DETERMINING PROPER ODORIZATION LEVELS

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History:

Over 300 people died in an explosion on March 18, 1937 in a New London, Texas public school building. The natural gas that was being delivered to the school building was not odorized. At that time the natural gas was odorless, and there wasn't a law on record to mandate Odorization.

As a direct result of this incident the United State Government passed a law that the chemical "Mercaptan" be put into natural gas to give it an identifying smell.

Odorization requirements:

Odorization of natural gas is regulated under the Federal Department of Transportation (DOT) Title 49, Part 192.625. The code basically states that "a combustible gas in a distribution line must contain a natural odorant or be odorized so that at concentration in air, of one-fifth of the lower explosive limit, the gas is readily detectable by a person with a normal sense of smell".

Since it was first introduced, this regulation has often led to the following question. What constitutes a person with a normal sense of smell? We as humans all have varying abilities to detect odors through our olfactory senses. It has been proven in scientific studies that age, gender, and physical ailments such as allergies and cigarette smoking all affect one's ability to detect odor. This has left us with a very "qualitative" means of detecting odorant through the use of the nose and a testing device that provides us the gas-in-air mixture. Many then ask the question why not use a more "quantitative" means of determining the odorant concentration?

We do have odorizers that can provide us with extremely accurate volumes of odorant being put into the gas distribution system. We also have extremely accurate means of measurement to determine gas volumes downstream of the odorizer. This then becomes a very simple mathematical computation of odorant volume verses natural gas measurement. This sounds all well and good, but one must remember that there are many other factors which affect the quantity and quality of the odorant that can be completely out of our control.

Factors which affect odor quality:

A key issue is finding an accurate means of computing volumes of odorant into the natural gas distribution system. How are we then able to determine whether the odorizer is functioning properly at all times? There are many types of odorizers available that employ several means of dispensing odorant into the distribution system. Many of these systems are affected by contaminants in the odorizer, and this raises the question of whether personnel are able to identify when this is occurring. A natural gas company must determine which type of odorizer, injection, bypass or wick, is best for each particular piping application.

The industry is now in an age of deregulation, with open access within natural gas transmission piping networks. Utilities and distribution companies are now able to get gas from numerous geographic locations including, the Gulf of Mexico, West Texas, Oklahoma, Western Canada, and the plain States (to name a few). Today we can also add the shale gas "plays" to the mix from various locations around the country as well other sources like refinery gas, landfill gas, LNG, etc. It use to be that companies on the downstream end of the supply chain consistently knew where they were getting their gas from, and what the quality and natural occurring odorants were contained in this source. Today, there is often a "blend" which can certainly affect chemical reaction with different odorant blending in the pipeline.

This open access and "blending" now allows for various gas quality issues, including the formation of distillates in the pipeline that can literally absorb odorant from the natural gas stream. Steps must be taken to insure that these liquids are removed from the system.

With newly installed plastic pipe, there can be other factors as well, including pipe wall adsorption. Generally, higher concentrations of odorant are added during the initial commissioning of a new pipeline which can, in effect, "pickle" the pipeline. With steel distribution pipe, internal corrosion can produce internal contaminants that can react chemically through oxidation; and this can certainly affect odorant concentration.

It has been noted that physical ailments, such as allergies and smoking, can affect a person's olfactory senses, and thus their ability to detect odorant. There can also be external odors within a residence or business that make it difficult to detect odorant, such as fumes from cooking, perfumes, and/or cleaning products. It is also possible for natural gas to travel through the soil from pipeline leaks, and lead to the loss of odorant via soil adsorption. A gas company must determine the appropriate blend of odorant for their particular geographic location.

Odorant concentration instruments:

The current regulation for odorant concentration testing is primarily met with the use of electronic instruments. DOT 192.625 (f) states" To assure the proper concentration of odorant in accordance with this section, each operator must conduct periodic sampling of combustible gases using an instrument capable of determining the percentage of gas in air at which the odor becomes readily detectable". These instruments all employ the use of the human nose (as stated in the regulation) to determine the gas-in –air mixture at which an individual can detect the smell of odorant. There are currently three instruments available for this use:

Bacharach Odorometer. This instrument is manufactured by the Bacharach Instrument Company and employs the use of a flow meter with glass and steel floats. The rate of gas flow reads out on the flow meter, and is compared to a calibrated chart for gas density and concentration

Heath Odorator. This instrument is manufactured by Heath Consultants Incorporated, and employs the use of solid-state electronics for the digital display of gas in air mixtures.

YZ Industries Dtex: This instrument is manufactured by YZ Industries and employs microprocessor based electronics and internal data logging of gas in air mixtures.

Regardless of the type of portable electronic instrument that is utilized, it is imperative that the gas company employees be fully trained and experienced in the use of the instrument when conducting a "sniff" test. The operator must be familiar with the operating manual to insure that they are following the manufacturer's operating procedures. Many gas companies conduct annual testing of their employees to insure that they are familiar with the testing device, and that they can in fact detect the smell of odorant. One such example would be to present the testing device to each gas company employee on an annual basis, and allow them to run a test. This not only insures that the employee understands the use of the particular instrument, but also determines each employee's ability to detect the odorant. Just as with the public at large, the industry will have employees with varying abilities in their olfactory senses. These must be known and documented. We must also follow the manufacturer's recommendation in regards to the calibration of each instrument to insure that the device is maintained and functioning properly.

Odorant monitoring program:

A comprehensive odorant monitoring program involves several other pieces of information besides the odorant "sniff" test with the odorant concentration instrument. Yes, this is the requirement, but most natural gas companies employ other means to insure that proper odorant is maintained in the distribution system.

Accurate records should be maintained on odorant injection rates and along with measurement records we can determine odorant levels in relation to gas volume. It is also important to keep complete records in relation to odorizer inspections to document proof of properly maintained and functioning equipment.

The tracking of customer leak calls to central dispatch is extremely important. A natural gas company generally has system averages throughout the year of daily leak calls. This is a direct result of how well your Odorization program is working. We will always have leaks within the distribution system, in customers' homes, pilot lights, and in the street, and when this occurs the public must be able to detect the odor and make the call. In the event that these averages increase, could signify that the odorant is being put in the system at a more substantial rate than normal. In the event the leak call averages drop could signify that there may be problems at the odorizer or in the piping network to initiate further action.

The simplest verification that natural gas has an odor is generally done by the customer service technician on daily routine calls. A simple box checked as "yes" or "no" on the service form that odorant can be detected at an appliance or meter set in the case of a change-out. This will not verify that the odorant is detected at the appropriate concentration, but it will signify that it does have an odor either absent, weak or strong.

The odor concentration meter tests will be performed on a periodic basis throughout the year and documented with the appropriate forms. We must remember that the more random tests that are conducted throughout the

distribution system the better informed we will become on the effectiveness of our Odorization program.

The use of "quantitative" analysis instrumentation such as titrators, analyzers and chromatographs for the chemical analysis is another vital step in odorant monitoring. These instruments provide for real-time determinations of total sulfur and in many cases individual mercaptan and sulfide component levels.

A combination of all the mentioned items will provide a natural gas company adequate records on the success of their Odorization program. We must remember that conditions are continually changing and we must be aware of the occurrences within our system. We need to analyze each piece of information and act accordingly when one or a combination of items looks out of the normal. Investigations must then be carried forward and solutions provided to insure adequate Odorization.

Chromatographic Analysis:

The use of titrators, analyzers, and chromatographs are several methods employed for quantitative sulfur analysis. A variety of detectors are used, including lead acetate tapes, chemiluminescence, flame photometric and electrochemical technologies. These detector technologies provide for total sulfur calculations and in many cases for complete component separation. These concentrations can generally be displayed in a variety of forms from grains, parts per million and pounds of odorant per gas volume. These instruments can be configured for laboratory use where samples are brought in or placed directly on the pipeline for real-time calculations. A number of communications packages are available for transfer of information directly to a centralized gas control. This "quantitative" method of determining actual odorant concentrations in the gas stream does not meet the Federal requirement for odorant reporting under DOT 192.625. It does however; provide another piece of information in terms of evaluating the overall effectiveness of the Odorization program.

A variety of manufacturer's including, but not limited to the following are available:

The **Sulfur Smart Series H2S Analyzers** by Del Mar Scientific are designed to analyze and monitor concentration levels of Hydrogen Sulfide in continuous flowing and pressurized streams, proving real-time values.

Galvanic Applied Sciences Inc. – **Series 900 Models**
These instruments are manufactured by Galvanic Applied Sciences Inc. and have various models employing lead acetate tape technology for the determination of H2S levels and alternate readings between total sulfurs and H2S.

Analytical Systems Intl Keco – **Model 1700 System Continuous Total Sulfur Analyzer**
This instrument measures total sulfur by hydrogenation. Sample is precisely metered into a continuous flowing stream of hydrogen gas

Siemens Applied Automation - **Process Gas Chromatograph**
Applied Automation offers a number of models of gas chromatographs for the detection of sulfur components.

Ionics - Sievers **355 Sulfur Chemiluminescence Detector (SCD)** chromatograph for analysis of sulfur compounds. The SCD utilizes a stainless steel burner to achieve high temperature combustion of sulfur containing compounds to form sulfur monoxide.

Chromatosud – **The Medor Range Analyzers**

The original MEDOR was developed by Gaz de France in the late 1970's and manufactured by Heath Consultants / Gastech through the 1980's and early 1990's. Chromatosud, the original manufacturer of the MEDOR in France distributes and upgrades the existing units in the United States. The original MEDOR in the United States has gone through many transformations utilizing interface operating systems from Hewlett-Packard, Spectra-Physics and Perkin-Elmer. The MEDOR Range Analyzers continues to provide the user a complete breakdown of individual mercaptan and sulfide components utilizing an electrochemical detection cell in a chromic acid solution.

These are primarily the more common titrators, analyzers and chromatographs that are commonly seen in the marketplace. We must remember that there are a wide variety of manufacturer's that custom configure instrumentation for the detection of sulfur related compounds for various pipeline, petrochemical and refinery applications. Regardless of the manufacturer, the information derived from this type of instrumentation provides yet another piece of the puzzle to insure that proper odorization is occurring.

CONCLUSIONS:

We can now see that the huge task of insuring that a proper odorization program has been implemented and maintained involves information gathering from a number of sources. There is actually no "one" piece of information that solely allows us to see the effectiveness of our odorization program but rather involves a combination of "pieces" to complete the puzzle. In the world today we must pay critical attention to our

odorization programs to protect life, property and insure complete **PUBLIC SAFETY**. We must remember that odorant in the pipeline is the public's primary leak detector and without this warning our public could be in serious danger in the event a leak goes unnoticed. A well documented and maintained program will certainly help us in the event of litigation.

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