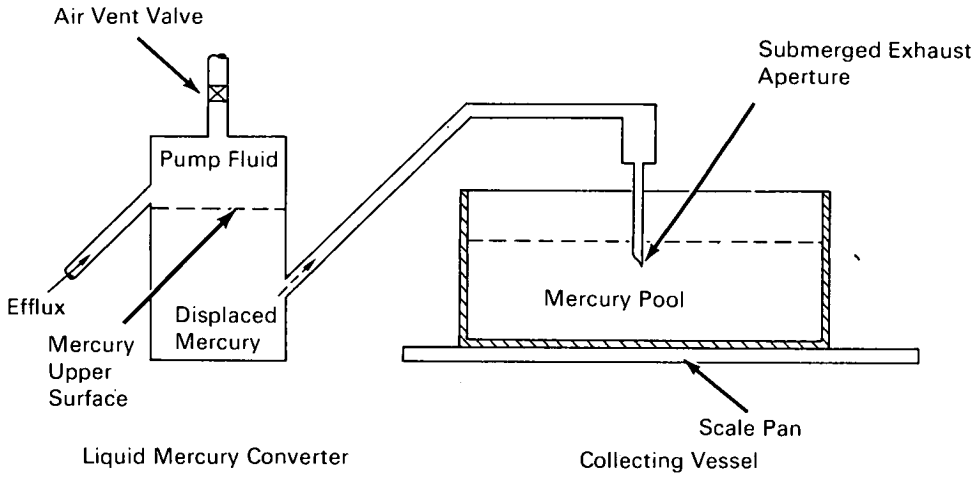
August 1969

Brief 69-10295

NASA TECH BRIEF

A Laboratory Method for Precisely Determining the Micro-Volume-Magnitudes of Liquid Efflux



The problem:

To accurately determine the micro-volume-magnitudes of liquid media expelled from electrostrictive surge pumps or other micro-dispensers of liquids.

The solution:

Discrete micro-volumetric quantities of ejected liquid are made to produce equal volumetric displacements of a more dense material e.g., liquid mercury. Weight measurements are obtained on the displaced, heavier liquid and used to calculate volumes based upon the known density of the heavy medium.

How it's done:

The diagram shows the essential elements of the system. All tubing, vessels and fittings are composed of rigid materials. Ambient temperature is maintained constant to prevent volumetric thermal expansions or contractions of system components and entrained liquids.

The pump or other ejection device is connected via small bore tubing to the exchange vessel (initially charged with mercury to two-thirds capacity). Residual air, entrained between the pump outlet and above the mercury level within the exchange vessel, is displaced through the vent valve by input liquid from the pump. The vent is then closed, and continued pumping causes mercury displacement through the lower outlet tube of the exchange vessel and thence through the "submerged" exhaust orifice into a pool of mercury contained in the collecting vessel. As the mercury column advances toward the exhaust orifice, it displaces entrained air forward of the column until a continuous path of mercury is established between the exchange vessel and the collecting vessel. Pumping is now interrupted. A continuous train of virtually incompressible liquids now exists between the pump and the collecting vessel. Additional finite volume inputs from the pump will produce equal volume displacements of mercury to the collecting vessel.

(continued overleaf)

As indicated in the diagram, the collecting vessel is located on the weighing pan of a balance. The balance employed by the innovator provided 50 μg resolution and allowed for cumulation of weight increments to 200 + mg without change of range.

At this point of the procedure, the balance reading is recorded and the pump is re-actuated to deliver a specific liquid volume. The resulting incremental weight shift indicated by the balance is converted to a highly accurate measurement of actual pump displacement. A calibration curve is used in the conversion to compensate for exhaust tube submersion buoyancy effects attending depression of the scale pan.

Notes:

1. This system was evolved for and used in a study to determine the accuracy and precision of high performance piezo electric pumps. Use of mercury as the high density liquid permitted determinations to within 5 nanoliters.
2. A study of usual methods used for measuring the output of low volume pumps reveals "dribble volume" as a common source of error; i.e., some of the expelled liquid is retained on the pump output aperture and hence is unmeasured. The system described avoids this type of error.
3. Documentation is available from:
   Clearinghouse for Federal Scientific
   and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10295

Patent status:

No patent action is contemplated by NASA.

Source: Roy L. Cloutier of
Berkeley Scientific Laboratories
under contract to
Ames Research Center
(ARC-10052)