United States Patent Office 3,472,626
Patented Oct. 14, 1969

3,472,626

TEST COMPOSITION AND PROCESS FOR DETECTING ORGANIC POLYHALOGEN COMPOUNDS

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No Drawing. Filed Jan. 10, 1966, Ser. No. 519,437
Claims priority, application Great Britain, Oct. 28, 1965, 45,700/65
Int. Cl. G01n 31/22, 31/00
U.S. Cl. 23—230 9 Claims

ABSTRACT OF THE DISCLOSURE

Method and solid composition for detecting certain organic polyhalogen compounds in aqueous fluids consisting of the utilization of a test system comprising a solid acid addition salt of pyridine such as pyridine citrate or pyridine tartrate and a solid caustic material such as caustic soda or caustic potash.

This invention relates to a method for the detection in aqueous liquids, of organic compounds containing chlorine, bromine or iodine, and to compositions useful in such a method. The term "halogen" is used herein to refer collectively to chlorine, bromine and iodine.

The detection of bound halogen in aqueous liquids such as urine is frequently of clinical importance. For example, workers who are habitually exposed to chlorinated solvents, such as those used as dry cleaning agents, paint removers, refrigerants, fire extinguishers, fumigants, anesthetics, and anthelmintics, are liable to absorb them in toxic quantity, and it is, therefore, important to be able to know when this has happened, e.g., by detecting the presence of such chlorinated compounds, or their metabolic produces, in the urine of such workers. For example,, trichloroethylene is widely used as a dry-cleaning solvent, and cases of poisoning with this compound have been reported. It is excreted as trichloroacetic acid in the urine, and a convenient method for the detection of the latter substance in urine is consequently desirable.

It is known that a red color is formed when halogenated organic compounds such as chloroform, bromoform, or iodoform are heated with pyridine and caustic alkali in aqueous medium, and this color reaction has been used for the detection of polyhalogen compounds including trichloroacetic acid. The test is applicable to a wide variety of organic compounds containing two or more halogen atoms joined to a single carbon atom and which in the presence of alkali are degraded to a reactive carbene species, e.g., as follows:

$$Cl_3CH + OH \rightleftharpoons Cl_3C^- + H_2O$$
$$Cl_3C^- \longrightarrow :CCl_2 + Cl^-$$

While this test is effective, it has heretofore always required the use of liquid reagents and the application of external heat.

A simple method has now been discovered, using only solid reagents and for which no external source of heat is necessary, by which it is possible to detect the presence of halogen-containing compounds of the aforesaid type in aqueous liquids containing them. According to the present invention, a method for detecting the presence, in an aqueous liquid, of an organic halogen-containing compound comprises adding, to a predetermined quantity of the said liquid, a solid, preferably non-hygroscopic, acid addition salt of a pyridine base unsubstituted in the 2- and 4-positions, and either solid caustic soda or solid caustic potash, the weights and weight ratio of the said alkali and acid addition salt being such that on admixture with the aforesaid predetermined quantity of aqueous liquid,

the mixture heats spontaneously to at least about 80° C. and a liquid pyridine base separates as a supernatant layer.

It is apparent that the color produced is proportional to the amount of polyhalogen present and by the expediency of proper color standards, a quantitative as well as quanlitative test method may be achieved.

The invention also provides, solid anhydrous compositions for use in the aforesaid method.

In the new method, when the solid caustic alkali and the solid pyridine salt are added to the aqueous liquid being tested, the alkali liberates the free pyridine base from the salt, and the heat of dissolution of the alkali in water, together with the heat of neutralization of any free acid groups which may be present, causes the mixture to heat up. Since pyridine bases are not very soluble in concentrated caustic alkali solution, the base liberated floats on the surface of the aqueous liquid and is colored red if any appropriate halogen-containing compound is present in the aqueous liquid. Immediately after addition of the solid reagents, the mixture is shaken, e.g., for about half a minute, to promote dissolution of the solid reagents and then allowed to stand. It is possible to devise formulations which, when added to a predetermined amount of aqueous liquid, cause the liquid to boil, thus obviating any need for shaking. A positive test should be apparent in not more than 5 minutes.

Sodium hydroxide is preferred to potassium hydroxide as it causes, weight for weight, a greater liberation of heat. The preferred pyridine base is pyridine itself, and the preferred non-hygroscopic pyridine salt is pyridine citrate or tartrate, though other acid addition salts of pyridine, e.g., pyridine oxalate, malonate, sulphosalicylate, maleate, fumarate, ketomalonate, sulphamate, phosphate, and hydrochloride, can be used if desired. The phosphate and hydrochloride being hygroscopic are not preferred but can be used if desired. It will be understood, however, that the presence of hygroscopic salts in the compositions of the invention gives rise to storage problems. Salts with acids which form very insoluble sodium salts under the conditions of the test should be avoided, e.g., p-toluene-sulphonates, as the sodium salts of such acids separate so quickly from the strongly alkaline solution that the dissolution of the reactants is inhibited. Substituted pyridine salts which have been found effective in the present invention include 3-methyl pyridine, 3-benzyl pyridine, 3,5-dibenzyl pyridine and the like.

It is especially convenient to compress a mixture of the solid caustic soda or potash and the solid pyridine salt into tablets each containing the correct quantity of reagent for use with a suitable small, predetermined, quantity of the aqueous liquid to be tested. For example, tablets may be made up weighing ½ to 1 gram each, suitable for reaction with ¼ to 1 cubic centimeter of urine. In the solid composition, the amount of caustic alkali must, of course, be more than sufficient to neutralize the acid in the pyridine salt and give a distinctly alkaline mixture. Generally, an amount of caustic alkali at least 50% greater than that necessary to neutralize the acid in the pyridine salt will be used, i.e., at least 1½ moles of caustic present for each mole of pyridine salt. The determination of appropriate quantities of the caustic alkali and the pyridine salt for use in connection with a predetermined amount of aqueous liquid, e.g., 0.5 cc., presents no difficulty and can readily be carried out by routine experiment. Thus a solution in water or the type of aqueous liquid for which the test method is likely to be employed, e.g., urine, of trichloroacetic acid or other substance known to react strongly in the test is prepared, suitably in a concentration of 15 mg. percent. To, e.g., 0.5 cc. of this solution, varying amounts of the solid reagents, e.g.,

pyridine citrate and caustic soda, are added and the mixture shaken and then allowed to stand, until a combination is formed which gives a strongly colored upper supernatant layer. Generally for 0.5 cc. of test liquid, the appropriate amount of caustic soda will be 0.25 to 0.5 g. and the appropriate amount of pyridine salt about 0.3 to 0.5 g. The use of larger proportions of solid reagents than this is liable to cause semi-solid mixtures to be formed in which color formation may be hard to detect. Smaller proportions, on the other hand, may give inadequate heating of the mixture so that no color formation occurs. However, as already stated, appropriate proportions can readily be determined by routine experiment.

When the solid compositions are made up in tablet form, they may conveniently contain, in addition to the pyridine salt and caustic alkali, additional substances to act as binding agents and/or disintegrating agents. Such substances include citric acid, tartaric acid, boric acid, potassium peroxosulphate, and polyethylene glycol, e.g., of molecular weight greater than about 4000.

In use, such solid compositions are added to the aqueous liquid under test, and the mixture is allowed to stand (without shaking if the mixture boils spontaneously) for from ½ to 5 minutes, generally about 1 minute. If the aqueous liquid contains an appropriate halogen-containing compound, a pink or red color develops in the supernatant pyridine layer. It has been found that the new method can give a readily detectable red color with concentrations of trichloroacetic acid as low as 0.004% by weight. As already made clear, it is important not to use too much or too little of the aqueous liquid under test in relation to the amount of caustic alkali and pyridine salt added.

A suitable composition in accordance with the invention is as follows:

	Parts by weight
Pyridine citrate	349
Caustic soda	279
Potassium peroxosulphate	43
Citric acid	19.1
Polyethylene glycol M. W. 6000	9.6

A tablet weighing about 0.7 g., made in the conventional manner from the above ingredients in the indicated weight ratios has been found to work satisfactorily. The citric acid may be replaced by tartaric acid, and the polyethylene glycol by boric acid or magnesium trisilicate. One such tablet is suitable for the treatment of about 0.5 ml. of aqueous liquid. The tablet is added to the aqueous liquid and the mixture allowed to stand. Ordinarily color will develop for a positive reaction in one-half to one minute, but it is advisable to allow the mixture to stand for five minutes if no red or orange color is produced, to ensure that the test is negative.

The present invention will be further illustrated but not limited by the following examples:

EXAMPLE 1

One-half (0.5) ml. of a urine sample containing 15 mg. trichloroacetic acid per 100 ml. urine was placed in a test tube and about 0.7 g. of pyridine citrate added thereto. About 0.5 g. (5 pellets) of sodium hydroxide (caustic soda) was then added and the tube gently shaken. Heat evolved immediately and in about 15 seconds a color started to develop. The tube was then allowed to stand and settle for about 30 seconds during which time a red-purple pyridine layer separated and floated on top of the test solutions. The color remained substantially unchanged overnight.

EXAMPLE 2

A test was carried out in the manner described in Example 1 with the exception that pyridine hydrochloride was substituted for pyridine citrate. Because of the hygroscopic nature of the pyridine salt used the composition was prepared immediately prior to use. A clear red-purple color appeared in the supernatant pyridine layer as in Example 1.

EXAMPLE 3

A test was carried out as in Example 1 with the exception that pyridine oxalate was substituted for pyridine citrate. A cloudy but perceptible red-purple color appeared in the supernatant pyridine layer as in Example 1.

EXAMPLE 4

A test was carried out as in Example 1 with the exception that 0.5 g. of pyridine tartrate and 0.4 g. of sodium hydroxide pellets were used in place of the 0.7 g. pyridine citrate and the 0.5 g. sodium hydroxide. The mixture was shaken for 60 seconds and after settling for 180 seconds a clear red supernatant pyridine layer formed in the tube.

EXAMPLE 5

A test was carried out as in Example 1 except that 0.5 g. of pyridine citrate and 0.9 g. of potassium hydroxide (caustic potash) were used in place of the 0.7 g. pyridine citrate and the 0.5 g. sodium hydroxide. The tube was shaken for 30 seconds and after settling for 3 minutes a clear brownish-red supernatant pyridine layer formed in the tube.

EXAMPLE 6

A test was carried out as in Example 1 except that 3-methyl pyridine citrate was used in place of the unsubstituted pyridine citrate. The color yield was equivalent to that achieved in Example 1.

EXAMPLE 7

A test was carried out as in Example 4 except that ground (powdered) sodium hydroxide was used in place of the pellets. After settling for 60 seconds a positive red supernatant pyridine layer formed in the tube.

EXAMPLES 8–15

In the following examples, the tests were carried out substantially as in Example 1 with the exception that 0.5 g. of pyridine citrate and 0.4 g. of sodium hydroxide were used in place of the 0.7 g. pyridine citrate and the 0.5 g. sodium hydroxide. Table 1 gives the polyhalogen being tested for, the concentration thereof in a water solution and the resultant response color of the supernatant pyridine layer.

TABLE 1

Example	Polyhalogen detected	Conc. (mg. percent)	Response color
8	2,2'-dichloropropionic acid	14.0	Pale pink.
9	Chloral hydrate	23.2	Red.
10	Chloroform	(1)	Red.
11	Carbon tetrachloride	(2)	Red.
12	Bromoform	(2)	Red.
13	Trichloroacetonitrile	(2)	Red.
14	Chloramphenicol	20	Red-brown.
15	Iodoform	(3)	Do.

[1] One drop of the polyhalogen added to ½ ml. water.
[2] Saturated aqueous solution.
[3] One crystal of the polyhalogen added to ½ ml. water.

What is claimed is:

1. A test composition for the detection, in an aqueous liquid, of an organic polyhalogen compound capable of forming a reactive carbene species which comprises a solid acid addition salt of a pyridine base unsubstituted in the 2- and 4-positions and at least 1½ moles of a substance selected from the group consisting of solid caustic soda and solid caustic potash for each mole of pyridine salt.

2. A test composition as in claim 1 wherein the solid acid addition salt of the pyridine base is selected from the group consisting of pyridine citrate, pyridine tartrate, pyridine oxalate, pyridine malonate, pyridine sulfosalicylate, pyridine maleate, pyridine fumarate, pyridine ketomalonate, pyridine sulfamate, pyridine phosphate and pyridine hydrochloride.

3. A test composition as in claim 1 wherein the solid acid addition salt of the pyridine base is pyridine citrate.

4. A test composition as in claim 1 wherein the solid acid addition salt of the pyridine base is pyridine tartrate.

5. A test composition as in claim 1 wherein the solid acid addition salt of the pyridine base is pyridine citrate and the caustic is caustic soda.

6. A test composition as in claim 1 wherein the polyhalogen compound is trichloroacetic acid.

7. A test composition as in claim 1 in the form of a compressed tablet.

8. A process as in claim 7 wherein the solid acid addition salt of pyridine is pyridine citrate and the caustic is caustic soda.

9. A process for detecting, in an aqueous liquid, an organic polyhalogen compound capable of forming a reactive carbene species which comprises adding to said aqueous liquid a test composition comprising a solid acid addition salt of a pyridine base unsubstituted in the 2- and 4-positions and a substance selected from the group consisting of solid caustic soda and solid caustic potash, said

caustic present in a quantity and form such that said aqueous liquid is heated to at least 80° C., whereby a liquid supernatant pyridine layer forms and observing the color formed in said supernatant pyridine layer.

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U.S. Cl. X.R.

23—253; 252—408