Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00158

Thin Film Air Mass Flow Sensor

Technology

This technology uses thin film resistance temperature detectors in a bridge arrangement to measure air mass flow rate with minimal disruption of the flow.

Benefits

This thin film mass flow sensor offers many advantages over existing mass flow sensor designs:

- A design that is fabricated on a thin airfoil to minimize flow disturbance
- A simple design that allows for low-cost batch fabrication
- A symmetrical design that allows measurement of forward and reverse flows
- A scalable design that can be sized to each specific application

Commercial Applications

- Automotive and truck intake manifolds
- Diesel generator intake manifolds
- Industrial gas mass flow sensors

Technology Description

Researchers at the NASA Glenn Research Center have developed a new air mass flow sensor to solve the problems that plague existing mass flow sensor designs. NASA's design consists of thin film resistance temperature detectors (RTDs) in a Wheatstone Bridge arrangement. To minimize disturbance to the airflow being measured, the RTD's are fabricated on a thin, constant-thickness airfoil; figure 1 shows one of NASA's prototype sensors. Compared to other air mass flow sensor designs, NASA's thin film sensor

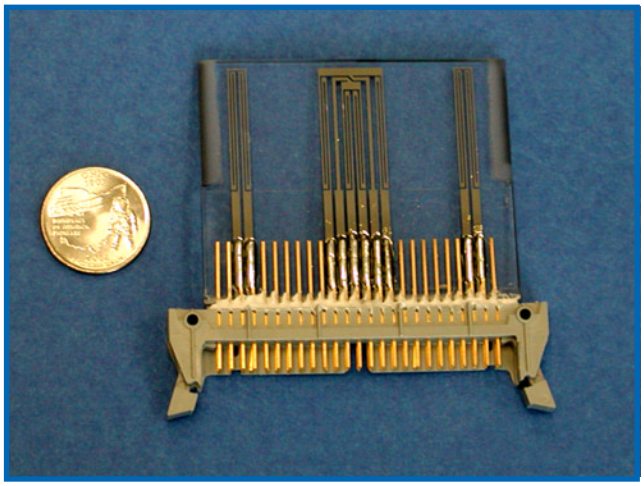

Figure 1.—Mass flow sensor.

- Is much more robust than hot wires
- Causes less airflow disturbance than pitot tubes
- Is more accurate than vane anemometers
- Is more simple to operate than thermocouple rakes

NASA's thin film air mass flow sensor works by converting the temperature difference seen at each leg of the thin film Wheatstone Bridge into a mass flow rate. Figure 2 shows a schematic of this sensor with air flowing around it. To operate the sensor, current is applied to the upstream leg of the bridge, which causes an increase in the temperature of that leg. The air passing over that leg has a cooling effect that reduces the leg's temperature and leads to reduced electrical resistance for that leg. The air, which has picked up the heat from the upstream leg, continues and passes over the downstream leg of

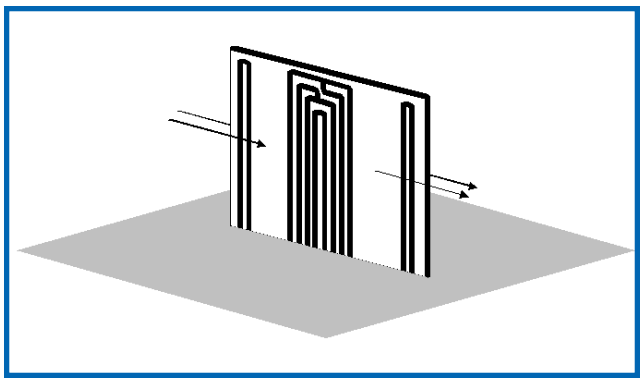

Figure 2.—Flow schematic.

the bridge. The heated air raises the temperature of this leg, which increases its electrical resistance. The resistance difference between the upstream and downstream legs unbalances the bridge causing a voltage difference that can be amplified and calibrated to the airflow rate. Separate temperature sensors measure the temperature of the airflow and are used to complete the calculation for the mass of air passing by the sensor.

A current application for air mass flow sensors is part of the intake system for an internal combustion engine. A mass flow sensor is used to provide accurate information about the amount of air entering the engine so that the amount of fuel can be adjusted to give the most efficient combustion. The ideal mass flow sensor would be a rugged design that minimizes the disturbance to the flow stream and provides an accurate reading of both smooth and turbulent flows; NASA's design satisfies these requirements better than any existing design. Most of the mass flow sensors used today are the hot wire variety. Hot wires can be fragile and cannot accurately measure a turbulent or reversing flow, which is often encountered in an intake manifold. Other types of mass flow sensors include pitot tubes, vane anemometers, and thermocouple rakes; all of which suffer from some type of performance problem. By solving these performance problems while maintaining a simple design that lends itself to low-cost manufacturing techniques, NASA's thin film RTD air mass flow sensor should lead to a more widespread use of mass flow sensors.

Options for Commercialization

NASA has been awarded a patent for this technology. NASA transfers its patented technology by licensing to companies that are able to develop the technology into commercial products. If you are interested in pursuing a license agreement for this technology, or if you would like to talk with NASA Glenn's thin film sensor experts, please contact the CTO office listed below.

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Reference

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Keywords

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Wheatstone Bridge