

Scholander P F. Analyzer for accurate estimation of respiratory gases in one-half cubic centimeter samples. *J. Biol. Chem.* 167:235-50, 1947.
[Edward Martin Biological Laboratory, Swarthmore College, PA]

A volumetric gas analyzer is described that will determine carbon dioxide, oxygen, and nitrogen in samples of ≤ 0.5 cc with an accuracy of ± 0.015 volume percent. It directly handles samples containing from 0 to over 99 percent absorbable gases. [The SCI® indicates that this paper has been cited in over 1,130 publications since 1955.]

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"My husband, Per Scholander, developed this technique while a research associate in physiology at Swarthmore College. He was very surprised that so many requests were made for this paper; apparently the method was of some use. The reason for developing the technique was that the standard, an excellent Haldane apparatus with similar accuracy, needed a large sample and could not analyze high oxygen contents. His comparative studies called for small samples and very high oxygen content. The main trick in this mini-analyzer was the use of a simple volumetric micrometer burette, based on displacement of mercury from a standard micrometer plunger enclosed in a glass tube.

"The principle of the $\frac{1}{2}$ cc analyzer is as follows: a gas sample is introduced into a reaction chamber connected to a micrometer burette and is balanced by means of an indicator drop in a capillary against a compensating chamber. Absorbing fluids for carbon dioxide can

be tilted into the reaction chamber without causing any change in the total liquid content of the system. During absorption, mercury is delivered into the vibrating reaction chamber from the micrometer burette, while maintaining the balance of the sample against the compensating chamber. Volumes are read in terms of micrometer divisions. Rinsing fluid and absorbents are accurately adjusted to have the same vapor tension.

"The analyzer permits the determination of CO_2 , O_2 , and N_2 in samples of respiratory gases ≤ 0.5 cc with an accuracy of ± 0.015 percent. It will directly handle samples containing up to 99 percent absorbable gases. An analysis requires from 6 to 10 minutes.

"An essential trick is to isolate the surface tension in the reaction chamber from that in the readout capillary. This requires application of a ring of a hydrophobic coating (rosin) about once in every 150-200 analyses. Without that coating, the accuracy is gone. Per had seen this important point disregarded so many times that whenever he saw one of these analyzers in a lab he closed his eyes and hurried past it.

"His lab has used this analyzer on expeditions from the Tropics to the Arctic, in tents and on ships. It was even taken on a Mt. Everest expedition. Per had not used it for years, however, and a number of electronic gadgets have now taken over. The original technique continues its usefulness at least as a standard for calibration of commercially available analyzers."^{1,2}

[Per F. Scholander, emeritus professor of physiology, Scripps Institution of Oceanography, died in June 1980.]

1. Davis R W. Lactate and glucose metabolism in the resting and diving harbor seal (*Phoca vitulina*). *J. Comp. Physiol.* 153:275-88, 1983.
2. Douglas N J, White D P, Pickett C K, Weß J V & Zwillich C W. Respiration during sleep in normal man. *Thorax* 37:840-4, 1982.