Automated Hydrogen Gas Leak Detection System

Leak-monitoring system with visual display of leak location.

The Gencorp Aerojet Automated Hydrogen Gas Leak Detection System was developed through the cooperation of industry, academia, and the Government. Although the original purpose of the system was to detect leaks in the main engine of the space shuttle while on the launch pad, it also has significant commercial potential in applications for which there are no existing commercial systems. With high sensitivity, the system can detect hydrogen leaks at low concentrations in inert environments. The sensors are integrated with hardware and software to form a complete system. Several of these systems have already been purchased for use on the Ford Motor Company assembly line for natural gas vehicles.

This system to detect trace hydrogen gas leaks from pressurized systems consists of a microprocessor-based control unit that operates a network of sensors. The sensors can be deployed around pipes, connectors, flanges, and tanks of pressurized systems where leaks may occur. The control unit monitors the sensors and provides the operator with a visual representation of the magnitude and locations of the leak as a function of time. The system can be customized to fit the user's needs; for example, it can monitor and display the condition of the flanges and fittings associated with the tank of a natural gas vehicle.

This leak-detection system deploys palladium/silver (PdAg) solid state hydrogen sensors at potential leak sites, such as vehicle fuel-line connections. The hydrogen sensors are the enabling technology and major innovation of the product. They are operated by a microprocessor-based control system that acquires data and uses closed-loop control to maintain the sensors at a constant temperature of approximately 80 °C. The PdAg sensors can detect hydrogen concentrations from 1 to 4000 ppm and do not require an oxygen atmosphere for this detection. Included on the sensor chip are a temperature detector and a heater. These allow temperature control and stable sensor operation in environments with varying temperatures. The PdAg sensors were developed by Case Western Reserve University in cooperation with the NASA Lewis Research Center. The sensor technology has been licensed to GenCorp Aerojet for commercial applications and in-house production.

The microprocessor-based electronics were developed by GenCorp Aerojet for NASA Marshall Space Flight Center for flight applications. Using multiplexing techniques, these electronics permit operation of up to 128 sensors. Signals are conditioned by hardware located near the sensor, and the resulting signal is fed to a multiplexing unit. Graphical, PC-based software displays the sensor readings and derived values, such as leak rate (e.g., standard cubic centimeters per hour (sccm/hr)), as well as a graphical image corresponding to the position and magnitude of the leaks.

A prime application of this system is checking pressurized systems for leaks as a part of safety and quality control. Such leak checking can be done with inert gas mixtures as well as with combustible hydrogen mixtures. Preferably, an inert mixture such as 1% H_2/99% N_2 can be used. The sensors are interfaced to a fuel-line component by a flexible $quot;boot" that surrounds the component to be tested (such as a fitting). When the system is pressurized, a leak causes the detected hydrogen concentration in the boot to increase. The rate of rise of the hydrogen concentration is proportional to the leak rate. The quantitative leak rate is determined by calibration of the sensor boot to account for the free volume of the boot and any leakage of gas out of the boot. The graphical interface displays an image of the boot with the plume of the leak, allowing the operator to pinpoint the leak.