September 1967

Brief 67-10316

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Radiation Counting Technique Allows Density Measurement of Metals in High-Pressure–High-Temperature Environment

The problem:

To develop a system for measuring densities of metals in extreme environments of 2000°C and 500 atmospheres. The extreme environments make conventional metal density measurements impractical.

The solution:

Use of radioactive tracers induced by neutron irradiation to provide a gamma ray flux proportional to the density of the metal.

How it's done:

The vapor and liquid densities of alkali metals at high temperatures and pressures are obtained by measuring the radiation emanating from the vapor and liquid phases of a radioactive alkali metal. The metal is contained in a high pressure cell fabricated from a molybdenum–30 weight-percent tungsten alloy. The radiation counting method involves sealing the metal in a container capsule, irradiating the capsule and metal to produce a gamma-emitting isotope, and then counting the activity of the vapor phase and liquid phase of the metal at increasing temperatures and pressures. A calibration of density versus irradiation level is performed at low temperatures, where accurate liquid density data are available.

Notes:

1. The effectiveness of this radiation counting method has been demonstrated by obtaining vapor and liquid densities of alkali metals from room temperature to near the critical point.
2. Although the equipment and technique were demonstrated on alkali metals, the concept is generally applicable to most metals, as well as to many other substances.
3. A thorough discussion of the technique and capsule used in this procedure, along with background data and results, is published in *The Review of Scientific Instruments*, volume 37, number 5, May 1966.
4. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B67-10316

   Source: I. G. Dillion, P. A. Nelson, and B.S. Swanson
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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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