Northeast GAS ASSOCIATION NYSEARCH

Technology Brief

# Development of Mercaptans Sensor with Non-Radioactive Ionizer

**Description:** **A program to develop a small, portable, sensor with a non-radioactive ionizer to detect and measure mercaptan concentrations at very low levels using gas chromatography (GC) and differential mobility spectroscopy (DMS) technologies.**

**Status:** **All sensor components: the non-radioactive ionizer, sorbent trap, power control module, the DMS module, GC, and microcontrollers are currently undergoing integration into a single operating unit.**

## BENEFITS

The use of odorants for natural gas detection is considered one of many major public health and safety advancements for the gas distribution industry. Small volumes of certain sulfur compounds known as mercaptans are injected into odorless natural gas to make it detectable. Currently, the primary method to detect mercaptans in natural gas is through operator "sniff" tests and costly gas chromatography lab analyses. A new technology to allow the measurement and detection of mercaptan concentrations at the parts per billion level which is the same level as that detectable to the human nose, would allow a more informed view and reduce the need for utility personnel to sniff natural gas for mercaptans. A highly sensitive mercaptan sensor would also provide rapid, reliable, and continuous results during spot checks throughout the gas distribution system.

## BACKGROUND

The odorization of natural gas is a federal requirement and local distribution companies (LDCs) follow their own comprehensive odorization program. Distributed natural gas must be readily detectable with a normal sense of smell at a concentration of one-fifth of the lower explosive limit. To verify this requirement, utility operators perform sniff tests to confirm the gas contains enough odorant. Quantifying the specific concentration of odorant within natural gas distribution lines is one of the main objectives of this project. Precise and detectable rapid quantification of mercaptan concentrations in natural gas are desired.

Following an initial feasibility study evaluating the performance of a non-radioactive mercaptans sensor, detection levels of mercaptan ranging from 0.1 parts per billion (ppb) to 8ppb were established. The human nose can detect mercaptans at concentrations as low as single parts per billion. The successful completion of the feasibility study, laboratory testing, and initial field testing of this project provided confidence in moving forward with further optimization and field testing. However, instability issues around mercaptans chemical degradation were encountered during field testing. UC Davis was identified as the chemical sensor experts to study and resolve these instability issues.

The team at U.C. Davis tested numerous trap materials and identified a sorbent trap that prevented further degradation of the parent mercaptan compound during analysis. The re-configured prototype with this new sorbent trap could detect mercaptans in the single parts per billion range without any stability issues as previously encountered.

The need to develop a portable mercaptans sensor with a non-radioactive ionizer using this new sorbent trap and more advanced separation technologies became apparent as the original components of the mercaptans sensor for the previous NYSEARCH work were no longer

commercially available.

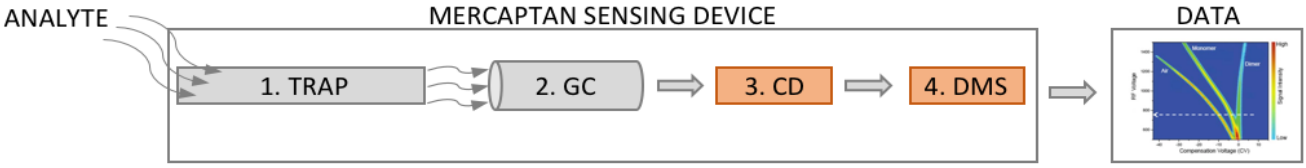


**Figure 1. Diagram of mercaptan detection**

## TECHNICAL APPROACH

The technology of the mercaptans sensor is based on a combination of gas chromatography (GC) and differential mass spectroscopy (DMS). NYSEARCH has tested GC-DMS mercaptans sensors with both radioactive and non-radioactive ionizers. The development of a highly sensitive mercaptans sensor with a non-radioactive ionizer begins with building and optimizing various modules and integrating all those components into a portable field unit. Figure 1 above shows the sample flow of a mercaptan sample.

UC Davis has successfully demonstrated corona discharge (CD) as an adequate non-radioactive ionization source and is in the process of developing and refining the µDMS module to be integrated with the corona discharge system. UC Davis has exhibited substantial knowledge and experience in development and evaluation of Ion Mobility systems of which GC/DMS is a subset. They have worked to modularize newer, more compact systems and through prior NYSEARCH work have solved the instability problem on the original NYSEARCH/ANI system. They have also developed a thorough knowledge of how the system is customized for gas industry in-line mercaptan sensing and smart nose applications.

Five different mercaptans predominantly used in the gas industry are selected for characterization with the newly developed GC/DMS: normal-propyl mercaptan (NPM), tert-butyl mercaptan (TBM), iso-propyl mercaptan (IPM), dimethyl sulfide (DMS), ethyl mercaptan (EM), and tetrahydrothiophene (THT).

Following modular testing with the select mercaptans and integration of all the component modules of the GC/DMS sensor, the prototype will be configured into a portable package as shown in Figure 2.

**Figure 2. Model of finished mercaptans sensor with non-radioactive ionizer**

## PROGRAM STATUS

Benchtop prototype testing is ongoing and integration of all the modules will be the next steps prior to organizing a field test for further testing. NYSEARCH intends on transferring the product to a commercial partner for final product development and introduction to market.

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