The Detection of Carbon Monoxide in Medicinal Oxygen

*By Frederick K. Bell and John C. Krantz, Jr.**

In an earlier communication (1) the authors described a method for the detection of carbon monoxide in medicinal oxygen. This method was based on the reduction of palladium chloride by carbon monoxide and the subsequent formation of molybdenum blue and was found to be sensitive to 10 parts per million of carbon monoxide. It was also found that this test responds to hydrogen so that modification was essential since some medicinal oxygen is prepared electrolytically and may therefore contain several tenths of a per cent of hydrogen, an impurity which is quite permissible for pharmacopœial purposes.

Our attention was first directed to the problem of altering the palladium test solution so that it might, in effect, react specifically with carbon monoxide. This mode of attack seemed promising in view of the work of Daller (2). Our efforts along this line were unsuccessful probably owing to the fact that in rendering the palladium solution practically inactive toward hydrogen, its reactivity toward the carbon monoxide was greatly reduced so that for the detection of small amounts of carbon monoxide the element of time became significant. Our original test, in the absence of hydrogen, required approximately twelve hours and any considerable lengthening of this time period would render the test impractical. We have also tried, without success, a number of methods for the removal of hydrogen from the gas mixture.

METHOD

In the face of these negative results, our attention was directed to another line of attack. The method we have devised is presented in this communication and may be briefly summarized as follows. A liter sample of the oxygen to be tested, to which have been added 50 cc. of nitrogen, is treated in a closed system with an alkaline solution of sodium hydrosulfite which removes most of the oxygen. Nitrogen is added to the residual gas until the volume is 100 cc. This 100-cc. volume, consisting mainly of nitrogen, is then tested by the hemoglobin method. A sample of carbon monoxide-free oxygen treated in the same manner serves as a standard.

The pure carbon monoxide used for the carbon monoxide–oxygen mixture was prepared by the reaction between formic and sulfuric acids. A stock mixture of 10 per cent carbon monoxide in oxygen was then prepared and the required amount of this stock mixture was introduced into a twenty-liter gasometer to give the final desired carbon monoxide–oxygen mixture. We have not analyzed these final mixtures, but their entire preparation has been repeated a number of times in the course of the work and consistent results have been obtained. A sample of analyzed carbon monoxide–oxygen mixture prepared in another laboratory was also found to check closely the results obtained from our own mixtures.

A cylinder of carbon monoxide-free oxygen, which was generously supplied by The Linde Air Products Company, was employed not only in preparing the carbon monoxide–oxygen mixtures but also for the blank determinations. A cylinder of commercial nitrogen was used.

With regard to the hemoglobin test, blood samples from a number of different sources were used. These include oxalated bloods from humans, dogs, rabbits and chickens and also defibrinated beef and sheep's blood. All of these bloods seem to have the same sensitivity. Oxygenation of the blood, before use, appears to have no effect on the sensitivity. The blood should be used within 24 hours after drawing and should be kept refrigerated until ready for use. As might be expected, hydrogen has no effect on the test, and we have verified this fact in our examination of a number of oxygen mixtures, with and without carbon monoxide, containing up to 0.5 per cent of hydrogen.

The experimental procedure can be carried out with the simplest equipment and we present it in its original form. Doubtless a number of refinements will present themselves especially in adapting the method to the requirements of a plant control laboratory.

Alone-liter, short ring neck, round-bottom Pyrex balloon flask, as shown in the above figure, is equipped with a tightly fitting two-holed rubber stopper. The capacity of the flask to the stopper was found to be approximately 1050 cc. The flask is filled with water and inverted over a pneumatic trough. Fifty cubic centimeters of nitrogen are introduced into the flask and then the remaining water, 1000 cc., is completely displaced by the oxygen to be tested.

The flask is then tightly closed with a rubber stopper bearing two glass stop-cocks, one of which is of the capillary type bearing a right-angle bend for convenience. In inserting this stop-cock through the rubber stopper the end of the arm should reach just to the lower surface of the stopper.

* From the Department of Pharmacology, School of Medicine, University of Maryland.

With both stop-cocks closed, the flask is removed from the trough and placed in its normal position. Through the vertical stop-cock, to which a funnel has been attached, is introduced a freshly prepared solution (3) of 50 Gm. of sodium hydrosulfite in 250 cc. of distilled water to which have been added 40 cc. of a solution of 500 Gm. of potassium hydroxide in 700 cc. of water. The oxygen absorption commences with the introduction of the first few drops of the solution and the entire volume of the hydrosulfite solution can be drawn into the flask, aided by occasional shaking, within a few minutes. With both stop-cocks closed, the flask is shaken vigorously for five minutes. Distilled water is then

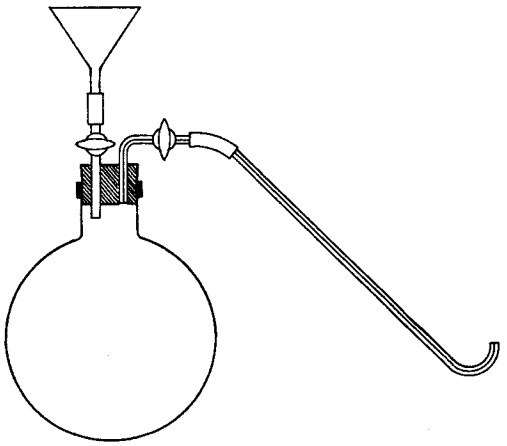

Fig. 1.—Flask and Attachments.

allowed to flow into the flask through the vertical stop-cock until atmospheric pressure is restored therein.

The residual gas volume of approximately 75 cc. is then transferred to a 100-cc. volumetric flask which has been filled with water and inverted over a pneumatic trough. To the capillary stop-cock is attached a delivery tube of capillary tubing for the transfer of the gas to the volumetric flask and the distilled water is introduced through the other stop-cock to displace the residual gas from the balloon flask. After complete transfer of the gas to the volumetric flask the balance of the water therein is completely displaced by nitrogen and the flask is then stoppered. Throughout the procedure, care should be taken to avoid the introduction of air into the gas sample.

A sample of carbon monoxide-free oxygen is carried through the same procedure and we then have two 100-cc. volumetric flasks corresponding, respectively, to the test gas and to the carbon monoxide-free oxygen.

To each of the flasks are added 2 cc. of a freshly prepared aqueous solution of 1 cc. of blood diluted to 20 cc. The flasks are immediately restoppered and, during a period of fifteen minutes, are rotated from time to time to facilitate maximum contact between the blood solution and the gas.

The blood solutions are then treated by the standard pyrotannic method in which one cc. of a fresh solution containing 1 Gm. of pyrogallic acid and 1 Gm. of tannic acid in 50 cc. of distilled water is added to each flask. After thorough mixing the flasks are allowed to stand in subdued light for 15 minutes after which time the contents of the flasks are transferred to small similar test-tubes for comparison. If the test gas contains 5 parts per million of carbon monoxide, the contents of the corresponding tube will show a pinkish tint in contrast to the brown color of that of the carbon monoxide-free sample.

SUMMARY

1. A method for the detection of carbon monoxide in medicinal oxygen has been described.

2. The method which involves a very simple procedure is considerably more rapid than the methods hitherto available and is sensitive to approximately 5 parts per million of carbon monoxide.

REFERENCES

(1) Bell, F. K., and Krantz, J. C., Jr., JOUR. A. PH. A., 27 (1938), 119.

(2) Daller, W., *Z. anal. Chem.*, 103 (1935), 83.

(3) Franzen, H., *Ber.*, 39 (1906), 2069.

A Study of the Extraction of Astringent Drugs*

By H. F. Lefevre† and C. O. Lee‡

Methods of drug extraction have been the subject of much pharmaceutical research. Recent work upon the problem has involved drugs containing alkaloids or other constituents which are rather easily assayed. The astringent drugs and their preparations are not easily standardized because their astringency is attributed to their tannin content for which there is no satisfactory assay.

This study was undertaken for the purpose of applying some of the more recently acquired knowledge of the subject of drug extraction to the preparation of astringent fluidextracts and to establish the following objectives:

* An abstract of a thesis submitted to the faculty of Purdue University in partial fulfilment of the requirements for the degree of Master of Science, August 1939.

† AMERICAN PHARMACEUTICAL ASSOCIATION Fellow, Purdue University, 1938–1939.

‡ Professor of Pharmacy, Purdue University.