Lawrence Berkeley National Laboratory

Recent Work

Title

MASS-SPECTROMETRIC DETERMINATION OF IONIZATION-PRESSURE -GAUGE SENSITIVITIES

Permalink

<https://escholarship.org/uc/item/55x1p995>

Author

Anderson, Harlan U.

Publication Date

1963-02-01

University of California
Ernest O. Lawrence
Radiation Laboratory

MASS-SPECTROMETRIC DETERMINATION
OF IONIZATION-PRESSURE-GAUGE SENSITIVITIES

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 5545*

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UNIVERSITY OF CALIFORNIA

Lawrence Radiation Laboratory
Berkeley, California

Contract No. W-7405-eng-48

MASS-SPECTROMETRIC DETERMINATION
OF IONIZATION-PRESSURE-GAUGE SENSITIVITIES

Harlan U. Anderson

February 1963

Mass-Spectrometric Determination Of Ionization-Pressure Gauge Sensitivities²

Harlan U. Anderson

Lawrence Radiation Laboratory
University of California
Berkeley, California

February 1963

In ionization pressure gauges, pressures are determined from measurement of the current of positive ions produced when a stream of electrons collides with the gas molecules. The sensitivity (S) of such gauges is defined as $i_p/i_e P$, where i_p is the positive-ion current, i_e is the electron current, and P is the pressure of the gas.¹ The sensitivity depends on the probability of successful collisions between electrons and molecules, and therefore varies from gas to gas. Most ionization gauges are calibrated with nitrogen or air and do not read correctly pressures for other gases or gas mixtures. If the sensitivity for a different gas (gas No. 2) is needed relative to the sensitivity for nitrogen (gas No. 1), the pressure gauge readings may be corrected in the following manner.

Since we have $P_1 = (i_{p1}/i_{e1})/S_1$ and $P_2 = (i_{p2}/i_{e2})/S_2$, the ratio of the pressures is $(P_1/P_2) = (S_2/S_1)(i_{p1}/i_{p2})(i_{e2}/i_{e1})$. Since the electron current is held constant, the expression is simplified to $(P_1/P_2) = (S_2/S_1)(i_{p1}/i_{p2})$. If we define $S_2/S_1 = S_{R2}$ as the ion-gauge sensitivity of gas No. 2 relative to reference gas No. 1, the equation becomes $P_1/P_2 = S_{R2} (i_{p1}/i_{p2})$. The ionization gauge reads values of i_p . If the gauge reads the same value for two different gases, then $P_2 = (1/S_{R2})P_1$. This means that a simple factor $(1/S_{R2})$ will convert the reading into the correct pressure for gas No. 2. Unfortunately, the reliabilities of published S_{R2} values for various gases are somewhat doubtful.

because results obtained by different investigators have sometimes differed significantly.

A new method has been devised to calibrate ion gauges for measurements of pressures of gases other than nitrogen. A mass-spectrometer signal is obtained as a function of the apparent (uncorrected) pressures recorded by an ionization gauge. Since the ionization gauge reads correctly only for nitrogen, the mass-spectrometer signal corresponds to a known pressure at the ionization gauge only for nitrogen. If, however, a high-pressure mixture of nitrogen and some other gas, whose partial pressure has been determined with a manometer or other high-pressure gauge, is allowed to leak into the system to establish a steady-state pressure, the mass spectrometer yields intensities that then correspond to the relative pressures of the two gases. From the previous calibration of the mass-spectrometer intensity against pressure for nitrogen, the absolute nitrogen pressure at the ionization gauge is known. The pressure of the second gas then can be determined from the known composition of the mixture. (The pressure ratio of the gauge must be corrected by the ratio of the square roots of the molecular weights of the two gases to correct for their differences in diffusion rates.) The true pressure of this gas at the ionization gauge relative to the mass spectrometer signal is known, therefore.

The method was tested at pressures near 10^{-4} mm for a Veeco Type RG 21A hot-filament ionization gauge with an RG 75K ionization tube. The output was connected to a Sanborn Type 151 amplifying and recording system. The ion-gauge circuit readings drifted less than 2% during a 24-hour period. A Consolidated Vacuum Corporation Type 21-620 mass spectrometer was used with the output recorded on a Varian G-10 recorder. The method is fairly rapid and shows rather good agreement with previous determination. Table I gives results of the measurements with average deviations and includes results of three other investigations for comparison.

FOOTNOTES AND REFERENCES

*This work was done under the auspices of the U. S. Atomic Energy Commission.

1. S. Dushman, Scientific Foundations of Vacuum Technique (John Wiley and Sons, Inc., New York, 1949), p. 333.
2. S. Dushman and A. H. Young, Phys. Rev. 68, 278 (1945).
3. S. Wagener and C. E. Johnson, J. Sci. Instr. 28, 278 (1951).
4. G. J. Schulz, J. Appl. Phys. 28, 1149 (1957).

Table I. Ion-gauge sensitivity relative to nitrogen

Gas	This work	Dushman and Young ^a	Wagener and Johnson ^b	Schulz ^c
H ₂		0.47	0.53	0.42
He		0.16		0.21
Ne		0.24		0.33
A	1.89	1.19		1.5
CO	0.90		1.07	
O ₂	0.90		0.85	
NO	1.16			

^aReference 2^bReference 3^cReference 4

This report was prepared as an account of Government sponsored work.* Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.