homogeneous mixture.

5. A liquid composition as claimed in claim 4 wherein the non-ionic surface active agent is a polyoxyethylated tridecyl alcohol containing about 9 to 10 mols of ethylene oxide per mol of tridecyl alcohol.

6. A concentrated liquid composition for cleaning tombstones in the presence of valuable vegetation which consists essentially of an homogeneous mixture of about 63.6% by weight of a 75% aqueous solution of orthophosphoric acid, about 33% by weight of ammonium bifluoride and about 3.4% by weight of a polyoxyethylated tridecyl alcohol containing about 9 to 10 mols of ethylene oxide per mol of tridecyl alcohol.

7. An improved method of cleaning tombstones which avoids damaging valuable vegetation in the vicinity of said tombstones, said method comprising applying to a tombstone an aqueous mixture of orthophosphoric acid and ammonium bifluoride in a ratio of about 1.25 to 1.8 parts by weight of orthophosphoric acid to 1 part by weight of ammonium bifluoride, said mixture also containing a small quantity of a water-soluble non-ionic surface active agent sufficient to provide a stable honogeneous mixture and acting as a wetting agent on said tombstone.

8. An improved method of cleaning tombstones which avoids damaging valuable vegetation in the vicinity of said tombstones, said method comprising applying to a tombstone an aqueous mixture of orthophosphoric acid and ammonium bifluoride in a ratio of about 1.4 to 1.5 parts by weight of orthophosphoric acid to 1 part by weight of ammonium bifluoride, said mixture also containing a small quantity of a water-soluble polyoxyalkylated aliphatic hydrocarbon as a non-ionic surface active agent sufficient to provide a stable homogeneous mixture and acting as a wetting agent on said tombstone.

9. An improved method of cleaning tombstones which avoids damaging valuable vegetation in the vicinity of said tombstones, said method comprising applying to a tombstone an homogeneous aqueous mixture consisting essentially of (*a*) a 75% aqueous solution of orthophosphoric acid, (*b*) ammonium bifluoride, (*c*) water and (*d*) a water-soluble polyoxyalkylated aliphatic hydrocarbon as a non-ionic surface active agent, the ratio of (*a*) to (*b*) in parts by weight being about 1.5:1 to 2.5:1 and the ratio of (*c*) to (*a*) and (*b*) combined in parts by volume being about 20:1 to 30:1, the non-ionic surface active agent being present in a quantity sufficient to provide a stable homogeneous mixture and acting as a wetting agent on said tombstone.

10. An improved method of cleaning tombstones which avoids damaging valuable vegetation in the vicinity of said tombstones, said method comprising applying to a tombstone an homogeneous aqueous mixture consisting essentially of (*a*) a 75% aqueous solution of orthophosphoric acid, (*b*) ammonium bifluoride, (*c*) water and (*d*) a water-soluble polyoxyalkylated aliphatic hydrocarbon as a non-ionic surface active agent, the ratio of (*a*) to (*b*) in parts by weight being about 1.85:1 to 2:1 and the ratio of (*c*) to (*a*) and (*b*) combined in parts by volume being approximately 25:1, the non-ionic surface active agent being present in a quantity sufficient to provide a stable homogeneous mixture and acting as a wetting agent on said tombstone.

11. An improved method of cleaning tombstones as claimed in claim 10 wherein the non-ionic surface active agent is a polyoxyethylated tridecyl alcohol containing about 9 to 10 mols of ethylene oxide per mol of tridecyl alcohol.

12. An improved method of cleaning tombstones as claimed in claim 10 wherein the aqueous cleaning mixture is applied by incorporation in a hot wet steam jet directed against said tombstone.

13. An improved method of cleaning tombstones which avoids damaging valuable vegetation in the vicinity of said tombstones, said method comprising: directing against a tombstone adjacent to valuable vegetation a hot wet steam jet carrying an aqueous cleaning mixture consisting essentially of about 63.6% by weight of a 75% aqueous solution of orthophosphoric acid, about 33% by weight of ammonium bifluoride and about 3.4% by weight of a polyoxyethylated tridecyl alcohol containing about 9 to 10 mols of ethylene oxide per mol of tridecyl alcohol, said mixture being diluted with approximately 25 parts by volume of water per part by volume of the mixture; and subsequently rinsing said cleaning mixture from said tombstone with water.

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