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Determination of Gas Volume Trapped in a Closed Fluid System

A formula derived from the ideal gas laws is the basis of a technique for rapidly measuring the quantity of entrapped gas in a sealed fluid system. Applicable to many thermodynamic-cycle and hydraulic systems, the technique entails extracting a small, known volume of fluid from the system and measuring the pressure drop that results.

Starting with a lengthy set of assumptions, the ideal gas law is used to describe the state of an entrapped gas bubble before and after fluid extraction. The following equation results:

$$V_s = P_1 P_2 (V_1 - V_2) / P_s (P_1 - P_2),$$

where V_s is the volume of entrapped gas at standard pressure,
 P_1 is the initial system pressure,
 P_2 is the system pressure after fluid extraction,
 P_s is the standard pressure, and
 $(V_1 - V_2)$ is the volume of fluid extracted.

Thus, by extracting a known volume of fluid and measuring the system pressure before and after extraction, the volume of entrapped gas can be computed.

The accuracy of the result depends strongly on the correctness of the initial assumptions. In order to obtain useable data for V_s , correction factors must be applied to compensate for such error sources as: 1) departures of the gas from the ideal; 2) elasticity and thermal expansion of the system container; 3) solubility of entrapped gas in the fluid,

and vapor pressure of fluid in the gas; 4) variation in hydraulic pressure within the system; 5) measurement under nonequilibrium conditions; and 6) leakage of fluid from the system.

Because these corrections are complex, it is not practical to apply this technique for a single measurement on one system. Rather, it is intended for use where multiple measurements are required, either in repeated checks of one system or in single determinations on many identical systems. Under such circumstances, the measurements may be calibrated empirically, or approximate correction factors may be applied in advance, and the technique can then be used to give a go/no-go indication rather than an accurate measurement.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

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Patent status:

No patent action is contemplated by NASA.

Source: J. E. Jolley and W. F. Hunter, of
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