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A Simple Device for Air Analysis

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CONVENTIONAL methods of atmospheric sampling and analysis of gases usually consist of scrubbing the air to be tested through a selective absorbing liquid for a determined period of time and then analyzing the solution.

A variation of this procedure lies in an "air titration" method whereby the air to be tested is drawn through a selective absorbing solution containing an indicator until a color change takes place. By noting the volume of air required to effect this color change a calculation can be made on the spot as to the concentration of gas present. Such a procedure has been described for the determination of sulfur dioxide in the atmosphere.[1]

From the industrial hygiene standpoint we have found that, depending on conditions, such "on the spot" information is often preferable to longer period sampling for the following reasons: (1) In contrast to the average values obtained by long period sampling, peak concentrations associated with hazardous conditions are noted at once. (2) Where extensive coverage is important, more representative analyses can be made in a given period of time. (3) Data is obtainable where laboratory facilities are not readily accessible. (4) A minimum of equipment is required.

Experiencing the need for a versatile, portable device which would expedite such sampling, we have developed and used for a number of years a simple apparatus which might be described as a spot sampler. The success which we have had in using the device has prompted us to describe it here for the benefit of those who might be seeking such methods and types of apparatus.

The device ready for use is shown in Fig. 1. It consists of a 100 cc syringe mounted on a 2½" x 12" x ¾" plywood board by means of bronze clips. A small hole is drilled 2" from the end of the board to accommodate a T tube of any convenient size with one arm bent as shown and connected to the tip of the syringe by means of rubber tubing. The back panel board consists of a piece of plywood 4" x 5" x ¼" with a 1½" x 1¼" x ¼" base nailed at the bottom. A small hole is drilled through the base and the plywood board to take a small bolt and wing nut which secures and holds the panel upright as shown. Two side arm test tubes are mounted on the panel

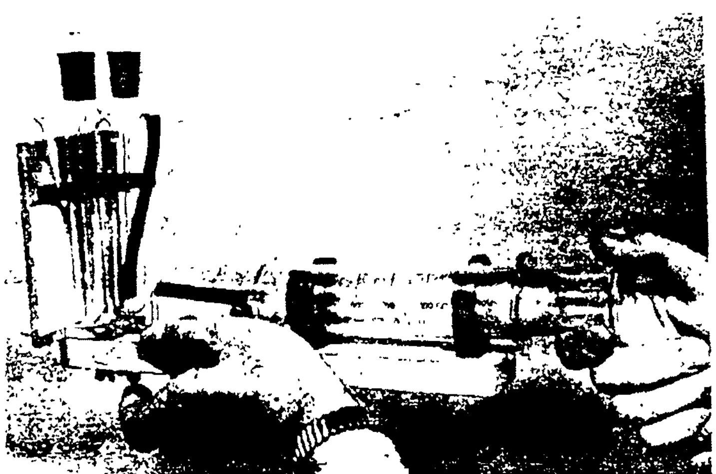

Fig. 1.

EXHIBIT #10

by means of metal clips. The inlets of the test tube consist of a piece of 5 mm O.D. pyrex tubing 6½" long drawn to a 2 mm opening at the bottom and inserted through a No. 2 one-hole rubber stopper.

In operation, 10 ml of the absorbing liquid is placed in the tube and, holding the device in the left hand, the left index finger is placed over the opening of the T Tube. The plunger is then pulled at a rate of about 100 cc per 30 seconds until the 100 cc mark is reached. The index finger is removed and the air expelled from the syringe by pushing the plunger to its original position. The aspiration is repeated until the end point is reached and the volume of air recorded. Since the amount of contaminant required to react with the quantity of absorbing solution is known by calculation, this amount is present in the volume of air scrubbed. Further calculation reveals it in terms of parts per million.

The device has been successfully used for testing industrial atmospheres for ammonia, sulfur dioxide, hydrogen sulfide, and hydrogen cyanide. It has also been used for collecting samples of other atmospheric constituents such as formaldehyde and alcohol for subsequent laboratory analysis. It has been especially useful for testing the "Airfluent" of vent stacks for ammonia, sulfur dioxide and hydrogen sulfide. In this case, stronger solutions must, of course, be employed.

The successful use of the device is based on the utilization of very dilute standard solutions which therefore require small volumes of air to effect color changes. Testing the device for efficiency is superfluous because the reagents selected for the gases described have been in common use for the same purpose for many years and warrant the use of almost any type of scrubbing device.

The procedures described below are those which have been satisfactory for field use.

Sulfur Dioxide

Reagents:

1. .0001 N Iodine (1 ml = .0032 mg. Sulfur Dioxide).
2. Fresh starch solution.

Procedure:

Pipette exactly 10 ml of the iodine into a side arm test tube, add a drop of starch and scrub the air containing sulfur dioxide through the solution until the blue color is discharged. Record the volume and calculate the concentration of sulfur dioxide present using the following formula:

$$\frac{10 \times .0032 \times 24{,}450}{\text{Vol. of air in liters} \times \text{Mol. Wt. of } SO_2} = \text{PPM}$$

Example: Assume 1500 cc of air required:

Then: $\frac{10 \times .0032 \times 24{,}450}{1.5 \times 64} = 8 \text{ PPM}$

Hydrogen Sulfide

Reagents:

1. .0001 N Iodine (1 ml = .0017 mg. Hydrogen Sulfide).
2. Fresh starch solution.

Procedure:

Proceed in the same manner as for Sulfur Dioxide. Record the volume and calculate the concentration of sulfur dioxide present using the following formula:

$$\frac{10 \times .0017 \times 24{,}450}{\text{Vol. of air in liters} \times \text{Mol. Wt. of } H_2S} = \text{PPM}$$

Ammonia

Reagents:

1. .0001 N Sulfuric acid (1 ml. = .0017 mg. ammonia).
2. Methyl Purple Indicator.

Procedure:

Pipette exactly 10 ml. of the acid into a side arm test tube, add a drop of indicator and scrub the air containing ammonia through the solution until the purple color changes to green. Record the volume and calculate the concentration of ammonia present using the following formula:

$$\frac{10 \times .0017 \times 24{,}450}{\text{Vol. of air in liters} \times \text{Mol. Wt. of } NH_3} = \text{PPM}$$

Hydrogen Cyanide

The procedure used for hydrogen cyanide is the one described by White.[2] In this case, we use the syringe assembly instead of the rubber bulb used by White because of increased accuracy in reading the volume of air required to match the colors.

Fig. 2.

On occasions, where the end point is not arp because of low concentrations of gas ing present there is an accuracy comnsation which exists between volume of r required for a good end point and concentration of reagent used. An example can be given in the case of the determination of sulfur-dioxide using dilute standard iodine. If the concentration of sulfur dioxide in the atmosphere is 8 PPM then by calculation 1500 cc of air is required to decolorize 10 ml of 0001 N iodine. A deviation of 100 cc more or less from 1500 cc gives answers of 7 6 and 8 7 PPM respectively.

This deviation is of no consequence when it is considered that the practical significance of air sampling is the indication of a range of concentrations which might exist during a working period and to which employee exposure might occur.

Fig. 2 shows how the device can be mounted in a small carrying case. Since distilled water is usually available .1N solutions can be carried in sealed ampoules for further dilutions, and indicators can be placed in screw capped vials.

References

1. PEARCE, S. J. and SCHRENK, H. H.: The Determination of Sulfur Dioxide in Air by Means of the Midget Impinger. U.S. Bureau of Mines, Report of Investigation 4282, May 1948.

2. WHITE, NORMAN G.: Hydrogen Cyanide as an Industrial Hazard Methods of Detection and Control. *American Industrial Hygiene Association Quarterly.* 9:81, 1948.

W.C.L. Hemeon Honored

ON JANUARY 22, 1953, the Junior Chamber of Commerce of Pittsburgh, Pennsylvania sponsored a dinner at which BENJAMIN F. FAIRLESS was acclaimed Pittsburgh's man-of-the-year. At the same time, W. C. L. HEMEON, Engineering Director of the Industrial Hygiene Foundation was accorded recognition for outstanding contributions in air pollution abatement, industrial dust control and ventilation. The honor was the 1953 Science Award which is given annually for outstanding contributions in the science field.