標準色の調製は同時に行う．

発生瓶 A に検液をとり，必要ならば少量の水で洗い込む．これにメチルオレンジ試液1滴を加え，アンモニア試液，アンモニア水 (28) 又は希塩酸を用いて中和した後，薄めた塩酸 (1→2) 5 mL 及びヨウ化カリウム試液5 mL を加え，2～3分間放置した後，更に酸性塩化スズ (II) 試液5 mL を加え，室温で 10 分間放置する．次に水を加えて 40 mL とし，ヒ素分析用亜鉛2 g を加え，直ちに B 及び C を連結したゴム栓 H を発生瓶 A に付ける．C の細管部の端はあらかじめヒ化水素吸収液5 mL を入れた吸収管 D の底に達するように入れておく．次に発生瓶 A は 25 °C の水中に肩まで浸し，1時間放置する．吸収管をはずし，必要ならばピリジンを加えて5 mL とし，吸収液の色を観察する．この色は標準色より濃くない．

標準色の調製　発生瓶 A にヒ素標準液 2 mL を正確に加え，更に薄めた塩酸 (1 → 2) 5 mL 及びヨウ化カリウム試液 5 mL を加えて 2 ～ 3 分間放置した後，酸性塩化スズ (II) 試液 5 mL を加え，室温で 10 分間放置する．以下前記と同様に操作して得た吸収液の呈色を標準色とする．この色は三酸化二ヒ素 ($As_2O_3$) 2 μg に対応する．

注意：試験に用いる器具，試薬及び試液はヒ素を含まないか，又はほとんど含まないものを用い，必要ならば空試験を行う．

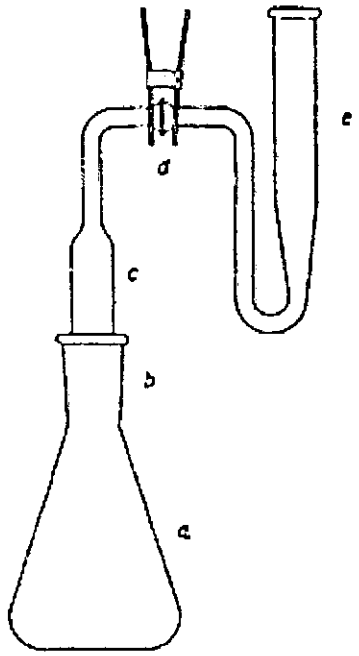
# ⟨211⟩ ARSENIC

This procedure is designed to determine the presence of trace amounts of arsenic (As) by converting the arsenic in a substance under test to arsine, which is then passed through a solution of silver diethyldithiocarbamate to form a red complex. The red color so produced is compared, either visually or spectrophotometrically, to the color produced similarly in a control containing an amount of arsenic equivalent to the limit given in the individual monograph. Limits are stated in terms of arsenic (As). The content of arsenic does not exceed the limit given in the individual monograph.

Two methods are provided, the methods differing only in the preliminary treatment of the test substance and the standard. Generally, *Method I* is used for inorganic materials, while *Method II* is used for organic materials.

**Apparatus—**

The apparatus (see illustration) consists of an arsine generator (*a*) fitted with a scrubber unit (*c*) and an absorber tube (*e*) with standard taper or ground glass ball-and-socket joints (*b* and *d*) between the units. However, any other suitable apparatus, embodying the principle of the assembly described and illustrated, may be used




Arsenic Test Apparatus

**Arsenic Trioxide Stock Solution—**Dissolve 132.0 mg of arsenic trioxide, previously dried at 105° for 1 hour and accurately weighed, in 5 mL of sodium hydroxide solution (1 in 5) in a 1000-mL volumetric flask. Neutralize the solution with 2 N sulfuric acid, add 10 mL more of 2 N sulfuric acid, then add recently boiled and cooled water to volume, and mix.

**Standard Arsenic Solution—**Transfer 10.0 mL of *Arsenic Trioxide Stock Solution* to a 1000-mL volumetric flask, add 10 mL of 2 N sulfuric acid, then add recently boiled and cooled water to volume, and mix. Each mL of *Standard Arsenic Solution* contains the equivalent of 1 µg of arsenic (As). Keep this solution in an all-glass container, and use within 3 days.

## METHOD I

**Standard Preparation**—Pipet 3.0 mL of *Standard Arsenic Solution* into a generator flask, and dilute with water to 35 mL.

**Test Preparation**—Unless otherwise directed in the individual monograph, transfer to the generator flask the quantity, in g, of the test substance calculated by the formula:

$$3.0/L,$$

in which $L$ is the arsenic limit in ppm, dissolve in water, and dilute with water to 35 mL.

**Procedure**—Treat the *Standard Preparation* and the *Test Preparation* similarly as follows. Add 20 mL of 7 N sulfuric acid, 3 mL of potassium iodide TS, 0.5 mL of stronger acid stannous chloride TS, and 1 mL of isopropyl alcohol, and mix. Allow to stand at room temperature for 30 minutes. Pack the scrubber tube (*c*) with two pledgets of cotton that have been soaked in saturated lead acetate solution, freed from excess solution by expression, and dried in vacuum at room temperature, leaving a 2-mm space between the two pledgets. Lubricate the joints (*b* and *d*) with a suitable stopcock grease designed for use with organic solvents, and connect the scrubber unit to the absorber tube (*e*). Transfer 3.0 mL of silver diethyldithiocarbamate TS to the absorber tube. Add 3.0 g of granular zinc (No. 20 mesh) to the mixture in the flask, immediately connect the assembled scrubber unit, and allow the evolution of hydrogen and the color development to proceed at room temperature for 45 minutes, swirling the flask gently at 10-minute intervals. Disconnect the absorber tube from the generator and scrubber units, and transfer the absorbing solution to a 1-cm absorption cell. Any red color produced by the *Test Preparation* does not exceed that produced by the *Standard Preparation*. If necessary or desirable, determine the absorbance at the wavelength of maximum absorbance between 535 and 540 nm, with a suitable spectrophotometer or colorimeter, using silver diethyldithiocarbamate TS as the blank.

**Interfering Chemicals**—Metals or salts of metals, such as chromium, cobalt, copper, mercury, molybdenum, nickel, palladium, and silver, may interfere with the evolution of arsine. Antimony, which forms stibine, produces a positive interference in the color development with silver diethyldithiocarbamate TS; when the presence of antimony is suspected, the red colors produced in the two silver diethyldithiocarbamate solutions may be compared at the wavelength of maximum absorbance between 535 and 540 nm, with a suitable colorimeter, since at this wavelength the interference due to stibine is negligible.

## METHOD II

NOTES—

(1) *Caution—Some substances may react with explosive violence when digested with hydrogen peroxide. Exercise safety precautions at all times.*

(2) If halogen-containing compounds are present, use a lower temperature while heating the test specimen with sulfuric acid, avoid boiling the mixture, and add the hydrogen peroxide with caution, before charring begins, to prevent loss of trivalent arsenic.

(3) If the test substance reacts too rapidly and begins charring with 5 mL of sulfuric acid before heating, use instead 10 mL of cooled dilute sulfuric acid (1 in 2), and add a few drops of the hydrogen peroxide before heating.

**Standard Preparation**—Pipet 3.0 mL of *Standard Arsenic Solution* into a generator flask, add 2 mL of sulfuric acid, mix, and add the total amount of 30 percent hydrogen peroxide used in preparing the *Test Preparation*. Heat the mixture to strong fuming, cool, add cautiously 10 mL of water, and again heat to strong fumes. Repeat this procedure with another 10 mL of water to remove any traces of hydrogen peroxide. Cool, and dilute with water to 35 mL.

**Test Preparation**—Unless otherwise directed in the individual monograph, transfer to a generator flask the quantity, in g, of the test substance calculated by the formula:

$$3.0/L,$$

in which $L$ is the arsenic limit in ppm. Add 5 mL of sulfuric acid and a few glass beads, and digest in a fume hood, preferably on a hot plate adjusted at a temperature not exceeding 120°, until charring begins. (Additional sulfuric acid may be necessary to wet some specimens completely, but the total volume added should not exceed 10 mL.) Cautiously add, dropwise, 30 percent hydrogen peroxide, allowing the reaction to subside and again heating between drops. Add the first few drops very slowly with sufficient mixing, in order to prevent a rapid reaction. Discontinue heating if foaming becomes excessive. When the reaction has abated, heat cautiously, rotating the flask occasionally to prevent the specimen from caking on glass exposed to the heating unit. *Maintain oxidizing conditions at all times during the digestion by adding small quantities of the hydrogen peroxide solution whenever the mixture turns brown or darkens.* Continue the digestion until the organic matter is destroyed, gradually raising the temperature of the hot plate until fumes of sulfur trioxide are copiously evolved, and the solution becomes colorless or retains only a light straw color. Cool, add cautiously 10 mL of water, mix, and again evaporate to strong fuming, repeating this procedure to remove any trace of hydrogen peroxide. Cool, add cautiously 10 mL of water, wash the sides of the flask with a few mL of water, and dilute with water to 35 mL.

**Procedure**—Proceed as directed for *Procedure* under *Method I*.

**Interfering Chemicals**—See *Interfering Chemicals* under *Method I*.

# 2.4.2. ARSENIC

METHOD A

The apparatus (see Figure 2.4.2.-1) consists of a 100 ml conical flask closed with a ground-glass stopper through which passes a glass tube about 200 mm long and of internal diameter 5 mm. The lower part of the tube is drawn to an internal diameter of 1.0 mm, and 15 mm from its tip is a lateral orifice 2 mm to 3 mm in diameter. When the tube is in position in the stopper, the lateral orifice should be at least 3 mm below the lower surface of the stopper. The upper end of the tube has a perfectly flat, ground surface at right angles to the axis of the tube. A second glass tube of the same internal diameter and 30 mm long, with a similar flat ground surface, is placed in contact with the first, and is held in position by two spiral springs. Into the lower tube insert 50 mg to 60 mg of *lead acetate cotton R*, loosely packed, or a small plug of cotton and a rolled piece of *lead acetate paper R* weighing 50 mg to 60 mg. Between the flat surfaces of the tubes place a disc or a small square of *mercuric bromide paper R* large enough to cover the orifice of the tube (15 mm × 15 mm).

In the conical flask dissolve the prescribed quantity of the substance to be examined in 25 ml of *water R*, or in the case of a solution adjust the prescribed volume to 25 ml with *water R*. Add 15 ml of *hydrochloric acid R*, 0.1 ml of *stannous chloride solution R* and 5 ml of *potassium iodide solution R*, allow to stand for 15 min and introduce 5 g of *activated zinc R*. Assemble the two parts of the apparatus immediately and immerse the flask in a bath of water at a temperature such that a uniform evolution of gas is maintained. Prepare a standard in the same manner, using 1 ml of *arsenic standard solution (1 ppm As) R*, diluted to 25 ml with *water R*.

After not less than 2 h the stain produced on the mercuric bromide paper in the test is not more intense than that in the standard.

METHOD B

Introduce the prescribed quantity of the substance to be examined into a test-tube containing 4 ml of *hydrochloric acid R* and about 5 mg of *potassium iodide R* and add 3 ml of *hypophosphorous reagent R*. Heat the mixture on a water-bath for 15 min, shaking occasionally. Prepare a standard in the same manner, using 0.5 ml of *arsenic standard solution (10 ppm As) R*.

After heating on the water-bath, any colour in the test solution is not more intense than that in the standard.

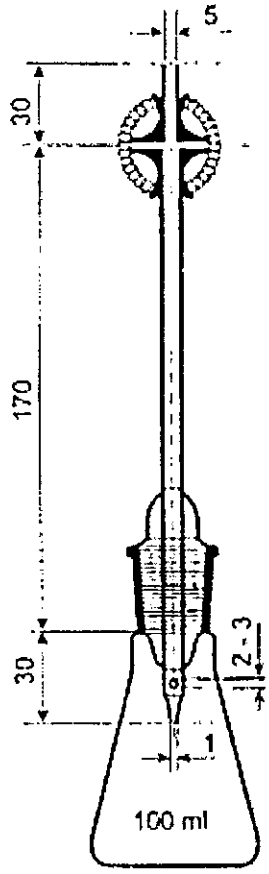



Figure 2.4.2.-1. - *Apparatus for limit test A for arsenic*
*Dimensions in millimetres*

## Limit Tests for Arsenic

*(Ph. Eur. method 2.4.2)*

Use Test [Method] A unless otherwise directed in the monograph.

***Test A***

The apparatus (Fig. 7–1) consists of a 100-ml conical flask closed with a ground-glass stopper through which passes a glass tube about 200 mm long and 5 mm in internal

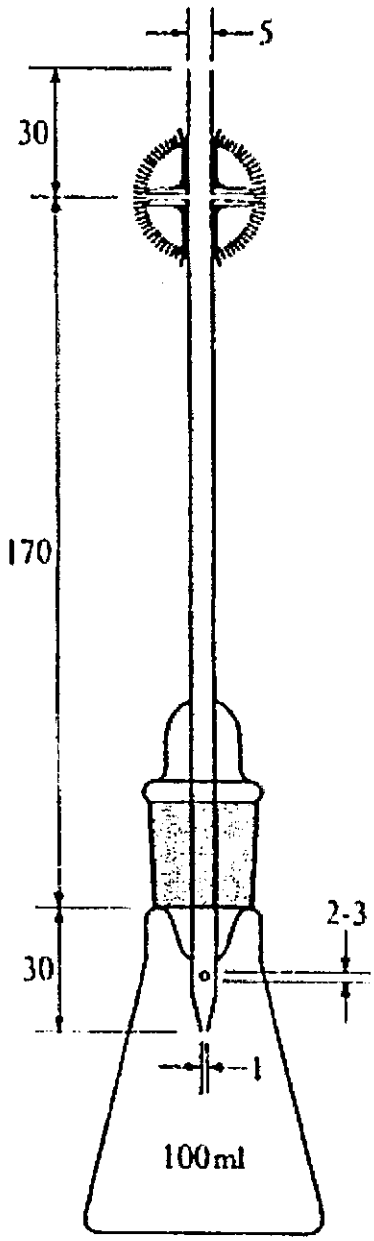



**Fig. 7–1** Apparatus for Limit Test for Arsenic
*Dimensions in mm*

diameter. The lower part of the tube is drawn to an internal diameter of 1.0 mm and 15 mm from its tip is a lateral orifice 2 to 3 mm in diameter. When the tube is in position in the stopper the lateral orifice should be at least 3 mm below the lower surface of the stopper. The upper end of the tube has a perfectly flat, ground surface at right angles to the axis of the tube. A second glass tube of the same internal diameter and 30 mm long, with a similar flat ground surface, is placed in contact with the first and is held in position by two spiral springs. Into the lower tube insert 50 to 60 mg of *lead acetate cotton*, loosely packed, or a small plug of cotton and a rolled piece of *lead acetate paper* weighing 50 to 60 mg. Between the flat surfaces of the tubes place a disc or a small square of *mercury(II) bromide paper* large enough to cover the orifice of the tube (15 mm × 15 mm).

In the conical flask dissolve the prescribed quantity of the substance being examined in 25 ml of *water* or, in the case of a solution, dilute the prescribed volume to 25 ml with *water*. Add 15 ml of *hydrochloric acid*, 0.1 ml of *tin(II) chloride solution AsT* and 5 ml of *potassium iodide solution*, allow to stand for 15 minutes and add 5 g of *activated zinc*. Immediately assemble the two parts of the apparatus and immerse the flask in a water bath at a temperature such that a uniform evolution of gas is maintained. After not less than 2 hours any stain produced on the mercury(II) bromide paper is not more intense than that obtained by treating 1 ml of *arsenic standard solution (1 ppm As)* diluted to 25 ml with *water* in the same manner.

***Test B***

Add the prescribed quantity of the substance being examined to a test tube containing 4 ml of *hydrochloric acid* and about 5 mg of *potassium iodide* and add 3 ml of *hypophosphorous reagent*. Heat the mixture on a water bath for 15 minutes, shaking occasionally. Any colour produced is not more intense than that obtained in a solution prepared in the same manner but using 0.5 ml of *arsenic standard solution (10 ppm As)* in place of the substance being examined.

# ARSENIC TEST

**Silver Diethyldithiocarbamate Colorimetric Method**
(Note: All reagents used in this test should be very low in arsenic content.)

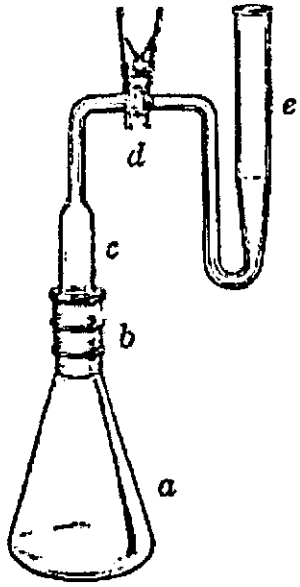



FIGURE 11 General Apparatus for Arsenic Test. (Courtesy of the Fisher Scientific Co., Pittsburgh, PA.)

**Apparatus** Use the general apparatus shown in Fig. 11 unless otherwise specified in an individual monograph. It consists of a 125-mL arsine generator flask (*a*) fitted with a scrubber unit (*c*) and an absorber tube (*e*), with a 24/40 standard-taper joint (*b*) and a ball-and-socket joint (*d*), secured with a No. 12 clamp, connecting the units. The tubing between *d* and *e* and between *d* and *c* is a capillary having an id of 2 mm and an od of 8 mm. Alternatively, an apparatus embodying the principle of the general assembly described and illustrated may be used.

Note: The special assemblies shown in Figs. 12, 13, and 14 are to be used only when specified in certain monographs.

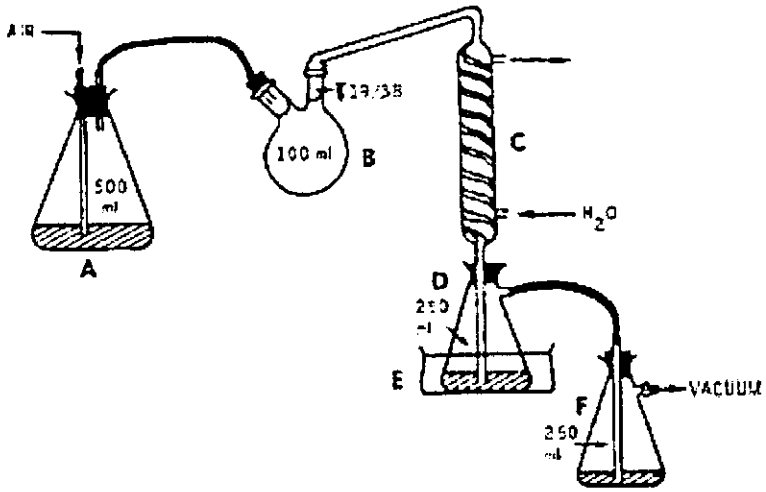



FIGURE 13 Special Apparatus for the Distillation of Arsenic Trichloride. (Flask *A* contains 150 mL of hydrochloric acid; flasks *D* and *F* contain 20 mL of water. Flask *D* is placed in an ice water bath, *E*.)

Transfer 10.0 mL of this solution into a 1000-mL volumetric flask, add 10 mL of 2 *N* sulfuric acid, dilute to volume with recently boiled water, and mix. Use this final solution, which contains 1 µg of arsenic (As) in each mL, within 3 days.

**Standard Arsenic Solution** Accurately weigh 132.0 mg of arsenic trioxide that has been previously dried at 105° for 1 h, and dissolve it in 5 mL of sodium hydroxide solution (1 in 5). Neutralize the solution with 2 *N* sulfuric acid, add 10 mL in excess, and dilute to 1000.0 mL with recently boiled water.

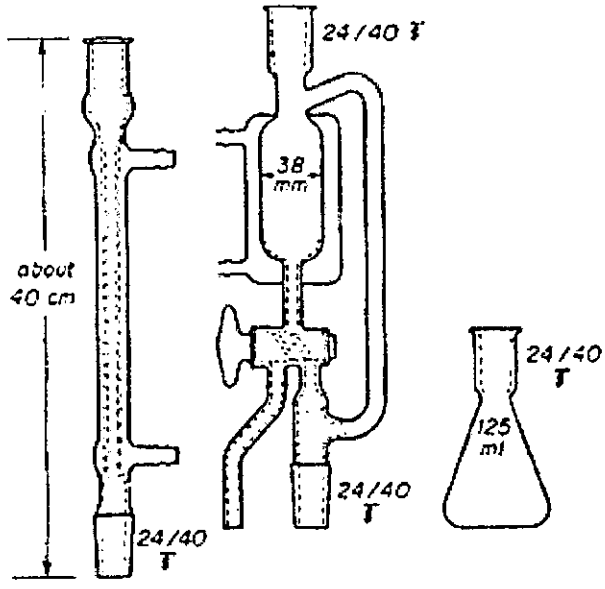



FIGURE 12 Modified Bethge Apparatus for the Distillation of Arsenic Tribromide.

**Silver Diethyldithiocarbamate Solution** Dissolve 1 g of recrystallized silver diethyldithiocarbamate in 200 mL of recently distilled pyridine. Store this solution in a light-resistant container and use within 1 month.

**Stannous Chloride Solution** Dissolve 40 g of stannous chloride dihydrate, $SnCl_2.2H_2O$, in 100 mL of hydrochloric acid. Store the solution in glass containers and use within 3 months.

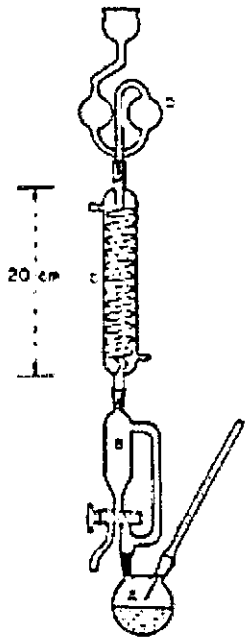



FIGURE 14 Special Apparatus for the Determination of Inorganic Arsenic. (*A*, 250-mL distillation flask; *B*, receiver chamber, approximately 50-mL capacity; *C*, reflux condenser; *D*, splash head.)

**Lead Acetate-Impregnated Cotton** Soak cotton in a saturated solution of lead acetate trihydrate, squeeze out the excess solution, and dry in a vacuum at room temperature.

**Sample Solution** Use directly as the *Sample Solution* in the *Procedure* the solution obtained by treating the sample as directed in an individual monograph. Prepare sample solutions of organic compounds in the generator flask (*a*), unless otherwise directed, according to the following general procedure:

**Caution:** Some substances may react unexpectedly with explosive violence when digested with hydrogen peroxide. Use appropriate safety precautions at all times.

**Note:** If halogen-containing compounds are present, use a lower temperature while heating the sample with sulfuric acid, do not boil the mixture, and add the peroxide, with caution, before charring begins to prevent loss of trivalent arsenic.

Transfer 1.0 g of the sample into the generator flask, add 5 mL of sulfuric acid and a few glass beads, and digest at a temperature not exceeding 120° until charring begins, preferably using a hot plate in a fume hood. (Additional sulfuric acid may be necessary to completely wet some samples, but the total volume added should not exceed about 10 mL.) After the acid has initially decomposed the sample, cautiously add, dropwise, hydrogen peroxide (30%), allowing the reaction to subside and reheating the sample between drops. Add the first few drops very slowly with sufficient mixing to prevent a rapid reaction, and discontinue heating if foaming becomes excessive. Swirl the solution in the flask to prevent unreacted substance from caking on the walls or bottom of the flask during digestion. *Maintain oxidizing conditions at all times during the digestion by adding small quantities of the peroxide whenever the mixture turns brown or darkens.* Continue the digestion until the organic matter is destroyed, gradually raising the temperature of the hot plate to 250° to 300° until fumes of sulfur trioxide are copiously evolved and the solution becomes colorless or retains only a light straw color. Cool, cautiously add 10 mL of water, heat again to strong fuming, and cool. Cautiously add 10 mL of water, mix, wash the sides of the flask with a few mL of water, and dilute to 35 mL.

**Procedure** If the *Sample Solution* was not prepared in the generator flask, transfer to the flask a volume of the solution, prepared as directed, equivalent to 1.0 g of the substance being tested, and add water to make 35 mL. Add 20 mL of dilute sulfuric acid (1 in 5), 2 mL of potassium iodide TS, 0.5 mL of *Stannous Chloride Solution*, and 1 mL of isopropyl alcohol, and mix. Allow the mixture to stand for 30 min at room temperature. Pack the scrubber unit (*c*) with two plugs of *Lead Acetate-Impregnated Cotton*, leaving a small air space between the two plugs, lubricate joints *b* and *d* with stopcock grease, if necessary, and connect the scrubber unit with the absorber tube (*e*). Transfer 3.0 mL of *Silver Diethyldithiocarbamate Solution* to the absorber tube, add 3.0 g of granular zinc (20-mesh) to the mixture in the flask, and immediately insert the standard-taper joint (*b*) in the flask. Allow the evolution of hydrogen and color development to proceed at

room temperature (25° ± 3°) for 45 min, swirling the flask gently at 10-min intervals. Disconnect the absorber tube from the generator and scrubber units, and transfer the *Silver Diethyldithiocarbamate Solution* to a 1-cm absorption cell. Determine the absorbance at the wavelength of maximum absorption between 535 nm and 540 nm, with a suitable spectrophotometer or colorimeter, using *Silver Diethyldithiocarbamate Solution* as the blank. The absorbance due to any red color from the solution of the sample does not exceed that produced by 3.0 mL of *Standard Arsenic Solution* (3 µg As) when treated in the same manner and under the same conditions as the sample. The room temperature during the generation of arsine from the standard should be held to within ± 2° of that observed during the determination of the sample.

**Interferences** Metals or salts of metals such as chromium, cobalt, copper, mercury, molybdenum, nickel, palladium, and silver may interfere with the evolution of arsine. Antimony, which forms stibine, is the only metal likely to produce a positive interference in the color development with the silver diethyldithiocarbamate. Stibine forms a red color with silver diethyldithiocarbamate that has a maximum absorbance at 510 nm, but at 535 to 540 nm, the absorbance of the antimony complex is so diminished that the results of the determination would not be altered significantly.

## ARSENIC LIMIT TEST

Unless otherwise directed in the individual monograph, Method II as shown below is used in preference to Method I.

**METHOD I (Gutzeit Procedure)**

**Preparation of the Sample Solution**

The solution obtained by treating the sample as directed in an individual monograph is used directly as the Sample Solution in the Procedure.

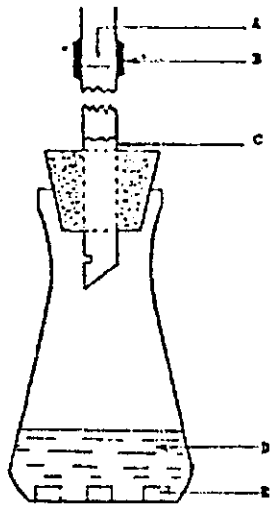
**Preparation of Standard Solution of Arsenic**

To 50 ml of water add 10 ml of stannated hydrochloric acid TS and 1.0 ml of dilute arsenic TS. The resulting solution, when treated as described in the procedure below, yields a stain on the mercuric chloride paper referred to as the standard stain, equivalent to 10 μg of As.

**Procedure**

Transfer the solution (D) to a conical flask of 120 ml capacity (see Figure). The flask is fitted with a rubber stopper, through which passes a glass tube, 200 mm long and with an internal diameter of 6.5 mm. The lower end of the glass tube is cut at an angle and a hole not less than 2 mm in diameter is blown in the side of the tube. About 40 mm above the stopper the tube is cut clearly and squarely into two parts: between the two parts of the tube is inserted a small disc of test paper (A), having a diameter equal to the outside diameter of the tube. The two parts of the tube, with the test paper, are tightly joined together with rubber tubing (B).

The test paper circle is made from filter paper (Whatman No. 1 or equivalent), soaked in a 5% solution of mercuric chloride in ethanol and dried in a current of air.




A. Mercuric chloride test paper disc
B. Rubber connection
C. Cotton gauze saturated with lead acetate
D. Test solution
E. Aluminum squares

**Figure. Apparatus for Limit Test for Arsenic**

Loosely plug the lower end of the tube with cotton gauze soaked in a 5% lead acetate solution and dried (C).

In the conical flask, add three squares (8 mm x 8 mm x 1 mm) of aluminium sheet (E) and immediately close the flask with the rubber stopper. Allow the flask to stand in a water bath at 25° for 45 min.

At the same time, carry out a parallel experiment using the standard solution of arsenic in place of the test sample. Compare the colours of the two mercuric chloride test papers. The intensity of the colour from the test sample should not be greater than that of the standard stain.

**METHOD II (Colorimetric Procedure)**

Apparatus

The general apparatus is shown in the accompanying diagram. It consists of a 125-ml arsine generator flask (A) with a 24/40 standard-taper joint (B) fitted with a scrubber unit (C) and an absorber tube (E) connected by a capillary of inside diameter 2 mm and outside diameter 8 mm via a ball-and-socket joint (D), secured with a No. 12 clamp, connecting the units. Alternatively, an apparatus embodying the principle of the general assembly described and illustrated may be used.

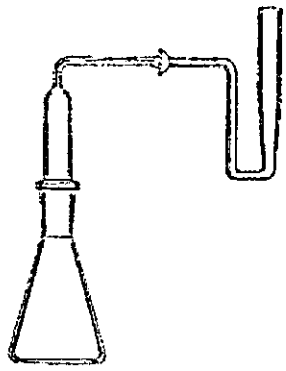


**Figure. Apparatus for Limit Test for Arsenic - Method II**

Reagents

Silver Diethyldithiocarbamate Solution

Dissolve 1 g of recrystallized silver diethyldithiocarbamate, $(C_2H_5)_2NCSSAg$, in 200 ml of reagent grade pyridine in a fume hood. Store this solution in a light-resistant container and use within 1 month.

Silver diethyldithiocarbamate is available commercially or may be prepared as follows. Dissolve 1.7 g of reagent grade silver nitrate in 100 ml of water. In a separate container, dissolve 2.3 g of sodium diethyldithiocarbamate, $(C_2H_5)_2NCSSNa \cdot 3H_2O$, in 100 ml of water, and filter. Cool both solutions to about 15°, mix the two solutions, while stirring, collect the yellow precipitate in a medium-porosity sintered-glass crucible or funnel, and wash with about 200 ml of cold water.

Recrystallize the reagent, whether prepared as directed above or obtained commercially, as follows: Dissolve in freshly distilled pyridine, using about 100 ml of solvent for each g of reagent, and filter. Add an equal volume of cold water to the pyridine solution, while stirring. Filter off the precipitate, using suction, wash with cold water, and dry in vacuum at room temperature for 2 to 3 h. The dry salt is pure yellow in colour and should show no change in character after 1 month when stored in a light-resistant container. Discard any material that changes in colour or develops a strong odour.

Standard Arsenic Solution

Weigh accurately 132.0 mg of arsenic trioxide that has been finely pulverized and dried for 24 h over a suitable desiccant, and dissolve it in 5 ml of sodium hydroxide solution (1 in 5). Neutralize the solution with diluted sulfuric acid TS, add 10 ml in excess, and dilute to 1,000.0 ml with recently boiled water, and mix. Transfer 10.0 ml of this solution into a 1,000-ml volumetric flask, add 10 ml of diluted sulfuric acid TS, dilute to volume with recently boiled water and mix.

Use this final solution, which contains 1 μg of arsenic (As) in each ml, within 3 days.

Stannous Chloride Solution

Dissolve 40 g of reagent grade stannous chloride dihydrate, $SnCl_2 \cdot 2H_2O$, in 100 ml of hydrochloric acid. Store the solution in a glass container and use within 3 months.

Lead Acetate-Impregnated Cotton

Soak cotton in a saturated solution of reagent grade lead acetate, squeeze out the excess solution, and dry in a vacuum at room temperature. Note: When preparing and using the cotton, take great care to avoid lead contamination.

Preparation of the Sample Solution

The solution obtained by treating the sample as directed in an individual monograph is used directly as the Sample Solution in the Procedure. Sample solutions of organic compounds are prepared in the generator flask (A), unless otherwise directed, according to the following general procedure:

Caution. Some substances may react unexpectedly with explosive violence when digested with hydrogen peroxide. Appropriate safety precautions must be employed at all times.

Note. If halogen-containing compounds are present, use a lower temperature while heating the sample with sulfuric acid, do not boil the mixture, and add the peroxide, with caution, before charring begins, to prevent loss of trivalent arsenic.

Transfer 1.0 g of the sample into the generator flask, add 5 ml of sulfuric acid and a few glass beads, and digest at a temperature not exceeding

120° on a hot plate in a fume hood until charring begins. (Additional sulfuric acid may be necessary to completely wet some samples, but the total volume added should not exceed about 10 ml.) After the sample has been initially decomposed by the acid, add with caution, dropwise, 30% hydrogen peroxide, allowing the reaction to subside and reheating between drops. The first few drops must be added very slowly with sufficient mixing to prevent a rapid reaction, and heating should be discontinued if foaming becomes excessive. Swirl the solution in the flask to prevent unreacted substance from caking on the walls or bottom of the flask during digestion. Maintain oxidizing conditions at all times during the digestion by adding small quantities of the peroxide whenever the mixture turns brown or darkens. Continue the digestion until the organic matter is destroyed, gradually raising the temperature of the hot plate to 250° - 300° until fumes of sulfuric acid are copiously evolved, and the solution becomes colourless, or retains only a slight straw colour.

Cool, add cautiously 10 ml of water, again evaporate (fumes of sulfuric acid evolved), and cool. Add cautiously 10 ml of water, mix, wash the sides of the flask with a few ml of water, and dilute to 35 ml.

Procedure

If the sample solution was not prepared in the generator flask, transfer to the flask a volume of the solution, prepared as directed, equivalent to 1.0 g of the substance being tested and add water to make 35 ml.

Add 20 ml of dilute sulfuric acid (1 in 5), 2 ml of potassium iodide TS, and 0.5 ml of Stannous Chloride Solution, and mix. Allow the mixture to stand for 30 min at room temperature. Pack the scrubber tube (C) with two plugs of Lead Acetate-Impregnated Cotton, leaving a small air space between the two plugs, lubricate joints (B) and (D) with stopcock grease, if necessary, and connect the scrubber unit with the absorber tube (E). Transfer 3.0 ml of Silver diethyldithiocarbamate solution to the absorber tube, add 3.0 g of granular zinc (20-mesh) to the mixture in the flask, and immediately insert the standard-taper joint in the flask. Allow the evolution of hydrogen and colour development to proceed at room temperature (25° ± 3°) for 45 min, swirling the flask gently at 10-min intervals. (The addition of a small amount of isopropanol to the generator flask may improve the uniformity of the rate of gas evolution.) Disconnect the absorber tube from the generator and scrubber units, and transfer the Silver diethyldithiocarbamate solution to a 1-cm absorption cell. Determine the absorbance at the wavelength of maximum absorption between 535 nm and 540 nm with a suitable spectrophotometer or colorimeter, using Silver diethyldithiocarbamate solution as the blank. The absorbance due to any red colour from the solution of the sample does not exceed that produced by 3.0 ml of Standard arsenic solution (3μg As) when treated in the same manner and under the same conditions as the sample. The room temperature during the generation of arsine from the standard should be held to within ± 2° of that observed during the determination of the sample.

Note 1. Metals or salts of metals such as chromium, cobalt, copper, mercury, molybdenum, nickel, palladium, and silver are said to interfere with the evolution of arsine. Antimony, which forms stibine, is the only metal likely to produce a positive interference in the colour development with the silver diethyldithiocarbamate. Stibine forms a red colour which has a maximum absorbance at 510 nm, but at 535 - 540 nm the absorbance of the antimony complex is so diminished that the results of the determination would not be altered significantly.

Note 2. All reagents used in the limit test for arsenic should be very low in arsenic content.

第７版　食品添加物公定書

強熱残分試験法

強熱残分試験法は、試料に硫酸を加えて強熱するとき残留する物質の量を測定する方法である。

以下、本試験法を用いる場合において、例えば、「0.10%以下」とあるのは、試料１～２ｇを精密に量り、硫酸を加え、450～550℃で３時間強熱するとき、その残分が試料の採取量に対して 0.10%以下であることを示す。「0.02%以下（５ｇ、850℃、30 分間)」とあるのは、試料約５ｇを精密に量り、硫酸を加え、850℃で 30 分間強熱するとき、その残分が試料の採取量に対して 0.02%以下であることを示す。また、成分規格・保存基準各条において乾燥物とある場合は、それぞれの成分規格・保存基準各条において規定する乾燥減量の条件で乾燥したものを試料として試験を行う。

操作法

あらかじめ白金製、石英製又は磁製のるつぼを別に規定する強熱条件に準じて約 30 分間強熱し、デシケーター中で放冷した後、その重量を精密に量る。

試料が大きな結晶又は塊の場合は、速やかに粉砕して径約２mm 以下の大きさとする。別に規定するもののほか、その１～２ｇを先のるつぼに入れ、その重量を精密に量り、硫酸少量を加えて潤し、徐々に強熱してできるだけ低温でほとんど灰化した後、放冷する。さらに硫酸１ml を加え、徐々に加熱して硫酸の蒸気がほとんど発生しなくなった後、電気炉に入れ、別に規定するもののほか、450～550℃で３時間強熱する。次にるつぼをデシケーター中で放冷し、その重量を精密に量る。ただし、得られた値が規定値に適合していない場合は、残留物が恒量になるまで強熱する。

## 16. 強熱残分試験法

強熱残分試験法は，試料を次の操作法によって強熱するとき，揮発せずに残留する物質の量を測定する方法である．この方法は，通例，有機物中に不純物として含まれる無機物の含量を知るために用いるが，場合によっては，有機物中に構成成分として含まれる無機物又は熱時揮発する無機物中に含まれる不純物の量を測定するために用いる．

医薬品各条に，例えば 0.10 % 以下 (1 g) と規定するものは，本品約 1 g を精密に量り，次の操作法によって強熱するとき，その残分が本品 1 g につき 1.0 mg 以下であることを示す．また，乾燥後とあるときは，乾燥減量の項の条件で乾燥した後，試料を採取する．

**操 作 法**

あらかじめ，白金製，石英製又は磁製のるつぼを 450 ～ 550 °C で恒量になるまで強熱し，放冷後，その質量を精密に量る．

試料は医薬品各条に規定する量の ± 10 % の範囲内で採取し，前記の容器に入れ，その質量を精密に量る．ただし，採取量が容量で示されているときは医薬品各条に規定する量を正確に量り，前記の容器に入れる．蒸発後と規定されているものは，そのまま適度に加熱して，液を蒸発させる．

次にこれに硫酸少量を加えて潤し，徐々に加熱してなるべく低温でほとんど灰化又は揮散した後，いったん放冷し，更に硫酸少量で潤して徐々に加熱し，白煙が生じなくなった後，450 ～ 550 °C で強熱し，残留物を完全に灰化し，放冷後，その質量を精密に量る．放冷はデシケーター (シリカゲル) で行う．

医薬品各条における強熱残分の規定が % 以下又は mg 以下で示されていて，上記の操作によって得た値がこの値より大きい場合，又は強熱残分の規定が一定の範囲をもって示されている場合は，恒量になるまで強熱を行う．

# ⟨281⟩ RESIDUE ON IGNITION

The *Residue on Ignition/Sulfated Ash* test utilizes a procedure to measure the amount of residual substance not volatilized from a sample when the sample is ignited in the presence of sulfuric acid according to the procedure described below. This test is usually used for determining the content of inorganic impurities in an organic substance.

**Procedure**—Weigh accurately 1 to 2 g of the substance, or the amount specified in the individual monograph, in a suitable crucible (silica, platinum, quartz, or porcelain) that previously has been ignited at 600 ± 50° for 30 minutes, cooled in a desiccator (silica gel or other suitable desiccant), and weighed. Moisten the sample with a small amount (usually 1 mL) of sulfuric acid. Heat, gently at first, at a temperature as low as practicable until the substance is thoroughly charred, cool, then, unless otherwise directed in the individual monograph, moisten the residue with a small amount (usually 1 mL) of sulfuric acid, heat gently until white fumes are no longer evolved, and ignite at 600 ± 50°, unless another temperature is specified in the individual monograph, until the carbon is consumed. Ensure that flames are not produced at any time during the procedure. Cool in a desiccator (silica gel or other suitable desiccant), weigh, and calculate the percentage of residue. Unless otherwise specified, if the amount of the residue so obtained exceeds the limit specified in the individual monograph, repeat the moistening with sulfuric acid, heating, and igniting as before, until constant weight is attained or until the percentage of residue complies with the limit in the individual monograph.

Conduct the ignition in a well-ventilated hood, but protected from air currents, and at as low a temperature as is possible to effect the complete combustion of the carbon. A muffle furnace may be used if desired, and its use is recommended for the final ignition at 600 ± 50°.

Calibration of the muffle furnace may be carried out using an appropriate digital temperature meter and a working thermocouple probe calibrated against a standard thermocouple traceable to the National Institute of Standards and Technology.

Verify the accuracy of the measuring and controlling circuitry of the muffle furnace by checking the positions in the furnace at the control set point temperature of intended use. Select positions that reflect the eventual method of use with respect to location of the specimen under test. The tolerance is ±25° at each position measured.

Sulphated Ash tests found in the *European* and *Japanese Pharmacopoeias* are considered equivalent to this test, except where noted.