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STABLE SOLVENT COMPOSITIONS

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This invention relates to chlorinated solvents, and particularly to new and highly effective stabilized solvent compositions composed of chlorinated hydrocarbons containing mixtures of stabilizing additives, said compositions being particularly suitable for the liquid and vapor phase degreasing of metals.

Chlorinated aliphatic hydrocarbons are useful as solvents for the degreasing of metals, for dry cleaning and for many other purposes. Such solvents are particularly useful in the degreasing of metals because of their low flammability and high solvency for oils and greases. Among the most widely used of these solvents are carbon tetrachloride, ethylene dichloride, trichloroethylene and perchloroethylene. Unfortunately, however, chlorinated aliphatic hydrocarbons in general attack and cause corrosion of metallic surfaces upon contact therewith. Such attacks, which also decompose the chlorinated aliphatic hydrocarbon, occur with surprising rapidity, especially at elevated temperatures.

A highly desirable chlorinated hydrocarbon is methyl chloroform, or 1,1,1-trichloroethane, which is known to have exceptionally good solvency powers and other highly desirable properties, particularly for metal cleaning operations. Unfortunately, however, this particular solvent also exhibits an aggravated tendency to decompose and concurrently attack metals, both at ambient or storage conditions, and at elevated temperatures suitable for cleaning operations.

While some stabilizing additives provide some degree of protection against decomposition of the chlorinated hydrocarbon solvents or against attack upon the metals themselves in liquid and vapor phase most do not provide sufficient protection for commercial use. Thus, even where a successful stabilizing additive has been found for particular chlorinated hydrocarbon solvent, the stabilized composition still may not meet the rigorous requirements of commercial applications. A commercially acceptable stabilizing additive, or stabilizing system of additives, for example, must also be capable of inhibiting against metal induced decomposition of the chlorinated hydrocarbon solvent under an array of plant conditions. One important situation is that wherein the solvent is exposed to iron under hydrolytic conditions. Often a stabilizer, otherwise acceptable commercially, fails to meet this stringent requirement because when a very small amount of water is accidentally introduced into the system severe corrosion of the metal and decomposition of the solvent results. Also, a stabilizing additive otherwise acceptable is often rejected by the trade because it adds color to the chlorinated hydrocarbon solvent. In addition, unavailability or excessive cost of the stabilizing additive is another factor which can influence the commercial acceptance of stabilizers.

Insofar as stabilizing 1,1,1-trichloroethane (methyl chloroform) is concerned, the problems are especially acute. From the standpoint of metal induced decomposition, 1,1,1-trichloroethane departs drastically from the norm of other chlorinated hydrocarbons. For example, metals, especially aluminum, will last for days or weeks without being attacked by ordinary chlorinated hydrocarbon solvents, but in the presence of 1,1,1-trichloroethane, however, aluminum is vigorously attacked and the 1,1,1-trichloroethane solvent reduced to a blackened

or charred mass within minutes. Further, as contrasted with the availability of stabilizers for ordinary chlorinated hydrocarbon solvents, only a few stabilizers are known which are reasonably effective in inhibiting 1,1,1-trichloroethane against such attack. Why these few stabilizers are effective is not known. The mere fact however that a stabilizer will inhibit decomposition of other chlorinated hydrocarbons does not mean that it will stabilize 1,1,1-trichloroethane.

The problem of stabilizing 1,1,1-trichloroethane in the vapor phase is especially acute because even a stabilizer which is useful for stabilization in the liquid phase is useless for stabilizing the vapor phase unless it has sufficient volatility to stabilize the vapor phase, and yet it cannot have such volatility as to unduly deplete the liquid phase.

It was heretofore discovered that dioxolane compounds when used alone are highly effective stabilizers for 1,1,1-trichloroethane. It has now been discovered that the inhibiting power of the dioxolane compound can be even further enhanced by the use of particular epoxide compounds. In addition, it has also been found that the inhibiting powers of dioxolane compounds can be yet further enhanced by the use of these dioxolane compounds in combination with exopide compounds and certain nitroaliphatic compounds. That these dioxolane compounds with epoxides or these dioxolane compounds with epoxides and nitroaliphatic compounds are capable of such inhibition is unexpected, particularly inasmuch as epoxides themselves are poor stabilizers for 1,1,1-trichloroethane. Thus, while the discovery of these dioxolane compounds as inhibitors for 1,1,1-trichloroethane has been of outstanding importance, dioxolane-1,1,1-trichloroethane systems nevertheless do have one shortcoming. The dioxolane-1,1,1-trichloroethane compositions thus leave something to be desierd when hydrolytic conditions occur and these compositions are in contact with iron, particularly certain forms of iron under extended hydrolytic conditions. Thus, the iron in contact with dioxolane-1,1,1-trichloroethane compositions thus undergoes significant corrosion when hydrolytic conditions occur. However, corrosion of iron under hydrolytic conditions is considerably and significantly reduced pursuant to the present invention which utilizes dioxolane-epoxide combinations of additives, and also dioxolane-epoxide-nitroaliphatic mixtures of additives with 1,1,1-trichloroethane.

An object of this invention is thus to provide stabilized compositions which are highly effective for degreasing aluminum, iron and other metals. A particular object is to provide 1,1,1-trichloroethane solvent compositions which retain chemical passivity during repeated cycles of exposure to metals at processing conditions, and against the degradation influences of moisture, elevated temperature, contact with various metals and metal halides, and light. Another object is to provide compositions especially suitable for the vapor phase degreasing of aluminum, iron and other metals. A further object is to provide additive compositions especially adapted for use in 1,1,1-trichloroethane as stabilizers therefor.

These and other objects are achieved according to the present invention by the provision of a stable 1,1,1-trichloroethane solvent composition of 1,1,1-trichloroethane containing dissolved therein a novel stabilizing mixture of additives in a quantity sufficient to inhibit the 1,1,1-trichloroethane against decomposition. The stabilizing mixture is one consisting essentially of a dioxolane, and an epoxide compound. On the basis of outstanding effectiveness and low cost the preferred class of stabilizer additives are those wherein the dioxolane compound is a

1,3-dioxolane compound containing up to two alkyl substituents each having from one to two carbon atoms, and the epoxide is a compound containing from about three to about four carbon atoms and having up to one chlorine atom. In an especially preferred embodiment of this invention to the stabilizing mixtures of dioxolane and epoxide compounds is included a third component, namely a nitroaliphatic compound and preferably one containing up to three carbon atoms in the molecule. These two and three component mixtures of stabilizing additives added to 1,1,1-trichloroethane form compositions having superb properties particularly in their ability to resist decomposition in the presence of iron under severe hydrolytic conditions, even in the vapor phase.

In yet another especially preferred embodiment of this invention the dioxolane and epoxide compounds are blended together to form bicomponent mixtures of additives concentrates or corrosion inhibitor compositions. These compositions form homogenous and essentially colorless solutions which can be rapidly and conveniently added to 1,1,1-trichloroethane in all desired proportions. The inhibited 1,1,1-trichloroethane compositions thus formed are highly resistant both to decomposition of the solvent and to corrosion of the metal with which the solvents are placed in contact. In particular, these additive concentrates when blended with 1,1,1-trichloroethane form highly useful compositions for degreasing the surfaces of metals.

A three component mixture of dioxolane, epoxide and nitroaliphatic compounds can also be blended together to form a corrosion inhibitor composition for 1,1,1-trichloroethane which is even better than the bicomponent corrosion inhibitor compositions formed of dioxolanes and epoxides. These tricomponent corrosion inhibitor compositions are especially effective from a cost-effectiveness standpoint. Accordingly another preferred embodiment of this invention is that of degreasing a metal by contacting the surfaces of the metal with 1,1,1-trichloroethane while maintaining bicomponent mixtures of dioxolane and epoxide compounds and also tricomponent mixtures of dioxolane, epoxide and nitroaliphatic compounds dissolved within the 1,1,1-trichloroethane in sufficient quantity to inhibit the 1,1,1-trichloroethane against decomposition.

In accordance with the practice of this invention, when a bicomponent mixture of stabilizing additives is employed in 1,1,1-trichloroethane there is provided an additive concentrate composed of a mixture of from about 10 percent to about 95 percent by weight of a dioxolane compound, and the balance of the additive concentrate consists essentially of an epoxide compound. A particular preferred bicomponent corrosion inhibitor composition is one composed of about 50 to about 95 weight percent of a dioxolane compound, and from about 5 to about 50 weight percent of an epoxide compound. This particular composition is particularly preferred because it provides especially high stabilizing benefits for 1,1,1-trichloroethane under general commercial degreasing conditions and is also available at low cost. When a tricomponent mixture of the stabilizing additives is employed in 1,1,1-trichloroethane, the tricomponent mixtures being even superior to the bicomponent mixtures, there is provided an additive concentrate of from about 10 weight percent to about 80 weight percent of a dioxolane compound, from about 10 weights percent to about 80 weight perecnt of a nitroaliphatic compound, the balance of the tricomponent mixture consisting essentially of from about 10 weight percent to about 60 weight percent of an epoxide compound. A particularly preferred tricomponent composition is one consisting essentially of from about 30 to about 60 weight percent of a dioxolane compound, from about 30 to about 60 weight percent of a nitroaliphatic compound, and from about 5 to about 40 weight percent of an epoxide compound.

These additive concentrates, or inhibiting compositions consisting essentially of mixtures of dioxolane and epoxide compounds, or of dioxolane, epoxide and nitroaliphatic compounds, when added to chlorinated hydrocarbon solvents, even in very minor quantities, form highly stable solvent compositions, which are highly beneficial for liquid and vapor degreasing of metals in general, especially iron, copper, aluminum, zinc, as well as their alloys. Not only are each of the dioxolane and nitroaliphatic components of the inhibiting compositions in themselves beneficial as stabilizers but surprisingly the dioxolane-epoxide stabilizer pair or the dioxolane-epoxide-nitroaliphatic mixture of compounds produce far greater benefits than can be attributed to the use of dioxolane alone or the predicted cumulative beneficial effects of a mixture of a dioxolane and an epoxide, or a mixture of dioxolane, an epoxide, and a nitroaliphatic compound. In other words, a multifold benefit beyond that which would be expected or predicted is obtained by the novel stabilizing mixtures. An especially highly preferred stabilized composition of this type is 1,1,1-trichloroethane containing an inhibiting amount of a stabilizing mixture consisting essentially of 1,3-dioxolane, epichlorohydrin, and nitromethane. The sum total weight of the mixture of corrosion inhibitor compositions used in any given chlorinated hydrocarbon solvent should be between about 0.3 and 12 weight percent of the solvent composition employed. Good results can be obtained when from about 2 to about 5 percent by weight of bicomponent and tricomponent mixtures of the stabilizers are present in the chlorinated hydrocarbon solvent. Preferably, a weight concentration of the stabilizing mixture of components is from about 3 to about 4 percent of the weight of the solvent employed. A particularly excellent 1,1,1-trichloroethane composition for greater cost-effectiveness is formed by adding to the 1,1,1-trichloroethane about 2.3 percent by weight 1,3-dioxolane, 0.8 percent by weight nitromethane, and about 0.2 percent by weight epichlorohydrin.

The following representative experimental data will serve toward a more complete understanding of the present invention. In the example immediately following tared strips of polished iron metal, and also strips of aluminum metal, were immersed within 1,1,1-trichloroethane stabilized with 1,3-dioxolane. These compositions were contained within closed glass flasks, each flask containing 1 mol of the stabilized 1,1,1-trichloroethane composition and in addition a small amount of water. The flasks were heated over a considerable period of time, and the compositions therefore subjected to quite severe hydrolytic conditions in the presence of iron.

All parts are in weight units except as otherwise specified.

EXAMPLE I

To each of four glass flasks (see Table I below) was added 1 mol of 1,1,1-trichloroethane and a sufficient quantity of water to form a 0.5 volume percent mixture of water in 1,1,1-trichloroethane. To the contents of two of these flasks (Flasks 2 and 3) was then dissolved a sufficient quantity of epichlorohydrin to form a 0.8 weight percent solution of epichlorohydrin in 1,1,1-trichloroethane. To one of these flasks (Flask 3) containing the epichlorohydrin was then added a sufficient quantity of nitromethane to form a 0.5 weight percent solution of nitromethane in 1,1,1-trichloroethane. To another flask (Flask 4) was then added sufficient quantities of 1,3-dioxolane and nitromethane to form a 2.3 weight percent solution of dioxolane, and a 0.5 weight percent solution of nitromethane in 1,1,1-trichloroethane. Tared strips of iron were then totally immersed within the contents of each of the four flasks. Each of the flasks was then sealed and placed in an oven, heated and maintained at a temperature of 100° C. for a period of 17 hours. At the end of this time, the flasks were removed from the oven, unsealed and the tared strips of iron removed, dried, and reweighed.

The tabulated data of Table I below shows the weight percent loss of iron which was found upon reweighing of each of the iron metal strips.

Table I

Flask No.	Stabilizing Additive (or Additives)	Weight Percent Loss of Iron
1	1,3-dioxolane	5.0
2	1,3-dioxolane plus epichlorohydrin	1.0
3	1,3-dioxolane plus nitromethane plus epichlorohydrin	0.63
4	1,3-dioxolane plus nitromethane	1.6

Thus, it is seen by the foregoing series of data in Table I that the epoxide compound coacts with the dioxolane compound to provide an improvement of 5-fold over the use of dioxolane alone for stabilization of 1,1,1-trichloroethane. Further, the use of a small amount of epichlorohydrin with the dioxolane and nitromethane mixture provides an improvement of approximately 8-fold over the use of dioxolane compound alone employed for stabilization of 1,1,1-trichloroethane. It is also apparent that the epoxide, dioxolane, and nitromethane mixture also provides advantages over even the combination of a mixture of dioxolane-nitroaliphatic compounds. Thus, the addition of a small amount of epichlorohydrin to a 1,3-dioxolane-nitromethane mixture provides an approximately 2.5-fold improvement over the use of the two components alone in 1,1,1-trichloroethane.

The following examples demonstrate a variety of corrosion inhibitor compositions which are preferred embodiments of the present invention to be used in stabilizing 1,1,1-trichloroethane in amounts between about 0.3 to 12 weight percent. The various tricomponent corrosion inhibitor compositions and the weight percent of each component within the respective corrosion inhibitor composition is as shown in Table II.

Table II

Ex.	Dioxolane Compound	Nitroaliphatic Compound	Epoxide Compound
II	10 percent 5-methyl-1,3-dioxolane	80 percent nitroethylene	10 percent epihydrin.
III	30 percent 4-methyl-1,3-dioxolane	50 percent nitroacetylene	20 percent 3,4-epoxybutane.
IV	50 percent 2,2-dimethyl-1,3-dioxolane	20 percent 1-nitropropane	30 percent 1,3-epoxypropane.
V	30 percent 2-ethyl-1,3-dioxolane	10 percent 1-nitro-2-propene	60 percent 2-chloro-3,4-epoxybutane.
VI	40 percent 4-methyl-1,3-dioxolane	20 percent 2-nitropropane	40 percent 1-chloro-2,3-epoxybutane.
VII	40 percent 4-ethyl-1,3-dioxolane	10 percent 2-nitro-1-propene	50 percent 1-chloro-2,3-epoxybutane.
VIII	60 percent 5,5-dimethyl-1,3-dioxolane	30 percent 2-nitro-1-propyne	10 percent 1-chloro-3,4-epoxybutane.
IX	80 percent 5-methyl-5-ethyl-1,3-dioxolane.	10 percent nitroethane	10 percent 2-chloro-3,4-epoxybutane.
X	20 percent 1,3-dioxolane	60 percent nitromethane	20 percent 2-chloro-3,4-epoxybutane.
XI	40 percent 5,5-diethyl-1,3-dioxolane	40 percent nitropropane	20 percent 3,4-epoxybutane.

The stabilizing mixtures, or corrosion inhibitor compositions, shown in Examples II through XI are added to 1,1,1-trichloroethane to form stabilized 1,1,1-trichloroethane compositions. The corrosion inhibitor compositions are added to the 1,1,1-trichloroethane in amount sufficient to form 0.3, 0.5, 1, 2, 4, 5, 6 10, and 12 weight percent compositions of a stabilizing mixture in 1,1,1-trichloroethane.

Example I is then repeated with each of these stabilized 1,1,1-trichloroethane compositions. As in Example I, the

solvents show little or no signs of decomposition. The metals also show little or no signs of significant chemical attack.

The following Table III shows various bicomponent systems of highly preferred additive concentrates consisting of dioxolane and epoxide compounds. These systems of additive concentrates also provide superior and significant results in stabilization of 1,1,1-trichloroethane, particularly in the presence of iron under hydrolytic conditions.

Table III

Ex.	Dioxolane Compound	Epoxide Compound
XII	10 percent 1,3-dioxolane	90 percent 1-chloro-2,3-epoxybutane.
XIII	20 percent 2-methyl-1,3-dioxolane	80 percent 1-chloro-3,4-epoxybutane.
XIV	30 percent 2-ethyl-1,3-dioxolane	70 percent 1-chloro-3,4-epoxybutane.
XV	40 percent 2-methyl-2-ethyl-1,3-dioxolane	60 percent 2-chloro-3,4-epoxybutane.
XVI	50 percent 2,2-dimethyl-1,3-dioxolane	50 percent 1-chloro-3,4-epoxybutane.
XVII	60 percent 2,2-diethyl-1,3-dioxolane	40 percent 1-chloro-2,3-epoxybutane.
XVIII	70 percent 4-methyl-1,3-dioxolane	30 percent 2-chloro-3,4-epoxybutane.
XIX	80 percent 5-ethyl-1,3-dioxolane	20 percent epihydrin.
XX	90 percent 1,3-dioxolane	10 percent 1,3-epoxypropane.
XXI	95 percent 1,3-dioxolane	5 percent 3,4-epoxybutane.

The corrosion inhibitor compositions of Examples XII through XXI (Table III) are added to 1,1,1-trichloroethane in sufficient quantity to form 0.3, 0.5, 1, 2, 4, 5, 6, 10 and 12 weight percent compositions of the stabilizing mixtures in 1,1,1-trichloroethane. Example I is then repeated with each of these compositions. As in Example I, the solvent compositions show little or no signs of decomposition and the metals are not significantly attacked.

The corrosion inhibitor compositions of Examples II through XI and Examples XII through respectively are added to 1,1,2-trichloroethane, carbon tetrachloride, ethylene dichloride, 1,1,2-trichloroethylene and perchloroethylene respectively, in sufficient quantities to form 0.3, 0.5, 1, 2, 4, 5, 10, and 12 weight percent compositions of the stabilizing mixtures in each of the respective hydrocarbon solvents. The procedure described in Example I is then again repeated with each of these compositions. In each instance, the solvent compositions show little or no signs of decomposition and the metals are essentially unattacked.

As indicated above, stabilized liquid compositions of the present invention show little or no tendency to attack metals even at boiling conditions. The stabilized liquid can be stored for considerable periods of time, usually for months, in contact with aluminum, iron, copper, zinc, and various other metals, or alloys thereof, without significant decomposition. Also vapors evolved from many of the stabilized liquid compositions show no tendency to attack metals. This makes many of the present solvent compositions highly effective for vapor phase degreasing operations.

For vapors degreasing applications, it is essential that the 1,1,1-trichloroethane composition be not only stable in the liquid state but also that it be susceptible to vaporiz-

ing and condensing with full retention of stability. This can be accomplished if an inhibitor has suffiicent volatility to be carried into the vapor space in sufficient quantities to stabilize the latter without unduly depleting the liquid phase. In the instant case the stabilizer compositions described herein provide excellent vapor phase inhibitors from the standpoint of volatility because the concentration of the additives in the vapor phase is very high in relation to their concentration in the liquid phase over a considerable concentration range, beyond the concentration thereof in a chlorinated hydrocarbon solvent necessary for effective stabilization. However, the volatility of the stabilizing additives is not so great as to be exhausted from the 1,1,1-trichloroethane system too rapidly, and therefore the stable solvent compositions can be used through many cycles without the necessity of adding fresh supplies of additives.

As was stated, a wide variety of dioxolane and epoxide compounds are suitable for the practice of this invention. Preferred dioxolane compounds are the 1,3-dioxolanes containing up to two alkyl substituents each having from one to two carbon atoms, and the preferred epoxide compounds are those containing from about three to about four carbon atoms and having up to one chlorine atom. Preferred nitroaliphatic compounds are those having not more than about three carbon atoms.

Nonlimiting examples of the highly preferred dioxolane compounds suitable to the practice of this invention include

1,3-dioxolane,
2-methyl-1,3-dioxolane,
4-methyl-1,3-dioxolane,
5-methyl-1,3-dioxolane,
2-ethyl-1,3-dioxolane,
4-ethyl-1,3-dioxolane,
5-ethyl-1,3-dioxolane,
2,2-dimethyl-1,3-dioxolane,
4,4-dimethyl-1,3-dioxolane,
5,5-dimethyl-1,3-dioxolane,
2,4-dimethyl-1,3-dioxolane,
2,5-dimethyl-1,3-dioxolane,
2,2-diethyl-1,3-dioxolane,
4,4-diethyl-1,3-dioxolane,
5,5-diethyl-1,3-dioxolane,
2,4-diethyl-1,3-dioxolane,
2,5-diethyl-1,3-dioxolane,
2-methyl-2-ethyl-1,3-dioxolane,
2-methyl-4-ethyl-1,3-dioxolane,
2-methyl-5-ethyl-1,3-dioxolane,
2-ethyl-4-methyl-1,3-dioxolane,
2-ethyl-5-methyl-1,3-dioxolane
and the like.

Nonlimiting examples of epoxides are such epoxides as epichlorohydrin,
2-chloro-3,4-epoxybutane,
1-chloro-2,3-epoxybutane,
1-chloro-2,4-epoxybutane,
1-chloro-3,4-epoxybutane,
2-chloro-3,4-epoxybutane,
1-chloro-2,4-epoxybutane,
epihydrin,
1,3-epoxypropane,
3,4-epoxybutane,
1,3-epoxybutane,
1,4-epoxybutane,
2,3-epoxybutane,
and the like.

Nonlimiting examples of nitroaliphatic compounds employed pursuant to the practice of this invention include nitroethylene, nitroacetylene, 1-nitropropane, 1-nitro-2-propane, 2-nitro-1-propene, 2-nitropropane, 2-nitro-1-propene, nitroethane, nitromethane, 1-nitropropane, 2-nitropropane, 2-nitro-1-propene, nitroacetylene and the like.

For vapor degreasing the most preferred of the dioxolane, epoxide, and nitroaliphatic compounds are those boiling within a range of from about 50° C. to about 120° C. and preferably from about 65° C. to about 85° C.

It will be understood that certain minor modifications may be made in the invention without departing from the spirit and scope thereof. For example, it will be understaood that the term "metal" as used in this specification includes all metals less active in the presence of chlorinated hydrocarbon solvents than aluminum, iron, copper, zinc, and alloys of these metals. Since the corrosion inhibitor compositions employed pursuant to the practice of this invention protects 1,1,1-trichloroethane against these extremely active metals, they will afford even greater protection against corrosion by 1,1,1-trichloroethane against these less active metals. Further, since these corrosion inhibitor compositions will protect 1,1,1-trichloroethane against metal induced decomposition, they will even more so protect ordinary chlorinated hydrocarbon solvents which are not as difficult to stabilize against metal induced decomposition as 1,1,1-trichloroethane. In addition, while specific ranges of additive concentrates—viz., from about 0.3 to about 12 weight percent—can be added to effectively stabilize chlorinated hydrocarbon solvents, amounts below and above this range of concentrations can be employed to provide some stabilizing benefits, and therefore all that is essential within the spirit and scope of the appended claims is that these additive concentrates be present in sufficient quantity to inhibit the 1,1,1-trichloroethane against metal induced decomposition.

Having described the invention what is claimed is:

1. A stable solvent composition consisting essentially of 1,1,1-trichloroethane containing from about 0.3 to about 12 weight percent of a mixture consisting essentially of from about 10 to about 80 weight percent of a dioxolane compound, from about 10 to about 60 weight percent of an epoxide compound, and from about 10 to about 80 weight percent of a nitroaliphatic compound dissolved therein, sufficient to inhibit the 1,1,1-trichloroethane against decomposition, said dioxolane compound being a 1,3-dioxolane compound containing up to 2 alkyl substituents each having from 1 to 2 carbon atoms, said epoxide being a compound containing from about 3 to about 4 carbon atoms and up to 1 chlorine atom, and said nitroaliphatic compound having not more than 3 carbon atoms.

2. The composition of claim **1** wherein the dioxolane compound is 1,3-dioxolane.

3. The composition of claim **1** wherein the epoxide compound is epichlorohydrin.

4. The composition of claim **1** wherein the nitroaliphatic compound is nitromethane.

5. The composition of claim **1** wherein the dioxolane is 1,3-dioxolane, the epoxide compound is epichlorohydrin and the nitroaliphatic compound is nitromethane.

6. A stable solvent composition consisting essentially of 1,1,1-trichloroethane containing from about 2 to about 5 weight percent of a mixture consisting essentially of from about 30 to about 60 weight percent a 1,3-dioxolane compound, from about 30 to about 60 weight percent of nitromethane, and from about 5 to about 40 weight percent an epoxide compound dissolved therein, sufficient to inhibit the 1,1,1-trichloroethane against decomposition, said 1,3-dioxolane compound containing up to 2 alkyl substituents each having from 1 to 2 carbon atoms, and said epoxide being a compound containing from about 3 to about 4 carbon atoms and up to 1 chlorine atom.

7. The composition of claim **6** wherein said epoxide is epichlorohydrin.

8. The composition of claim **6** wherein said 1,3-dioxolane compound is 1,3-dioxolane and said epoxide compound is epichlorohydrin.

9. A stable solvent composition consisting essentially of 1,1,1-trichloroethane containing about 2,3 weight per-

cent of 1,3-dioxolane, about 0.8 weight percent of nitromethane and about 0.2 weight percent of epichlorohydrin.

References Cited by the Examiner

UNITED STATES PATENTS

2,321,967	6/1943	Arundale	252—364 XR
2,852,471	1/1958	Atkins et al.	252—171
2,870,094	1/1959	Cathcart	252—171
2,904,600	9/1959	Copelin	260—652.5
2,923,747	2/1960	Rapp	260—652.5
2,970,113	1/1961	Bachtel	252—171
2,993,007	7/1961	Anderson et al.	252—392
3,008,999	11/1961	Kauder	260—652.5
3,061,553	10/1962	Riggs	252—392
3,113,156	12/1963	Sims	260—652.5

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