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NASA TECH BRIEF

Ames Research Center

System for Measuring Transients in Fluid Flow

The problem:

To measure fluid-flow transients in small fast-acting electrically actuated valves so that performance of the valves can be determined as a function of voltage, pressure, temperature, presence of particulates, number of actuation cycles, and time.

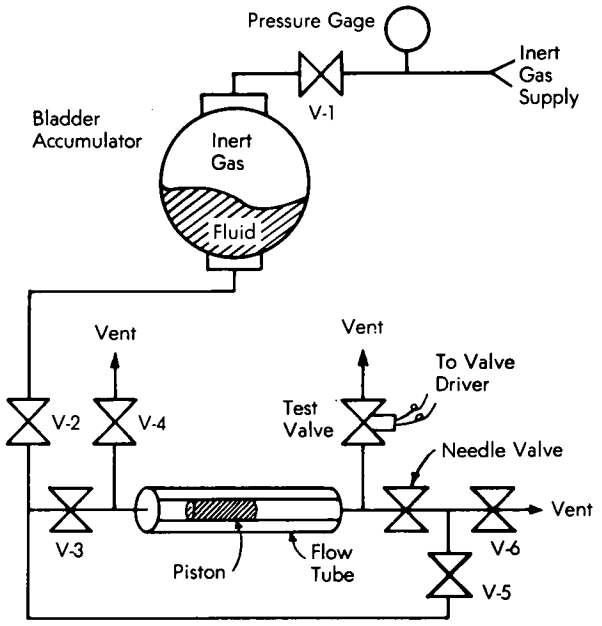
The solution:

Place a piston in the flow stream and measure its displacement with an electro-optical monitor.

How it's done:

The schematic diagram illustrates the valve test station. The piston, placed in precision-bore transparent tubing (2-mm I.D.) before the start of a test, may be an immiscible opaque-dyed fluid of about the same density as the test fluid, or a solid which will form a detectable, contrasting interface with a transparent test fluid; alternatively, the test fluid may be opaque and the piston transparent. At the start of a test, the piston is located near the left end of the flow tube; valves 2 and 3 are open, and 4, 5, and 6 are closed. The needle valve is almost completely open; as it is turned, its stem displaces a varying amount of fluid so that it acts as a vernier control for the initial position of the piston. When the test valve is actuated, the piston is moved by the pressurized fluid, and the displacement is monitored by an electro-optical tracking system and recorded by an oscilloscope camera.

After a test run, valve 5 is opened and valve 3 is closed; the piston is moved back to its original position by manipulating valve 4. Fine adjustments of piston position are made with the needle valve while observing a dc voltmeter attached to the output of the electro-optical tracker. If the piston is moved too far to the left, it can be repositioned by opening valve 3, closing valve 5, and opening valve 6. Gas bubbles in the system will be indicated by anomalous piston motion during the repositioning process.



The piston is magnified to form a 25-mm diameter by 25-mm long image by a system composed of three cylindrical lenses, one of which is the thick-walled glass flow tube itself. This system provides magnification only in the direction transverse to the motion of the piston, and prevents the tracker from losing the thin piston without introducing errors in measurements of the piston's position.

The electro-optical monitor produces an output voltage proportional to the displacement of the piston. The photograph of the oscilloscope display characterizes the transient flow properties of the valve since the displacement voltage is directly proportional to the flow volume. An electronic differentiator can be

(continued overleaf)

used to convert volume—time signals to flow-rate signals, which are not readily relatable to the performance of the valve and actuator; extremely small fluid flow rates can be measured.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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Reference: TSP 74-10217

Patent status:

NASA has decided not to apply for a patent.

Source: Durk J. Pearson of
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