Northeast GAS ASSOCIATION
NYSEARCH

Technology Brief

Highly Sensitive Mercaptans Instrument for Odorant Characterization in Gas Mains

Description: **A mercaptans instrument based on a combination of differential mobility spectroscopy and gas chromatography to achieve very low levels of detection.**
Status: **Prototype instrument is undergoing laboratory testing.**

BENEFITS

Sulfur compounds (mercaptans) are either artificially introduced in very small amounts in odorless natural gas by operators, in order to make its detection in case of leakage noticeable, or they exist in very small concentrations naturally in alternate supplies of natural gas, such a landfill gas, biogas, etc. As a result, they are considered "trace" compounds. In any case, it is imperative to be able to measure their concentration in the gas because their interaction with components of the infrastructure can result in corrosion and other undesirable effects and/or because we need to know that there is enough of them to be sensed by humans in case of a leak. At the present time, they can be detected only through the use of bulky and expensive gas chromatographs.

From the above, it is clear that the industry would benefit from an instrument that would allow it to measure the concentration of mercaptans in natural gas and other related gases in the field. The instrument needs to be less expensive than gas chromatographs, portable, and accurate enough to detect mercaptans at the 1 ppb level, i.e. the level of detection of the human nose.

BACKGROUND

Mercaptans are sulfur compounds that are used to odorize natural gas so that leaks are apparent. They are introduced in the gas stream at various locations in the natural gas distribution system. The human nose can detect this odorant because it is sensitive to mercaptans at levels of a few parts per billion (ppb)! Regulations require that operators conduct periodic sampling of natural gas to ensure proper concentration of odorant. Proper level is considered a concentration that allows the average person to detect a natural gas leak that has resulted in a concentration of natural gas in air of less than 1/10 of the lower flammability limit, which is about 5% natural gas in air. Dedicated employees periodically "sniff" samples of natural gas drawn from various parts of the system and measure the level of natural gas concentration in air at which detection is sensed. If that level is below the 0.5% (1/10th of 5%) limit, then the gas is considered to be properly odorized. Given the various levels of sensitivity to smell that individuals exhibit, the test is subjective. However, there is no accurate, portable mercaptans instrument in the market that would allow LDCs to carry such a test on a routine basis and replace the sniffing test. Existing gas chromatographs are expensive and bulky for this purpose.

TECHNICAL APPROACH

NYSEARCH in collaboration with PHMSA/ USDoT, is funding Applied Nanotech, Inc., of Austin, TX, to develop an instrument able to measure the main components of mercaptans mixtures routinely encountered in natural gas, renewable natural gas, biogas, landfill gas, etc. The instrument will allow the detection and measurement of such compounds at the parts per billion (ppb) level, thus serving as an artificial human nose. The instrument is based on a combination of Gas Chromatography (GC) and

Differential Mass Spectroscopy (DMS; which advances the art of ion mobility spectroscopy). A schematic diagram of the basic principles behind the GC-DMS technology is depicted in Figure 1. A gas sample is introduced into the instrument through the micro trap. First the gas is flowed through the GC column where the components of interest (mercaptans) are separated from the rest of the gas. These components of interest eluted by the GC then flow into the DMS unit, where they first flow through an ionization region, where molecules

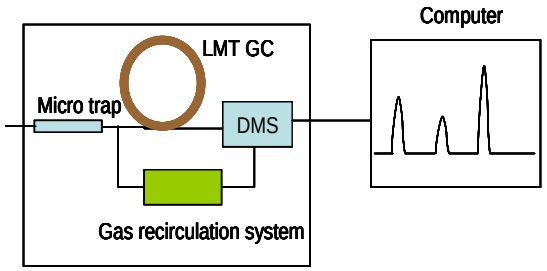

Figure 1: Depiction of Combined Gas Chromatography and Differential Ion Mobility (DMS) Technology

are ionized. In the ion filter, the charged molecules are filtered according to their "mobility", i.e. the speed with which they move in an electric field of certain strength. The selected ions, both positive and negative, are then detected by collector electrodes and identified based on their mobility (which is unique for each molecule and is experimentally determined). The elemental composition of the analyses is thus determined. The technology has demonstrated capability of measuring multiple analyses in the ppb range or better with a high degree of selectivity and can be made small and portable. The chosen mercaptans for this program were tert-butyl mercaptan (TBM), normal propyl mercaptan (NPM), iso-propyl mercaptan (IPM) and ethyl mercaptan (EtM). These mercaptans are the most widely encountered in the blends used by the natural gas industry.

PROGRAM STATUS

A feasibility study was first carried out to establish the ability of this technology to detect mercaptans at the ppb level. Upon successful completion, an effort was undertaken to develop a laboratory prototype instrument (see Figure 2) in order to optimize the various components and design critical components. In an on-going effort, an engineering prototype is being built which, upon completion of a complete set of laboratory studies, will be tested in the field by NYSEARCH member companies. Field testing is expected to be initiated by the end of 2011. Upon successful completion of the field tests, commercialization of the technology will be undertaken.

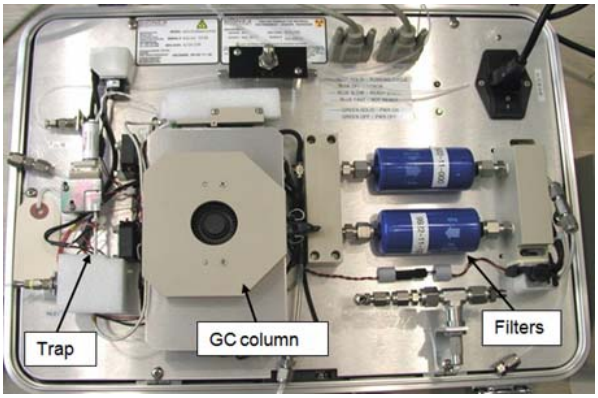

Figure 2: Laboratory Prototype Mercaptans Instrument

Highlights

- Sensor can detect mercaptans with same sensitivity as human nose (at the ppb level)
- Prototypes have undergone successful lab testing
- Field testing and commercial transfer are planned

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