National Aeronautics and
Space Administration

TECHNOLOGY SOLUTION

Sensors

Optical Mass Sensor for Multi-Phase Flows

Noninvasive device provides both static and dynamic measures of void fraction in gas-vapor mixes

NASA's Marshall Space Flight Center is offering opportunities for its new fiber optic mass flow sensor system. Capable of measuring multi-phase flows in a pipe, the technology is minimally invasive, cost effective, retrofittable, and compact. MSFCs new technology combines high accuracy, intrinsically safe operation, and low-cost flow sensing for virtually any optically transparent medium, providing a superior product for measuring multi-phase flows.

BENEFITS

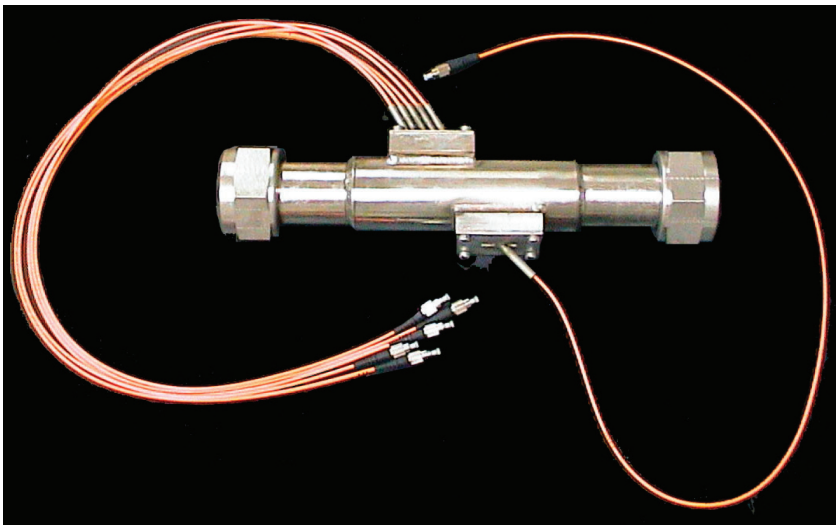
- Provides void fraction and quality values through real-time flow rate measurement
- Has no moving parts
- Keeps all sensor components external to flow path and insensitive to pipe material
- Is safe from electromagnetic interference and poses no radiation hazard
- Retrofits to existing piping systems from 0.5 to 12 in diameter
- Accommodates various flow schemes found within pipes including bubbles
- Is a potentially inexpensive sensor design

THE TECHNOLOGY

Unlike commercial turbine and Venturi-type sensors, which are flow intrusive and prone to high error rates, NASA's new flow sensor technology uses an optical technique to precisely measure the physical characteristics of a liquid flowing within a pipe. It generates a reading of the flows density, which provides a highly accurate mass flow measurement when combined with flow velocity data from a second optical sensor.

NASA's sensor technology provides both a void fraction measurement, which is a measurement of the instantaneous gas/liquid percentage of a static volume and a quality measurement, which is the fraction of flow that is vapor as part of a total mass flow. It also provides a direct measurement of the gas/liquid concentration within the flow, making it suited for real-time measurement of multi-phase flows.

The technology was originally developed to accurately determine the flow rates and tank levels of multi-phase cryogenic fuels used on various NASA vehicles including the Space Shuttle and in ground-based propulsion testing. It can also be used for a wide range of gas/liquid ratios, flows with complex cross sectional profiles, flows containing bubbles or quasi-solids, and essentially any liquid, gas, or multi-phase flow that can be optically characterized. Because it is insensitive to position, the new technology also has potential for use in zero-gravity tank level sensors.



The NASA optical mass flow sensor as designed for in-line cryogenic fuel measurements.

APPLICATIONS

The technology has several potential applications:

- Cryogenic liquid and fuel flow, handling, and storage measurements
- Oil and gas industry multi-phase flows
- Industrial, automotive, and aerospace multi-phase flows
- Powder spray coatings
- Food processing
- Chemical processing, handling, and storage
- Zero-gravity liquid tank level sensors

PUBLICATIONS

Patent No: 7,738,084

-V. Korman. "Density and Cavitating Flow Results from a Full-Scale Optical Multiphase Cryogenic Flowmeter", (2007)

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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More Information

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