Balanced Flow Meters Without Moving Parts

These meters perturb flows less than their predecessors do.

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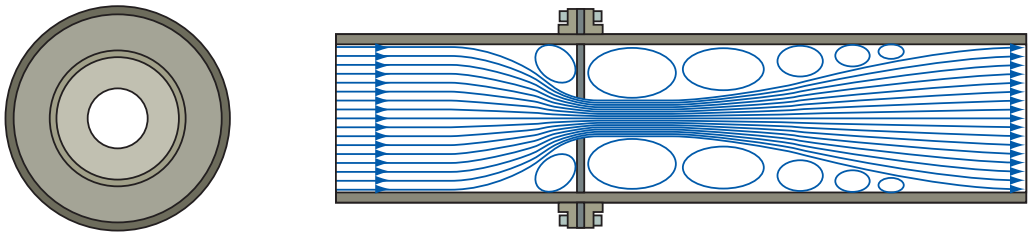
Balanced flow meters are recent additions to an established class of simple, rugged flow meters that contain no moving parts in contact with flow and are based on measurement of pressure drops across objects placed in flow paths. These flow meters are highly accurate, minimally intrusive, easily manufacturable, and reliable. A balanced flow meter can be easily mounted in a flow path by bolting it between conventional pipe flanges. A balanced flow meter can be used to measure the flow of any of a variety of liquids or gases, provided that it has been properly calibrated.

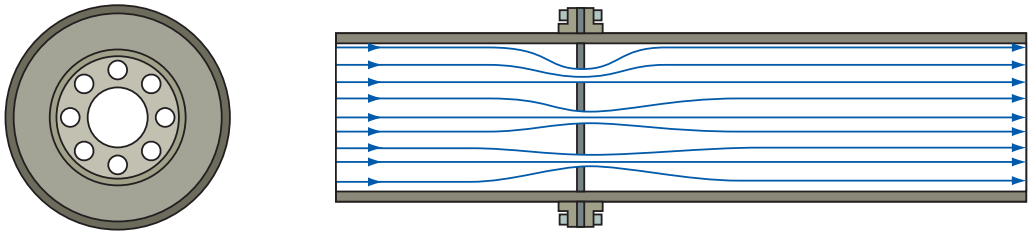
The innovative aspects and advantages of a balanced flow meter are probably most easily understood by comparing it with its most closely related predecessor, a standard orifice-plate flow meter (see figure). Any flow meter based on the aforementioned pressure-drop principle necessarily introduces some turbulence, permanent pressure loss, and concomitant dissipation of kinetic energy of flow. The turbulence, in turn, introduces a degree of non-repeatability into the measurements and increases the degree of uncertainty of the relation between differential pressure and the flow rate. Relative to the standard orifice-plate flow meter, the balanced flow meter introduces less turbulence and two times less permanent pressure loss and is therefore capable of offering 10 times greater accuracy and repeatability with less dissipation of energy. A secondary benefit of the reduction of turbulence is the reduction of vibration and up to 15 times less acoustic noise generation.

Both the balanced flow meter and the standard orifice-plate flow meter are basically disks that contain holes and are instrumented with pressure transducers on their upstream and downstream faces. The most obvious difference between them is that the standard orifice plate contains a single, central hole while the balanced flow meter contains multiple holes. The term "balanced" signifies that in designing the meter, the sizes and locations of the holes are determined in an optimization procedure that involves balancing of numerous factors, including volumetric flow, mass flow, dynamic pressure, kinetic energy, all in an effort to minimize such undesired effects as turbulence, pressure loss, dissipation of kinetic energy, and non-repeatability and nonlinearity of response over the anticipated range of flow conditions. Due to proper balancing of these factors, recent testing demonstrated that the balanced flow-meter performance was similar to a Venturi tube in both accuracy and pressure recovery, but featured reduced cost and pipe-length requirements.

This work was done by Anthony R. Kelley of Marshall Space Flight Center and Paul Van-Buskirk of Quality Monitoring and Control.

This invention has been patented by NASA (U.S. Patent No. 7,051,765). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-31952-1.





The **Flow in the Balanced Flow Meter** is straighter and less turbulent. One consequence is the net pressure loss downstream for the balanced flow meter is less than half that of the standard orifice-plate flow meter.