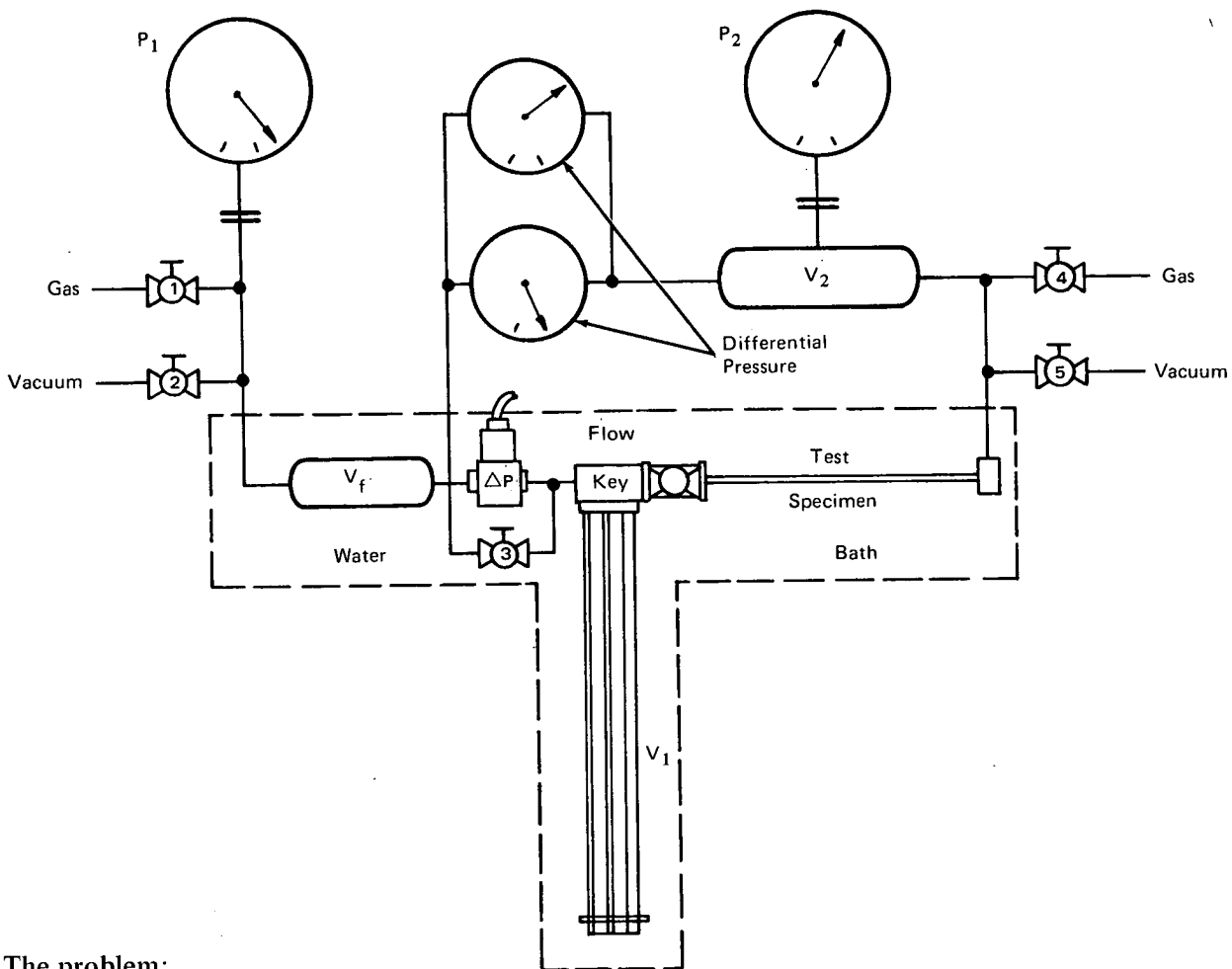
June 1972

B72-10289

NASA TECH BRIEF

Goddard Space Flight Center

Flow Equation for Porous Plug and Capillary Tube Flow Restrictors



The problem:

Until recently, the relationships predicting the low-flow performance of resistojet thruster systems were nonexistent. The compressible Darcy equation and the Green and Duwez expression did not adequately describe the low-flow characteristics of such systems.

The solution:

An empirical model was formulated for both the porous and capillary elements that describes their low-flow characteristics.

How it's done:

Sets of metal flow restrictors covering two orders of magnitude of permeability were flow tested with nitrogen, argon, and ammonia gases. Measurements were taken using the apparatus shown in the figure.

(continued overleaf)

Fresh test gas is introduced through valve #1 at the pressure measured by gage P_1. With the valve #3 open, both the reservoir volume V_1 and the reference volume V_f are charged to the same initial pressure. Electronically operated valve #6 separates the test gas from the test specimen on the downstream side of the key block. Constant pressure downstream is maintained by the surge tank V_2 and is monitored by gage P_2. The switch controlling valve #6 is connected to an electronic counter which measures the flow duration. From this duration, an average flow rate is derived.

The flow charts generated from the test data suggest that the following model is useful for both porous and capillary elements:

$$\dot{w} = \frac{K}{T}(P_1^{\,n} - P_2^{\,n})$$

where $\dot{w}$ is the mass flow rate; T is the absolute temperature; P_1 and P_2 are the absolute upstream and downstream pressures, respectively; n is a pressure exponent indicating the resultant effects of viscous and inertial forces; and K is a constant related to the physical characteristics of the restrictor such as area, length, permeability, surface roughness, etc.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
Code 207.1
Greenbelt, Maryland 20771
Reference: TSP72-10289

Patent status:

No patent action is contemplated by NASA.

Source: W. S. Davis of
Avco Corp.
under contract to
Goddard Space Flight Center
(GSC-11387)