Northeast GAS ASSOCIATION

NYSEARCH

Technology Brief

Low Cost, Highly Accurate and Reliable Micro-Resonator-Based Methane and Natural Gas Sensor

Description: **A robust, low cost and reliable methane and natural gas sensor, based on Micro-resonator technology, is being developed for natural gas applications.**

Status: **Prototype sensor and instrument are undergoing extensive field testing.**

BENEFITS

Methane detectors are used widely by natural gas utilities personnel as well as natural gas customers in order to detect the presence of natural gas. The most widely used sensors are those installed to sense a natural gas leak. Given that the lower flammability limit of methane in air is about 5% by volume, these sensors typically operate in the 0 – 5% range. Another set of applications is that of measuring the concentration of natural gas in order to determine the absence of other desirable or undesirable gases. These sensors typically require an operational range of 0 – 100% methane. Existing sensors are either too expensive for many of these applications or do not have the required sensitivity and lower detection limit. Thus the availability of an inexpensive, robust, highly sensitive methane sensory device for detecting natural gas in the 0 - 100% concentration levels could benefit the entire industry.

BACKGROUND

A number of instruments are available in the market that measure concentration of methane and/or combustibles. They vary in accuracy, range, price, and calibration needs. Typically, low cost sensors suffer from reliability and robustness issues, resulting in many false positive alarms. Similarly, higher cost sensors are sensitive enough but only at the low end or the upper end of the methane-in-gas concentration range. Sensory technologies are rapidly developing this last decade and great advances have been made on many fronts. A continuous search within NYSEARCH is being made for new technologies that could provide the industry with such a sensor. Through the Oracle project, NYSEARCH has identified the micro-resonator technology as a technology able to provide all the features needed.

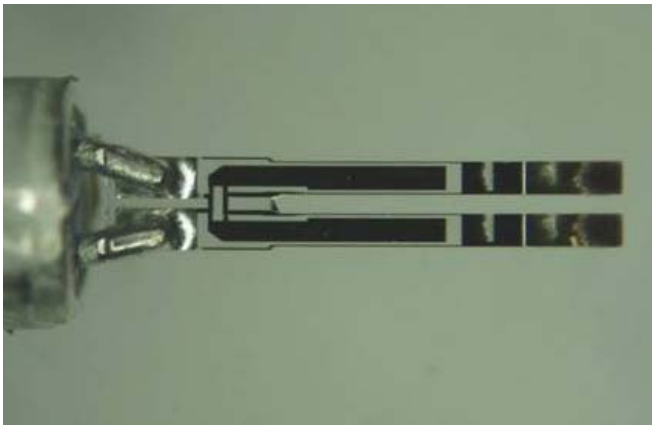

Figure 1: Tuning Fork Used in the MR Methane Sensor

TECHNICAL APPROACH

With funding from NYSEARCH, Applied Nanotech, Inc. of Austin, TX, initiated a feasibility study to determine whether an inexpensive, line and/or battery powered, miniature methane (natural gas) sensor could be developed based on its micro-resonator technology, with a range of zero to 100% in air or nitrogen, a detection limit of 0.25%, and a resolution of 0.1%. The targeted commercial price of the instrument should be no more than $500 and its total weight less than one pound.

A micro-resonator is a sensor able to measure the viscosity of a gas mixture. Changes in gas composition give rise to changes in the oscillation frequency of a tuning fork microresonator (MR). This methane sensor uses a pair of quartz tuning forks (see Figure 1) oscillating at a very high frequency. The frequency difference between a measuring microresonator and a reference microresonator enclosed in a vacuum package will be proportional to the methane concentration in a mixture of natural gas and air. Since the resonance frequency of a microresonator depends on the ambient temperature and pressure, the MR sensor also incorporates

Figure 2: Engineering Prototype of MR Methane Sensor

pressure and temperature sensors for compensation against variations of ambient conditions. In addition, a humidity sensor will allow for compensation due to variable humidity levels in the mixture. Given that sensor elements have both digital and analog outputs, the system has an analog-to-digital converter integrated into it. Finally, due to the fact that different sensor components will have slightly different electrical characteristics, each sensor will have individual calibration requiring a 5V power source. The final engineering prototype is shown in Figure 2.

PROGRAM STATUS

The development of the methane sensor has been completed and laboratory testing has shown that all specifications have been met. The sensor is currently undergoing field testing at NYSEARCH member companies to determine its robustness, reliability and performance. At the successful completion of the field testing program, the commercialization effort will be initiated.

Highlights

METHANE SENSOR SPECIFICATIONS

- Concentrations range 0 – 100%
- Operating temperature -20°C to 50°C
- Storage temperature -40°C to 90°C
- Relative humidity 0-95%
- Ambient pressure 30 - 110 kPa
- Response Time (T_{90}) 1 sec
- Alarm limit 1%
- Accuracy 0.25% of full scale
- Resolution 0.1% of full scale
- Supply voltage 5.0 VDC

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