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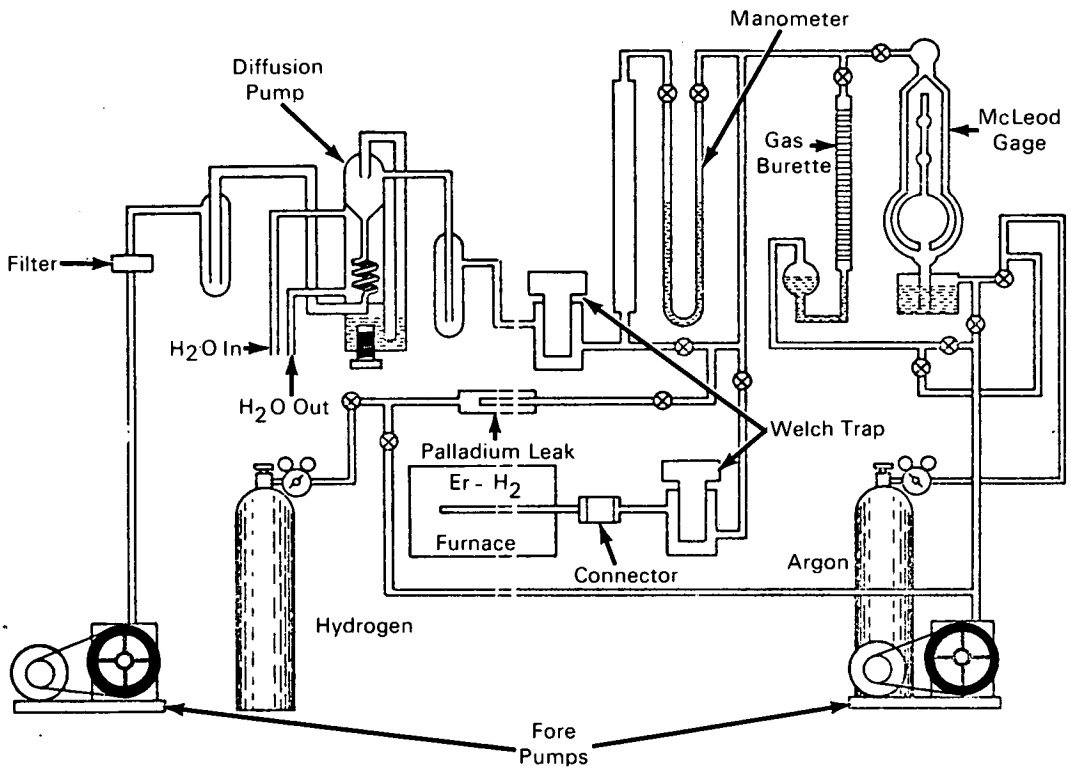
NASA TECH BRIEF

Use of Thermodynamic Properties of Metal-Gas Systems as Low-Pressure Standards



Schematic Diagram of the Modified Sievert's Apparatus

A method has been developed for accurately calibrating low-pressure measuring instruments, using the thermodynamic properties of a metal-gas system composed of hydrogen (H) in two-phase equilibrium with erbium (Er), to obtain reproducible hydrogen pressures.

A schematic diagram of a modified Sievert's apparatus used for making precision measurements is shown. For the two-phase region, Er-H solid solution plus erbium dihydride, a thermodynamic relationship was established. The manner in which the equilibrium pressure of hydrogen over erbium varied as a function

(continued overleaf)

of temperature and composition was determined experimentally for temperatures of 820° to 1220°K and pressures of 4×10^{-4} to 10 torr.

The data were fitted by the van't Hoff equation:

$$\log_{10} P = \frac{-A}{T} + B$$

where P is the pressure (in torr) of hydrogen gas in equilibrium with the two phases (dihydride and solid-solution), T is the absolute temperature, and A and B are constants. If the logarithm of pressure is plotted against the reciprocal of absolute temperature, a straight line is obtained. The slope and intercept of the straight line are represented by A and B, respectively. These constants were very accurately determined for the erbium-hydrogen system. A statistical analysis of the measurement errors was performed.

Data from 12 independent runs representing 252 data points provided the following relationship:

$$\log_{10} P = \frac{-11{,}490 \pm 18}{T} + 10.668 \pm 0.019$$

where the uncertainties in the measurements (the plus and minus terms of the above equation) are one-standard-deviation values determined by computer least-squares analysis. For example, one standard deviation, the uncertainty for a pressure of 10^{-3} torr, is 0.34% of the magnitude of pressure plus the uncertainty of the temperature measurement. Once the equilibrium equation is established, the corresponding erbium temperature can be calculated for the desired hydrogen pressure.

An erbium-hydrogen system will serve as a reliable secondary standard for the calibration of low-pressure measuring instruments. Metal-oxygen and metal-nitrogen systems may also be suitable as secondary standards.

Note:

The following documentation may be obtained from:

Clearinghouse for Federal Scientific
and Technical Information
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.65)

Reference:
NASA-CR-1271 (N69-16099), The Use of Thermodynamic Properties of Metal-Gas Systems as Reduced-Pressure Standards

Patent status:

No patent action is contemplated by NASA.

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