PRINCIPLES OF ODORIZATION

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Introduction/History

Natural Gas has no innate odor, color, or taste; therefore, odorization is one of the most important aspects to safely transporting natural gas to customers in a distribution system. As demand for natural gas rises as does the technology involved in odorization.

The first odorization occurred in Germany in the 1880s by a German scientist as a means of detecting leaking blue water gas. Fragmented and unregulated odorization of natural gas continued in the United States throughout the early 20th century until tragedy struck in in 1937 in New London, TX. An undetected gas leak at the New London School caused an explosion that completely leveled the school and ultimately killed over 300 people. As a result of this tragedy, the Texas legislature immediately moved to make the odorization of natural gas mandatory. Soon regulation spread across the entire United States. For this reason, it is important that we understand the tremendous responsibility of knowing and implementing the odorization process.

The purpose of this paper is to present the basic information regarding the odorization process and the most important aspects of any proper odorization system. Further, we will discuss the requirements outlined in the Code of Federal Regulations Title 49 Part 192.625. In short, Section 192.625 – Odorization of Gas states:

"A combustible gas in a distribution line must contain a natural odorant or be odorized so that at a concentration in air of one-fifth (20%) of the lower explosive limit, the gas is readily detectable by a person with a normal sense of smell."

Public safety is the number one priority for this regulation, and by providing proper odorization one can receive an adequate warning to recognize a leak and prevent another tragedy.

System Considerations for an Odorization Program

The following items are important to consider when implementing an odorization program:

- Odorant Tank Size
- Odorant Selection
- Odorant System Type
- Odorant Level Detection
- System Audit Trail

Odorant Tank Size

When designing any Odorization system, one of the first considerations must be given to tank size. Most companies look to size a tank so that it is filled once a year. Depending on the flow of the gas at the site, tanks may have to be filled multiple times a year. Tanks must be ASME Code certified and DOT Code certified for transportable applications. Beyond site location, accessibility and code restrictions, the following factors must be considered when determining the tank size:

- Gas Flow Rate in MMscf/h
- Odorant Injection Rate in lb/MMscf
- Odorant Density

With this information, we can determine the annual usage of odorant at that location and size the system appropriately.

Odorant Selection

After the tank size is determined, odorant selection is the next consideration. Proper odorant selection is based on a number of factors. General knowledge of the gas composition, including moisture content, CO2 levels, natural mercaptans, H2S, and total sulfur will affect the required odorant level in the pipeline. Other factors to consider include vapor pressure, resistance to oxidation, and soil penetration. Blends fall into three different categories:

- All Mercaptan Blends
- Mercaptan and Sulfide Blends
- Tetrahydrothiophen (THT) and Mercaptan Blends

There are a number of odorant blends currently being manufactured. The most common are:

- Isopropyl Mercaptan (IPM)
- Normal Propyl Mercaptan (NPM)
- Teritary Butly Mercaptan (TBM)
- Secondary Butyl Mercaptan (SBM)
- Dimethyl Sulfide (DMS)
- Methly Ethyl Sulfide (MES)
- Tetrahydrothophene (THT)

By combining one or more of the odorant blends above, companies can determined the best blend for their odorization system. Two common odorant blends are 80% TBM and 20% DMS and 77% TBM, 16% IPM, and 6% NPM. With so many variables, odorant selection is a very important aspect to any proper odorization network.

Odorant System Type

The next objective is to determine which odorant equipment is best for your application. Title CFR 49, Part 192.625 states: "Equipment for odorization must introduce the odorant without wide variations in the level of odorant."

In order to determine the proper equipment for an odorization site, the following information is generally required:

- Gas Flow Input Signal
- Location
- Pipeline Flow Rates
- Odorant Blend and Injection Rate
- Pipeline Pressures
- Gas Temperatures
- Ambient Temperatures
- Voltage Source
- Electrical Classification
- Programmable Logic Controller (PLC) options

Odorization equipment generally falls into one of two categories: chemical injection or chemical absorption. In selecting a system, the equipment manufacturer should supply several options to fit the customer's site specific needs.

Chemical Injection

A chemical injection system delivers a known volume of liquid odorant into a pipeline, typically through a pump or drip method. Injection systems are generally utilized in high gas volume or high injection rate applications where there is no pressure drop at the site. Pump systems are designed to overcome higher pipeline pressures.

The basic components of an injection system include:

- ASME Certified Odorant Tank and 110% Containment Pan
- Tank Level Device
- Filter Dryer
- Odorant Pump
- Odorant Positive Displacement Meter
- Solenoid Valves, Regulators, Relief Valves and Check Valves
- Programmable Logic Controller (PLC)
- Injection Probe

The pumps, positive displacement meter, solenoids, regulators, and relief valves are mounted in a carbon steel NEMA 4 enclosure.

Chemical Absorption

A chemical absorption system utilizes the diffusion of odorant into the flow of gas. The simplest form of this type of system is the wick system. Simply put, unodorized gas flows across a wick located in an odorant tank and absorbs the odorant in the process. A needle valve is placed on the flow to control the concentration of gas flowing across the wick and therefore increase or decrease odorization. This type of system is generally used in low flow situations with smaller odorant tanks.

The alternative to this is utilizing an orifice plate to allow a partial flow of gas to be diverted through a tank where it absorbs odorant vapors and then is returned to the main gas line. The pressure differential created by the flow restriction pushes the gas through the odorant tank and ultimately back to the main gas line. Odorant injection levels can be adjusted by diverting more or less of the partial flow of gas into the tank. With this system, it can be difficult to maintain proper odorization levels when flow rates vary too much.

Another style of chemical absorption is a pulse bypass system. In this type of system, unodorized gas enters an odorant tank and absorbs the odorant vapors coming from the liquid odorant in the tank. These concentrated odorant vapors leave the tank and enter the pipeline as saturated gas odorant. In this system, all the liquid odorant stays in the odorant tank and all system components are operated upstream of the odorant tank.

The basic system components of a pulse bypass system include:

- ASME Certified Odorant Tank and 110% Containment Pan
- Tank Level Device
- Filter Dryer
- Solenoid Valves, High Pressure Regulator, Relief Valves and Check Valves
- Flow Switch
- Programmable Logic Controller (PLC)

Pulse bypass systems are used in locations where there is a regulated pressure drop. The system utilizes the pressure drop to bypass to odorized gas into the pipeline. Pulse bypass odorizers are essential at locations where any odorant smell cannot be tolerated because of the site's proximity to hospitals, schools, nursing homes, etc. A pump malfunction or vent gas is not an option at these sites, as either can lead to excessive gas leak calls.

Considerations Prior to Installation

First ensure the pipeline has been “pickled” and/or is ready for a new odorization. The process of pickling is pre-odorizing or saturating the pipeline with odorant. To prevent odor fade once the odorization unit is installed and adding odorant to the line. The three most common methods of pickling gas pipelines are injection of highly odorized gas (over 40 parts per million), slugging the line by pouring odorant directly into the pipeline, and a continuous injection at a controlled dose. Each pipeline is unique and a number of factors should be considered to determine the best way to prepare the pipeline. Prepare the site with a flat, level surface such as a concrete slab. Confirm the necessary electrical connections have been run to the location of the odorizer and are functioning properly. Ensure the necessary input information is ready to be connected to the operational controller of the unit.

Lastly, after receiving the equipment, check the equipment for compliance and any damage that may have occurred during shipment. Immediately contact the supplier if there is any damage or equipment out of compliance. Always perform leak checks on any piping components to ensure they did not become loose during shipment.

System Installation and Start-up

After mounting the skid to a flat, level surface connect a grounding wire to the grounding lug on the skid to safely ground the system. Further connect the skid drain port to an appropriate draining location.

Depending on the type of system being utilized an injection probe may or may not need to be installed on the pipeline to properly infuse the odorant into the pipeline.

At this point, the technician is now ready to make all the necessary connections, including but not limited to connecting the odorant outlet to the inlet of the desired injection point on the pipeline and making all the required electrical connections, such as power supply and flow signal.

Next, fill the odorant tank to the desired volume, taking care not to exceed 80% of the total volume of the odorant tank. When filling and refilling the odorant tank always use extreme caution: odorant has a very strong odor that, if released, can cause issues in populated areas resulting in leak calls. With this in mind all proper personal protection equipment (PPE) should be worn.

Check the odorant tank for any possible leaks and make the necessary repairs. Apply the supply gas to the actuation filter which will be used to operate the unit. Open the necessary valves in the proper order. Last verify all components are working properly and all set points in the controller are accurate.

Role of the Programmable Logic Controller

Generally considered the brains behind any odorization system, the programmable logic controller (PLC) is an all-in-one operation station. When properly programmed, the PLC allows the operator to view current and previous conditions. The PLC utilizes a flow input signal to determine the odorization rate required to meet the programmed injection rate. Using data it receives at a location, the PLC tells the solenoids, valves, and/or pumps when, how often, and for how long to provide odorant to the pipeline. The PLC establishes an audit trail that logs gas flow, odorant usage, injection rate and odorant tank level. Alarms are also logged on the PLC and it provides a general alarm digital output with multiple digital and analog outputs available for customization. The PLC is capable of communicating via Ethernet or Modbus. Lastly, the PLC stores all this data to an 8 GB micro SD card which can be exported as an Excel file to any compatible device.

Odorant Level Detection

Once the odorant is introduced into a pipeline, tests need to be performed to provide verification of proper odorant levels in the pipeline. In order to comply with federal regulations, odorant must be readily detectable at one-fifth the lower explosive limit by someone with a normal sense of smell. In this case, a service person would need to obtain a current sample of gas from the line and determine if there is an adequate smell to the gas. Most companies employ guidelines for this procedure, which will identify who, what, when, where, and how odorant concentration checks must be performed. There are a number of instruments available that can determine odorant concentration levels in either pounds per million cubic feet (lb/MMcf) or parts per million (ppm). The accuracy of such equipment must be periodically verified.

One of the most common methods in monitoring odorant concentration is the sniff test. The three most common portable test instruments are the Heath Odorator, the DTEX unit made by YZ systems, and the Odormeter by Bachrach. An electrochemical cell fixed monitor is made by Welker. Technical information for each of these systems can be found at the manufacturers' websites. Further reference material can be found in ASTM Standard D6273, "Standard Test Methods for Natural Gas Odor Intensity."

System Audit Trail

As part of any proper odorization system, documentation must be maintained. In Code 49 192.625 it states that a gas company must be "receiving a written verification from their gas source that the gas has the proper concentration of odorant." As a technician makes periodic visits to odorant sites, one can obtain and record the information necessary to comply with company procedure and policy. As discussed previously, properly programmed PLCs can perform and maintain audit and alarm logging. Necessary information generally includes accumulated flow rates, odorant usage, injection rates, and date and time stamps of any alarms or system malfunctions. No matter the sophistication of the audit log, keeping documentation of important information is mandatory in maintaining proper odorization systems.

Conclusion

Odorization is a simple yet complex task, with companies using differing methods to inject and monitor its effectiveness. As shown, there are many factors that go into maintaining a complete and effective odorization system. Odorization is done for the safety of everyone and as such should be one of the most important aspects of any gas operation.

References

Code of Federal Regulations, Title 49 Part 192.625.

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