

Odorant Transfer and Delivery Systems

JURAJ STRMEN

TECHNICAL DIRECTOR

MIDLAND RESOURCE RECOVERY INC.



Background

Natural gas odorant liquids are transported and stored using various technologies and systems. This paper discusses the equipment and procedures for completing safe odorant transfers. It also describes the risks associated with odorant transfers, such as liquid spills or vapor releases, as well as good practices to mitigate risk.

Introduction

Natural gas odorant, often referred to as “mercaptan odorant”, is a liquid that is added to

natural gas to impart a distinct sulfur smell to the gas that is otherwise odorless.

There are about a dozen different blends of natural gas odorants used in the US. Most of them are based on two main components: the odorant and the antifreeze agent. The odorant portion can be either mercaptan- or thiophane-based. The antifreeze agent is typically isopropyl mercaptan or a sulfide such as dimethyl sulfide.

In the US, odorant liquids are manufactured in refineries and transported by truck or DOT tanks to client sites. At the client site, transport tanks are offloaded to bulk odorant storage tanks. Typical refill frequency for bulk odorant storage tanks is once per year.

Odorant transport equipment

The most common means of transport of liquid odorant in the US is by tanker truck. Tanker truck volumes range between 5,000 and 6,000 gallons, with 250 psig rated DOT tanks that are anchored to a truck chassis. These bulk transport trucks are used to fill large odorant tanks (250-10,000 gallon) where accessibility to the site permits.

Tanker trucks are fully equipped with over-pressure protection, liquid and vapor return manifolds, liquid metering and a vapor compressor.

Tanker trucks are filled at the manufacturer’s facility, tested for quality and driven to client’s odorization station for offloading.

The second category of transport vehicles are micro-bulk trucks. These trucks have smaller - 100 to 2,000 gallon - DOT vessels that are used to transport odorant. These trucks are typically used to fill client tanks that are between 20 and 1,000

gallons in capacity. They are also used when space restrictions at client sites do not permit large tanker trucks to pull-in or turn around.

Micro-bulk trucks are also equipped with over-pressure protection, liquid and vapor return manifolds, liquid metering and a vapor compressor.

The third category of transport vessels are DOT transport tanks. DOT tanks range in sizes from 5 to 250 gallons. DOT tanks are typically 250 psig rated vessels that are the property of the odorant manufacturer or distributor. These returnable cylinders are filled at the manufacturer's plant and are transported in box trucks or trailers by third party hazmat carrier to the client site. After the client takes possession, the DOT tanks are typically brought to the odorant station to be emptied into bulk odorant storage vessel.

DOT drums are also used to transport odorant product. However, due to lower pressure rating of these drums, this practice is seldom used in the US.

DOT drums are used commonly for transporting hazardous waste odorant destined for incineration. In that case however, the drums are over-packed for increased protection.

DOT regulatory information

Natural gas odorant is classified by DOT CFR 49 Part 172 as flammable liquid. It is transported as a hazardous product. Transporters must conform to strict guidelines such as hazmat training, CDL hazmat license, hazard communication, emergency response training.

Requirements for placarding are specified in 49 CFR 172.500. For example, Scentinel E would have the UN 3336, flammable liquid 3 placard. It

must be legible on all four sides of the vehicle. The odorant safety data sheet (SDS) must be carried in the vehicle, and the driver must have a CDL hazmat license.

Odorants can be transported without placards under the Materials of Trade exception (see 49 CFR 174.600, max of 8 gallons of odorant) or as stated in the non-bulk packaging rule 49 CFR 171.8 (max of 119 gallons of odorant).

Equipment needed for odorant delivery

The equipment needed for an odor-free odorant delivery is as follows:

1. Vapor compressor.

Vapor compressors are used on bulk and micro-bulk trucks to transfer vapor from receiving tank to delivery truck. By offloading pressure at the receiving tank, a pressure differential of about 10-30 psig is created between two vessels. This pressure differential allows liquid odorant to flow into the receiving tank. Turbine or mass flowmeters are used to measure the amount of odorant that is delivered.

The vapor compressor allows the odorant transfer to be completed in a closed loop where displaced vapor during the filling operations is continuously returned to the source tanker truck to maintain liquid flow.

The closed-loop odorant transfer has the advantage of not needing to flare or scrub mercaptan vapors during liquid transfer. Using odorant specific procedures and mercaptan-compatible materials and equipment, closed-loop odorant transfers yield odorless odorant transfers.

2. Flare

During smaller odorant transfers from DOT cylinders to bulk odorant tanks, small odorant vapor flares can be used to depressurize the receiving tank below the pressure of the bulk tank to generate the pressure differential needed to establish liquid flow.

Furthermore, when odorant needs to be added to high pressure tanks, the pressure can be flared off prior to fill.

The typical desired pressure differential is between 10 and 30 psig, while the receiving tank pressure is maintained between 5 and 30 psig. For example, a 350 psig bypass odorizer would need to be flared down to about 10 psig before odorant transfer into this vessel can be started.

Flaring has the advantage of being compact and - with proper pressure and flame arrestor protection- very safe to use.

The disadvantage is that combustion of odorant vapors produce sulfur oxides which are a health hazard. Although typically used in only small volume depressurizations, caution must be taken for operator to be upwind of flaring and not to flare during weather inversions as the sulfur oxides can linger near low laying areas, increasing nuisance calls and be a potential health hazard for the operator.

3. Carbon filters

Activated carbon systems are a useful tool in odor-free odorant transfers.

These can be used in 15-, 30- or 55-gallon format to remove pressure from the receiving tank. The granular shape of the activated carbon maximizes

the geometric surface area, increases the surface and pore diffusion rate and increasing the effectiveness of the adsorption of volatile organic compounds with a short contact time.

Activated carbon filters can be used with explosion-proof (XP-rated) fans that apply suction and force scrubbing action through the carbon bed, or they can be used in a passive mode where vapors from the tank are passively moving through the carbon bed by pressure differential.

The advantages of carbon beds is that they are portable and can be recycled to 96% wt.

The disadvantage is that there is a possibility of thermal excursions in activated carbon beds when these are not used properly. The factors that would increase thermal excursion events are high VOC concentrations in the feed stream. This can be controlled by slowing down the process, controlling VOC inlet concentration, carbon monoxide and temperature measurement at the outlet.

4. Spill kit

During an odorant transfer, the operator should have a spill kit ready in case of a release of odorant liquid or vapor into the environment.

Odorant-specific spill kits typically include odorant-specific personal protective equipment (full-face respirator, gloves, shield, Tyvek booties and coveralls), odor-kill liquids, odor-masking agent, absorbent pads and granules, an odor-control carbon filter, a drum to receive the recovered material.

Guidelines for safe odorant delivery

Safety is a high priority during odorant transfers. Liquid odorant is a flammable liquid and must be handled with extreme caution.

Operators should be OQ-qualified for abnormal conditions, hose connection/disconnection pressure test, NPT/compression fittings. Further training would include specific equipment training, labeling, placarding, bill-of-lading and safety data sheet information knowledge, as well as physical and chemical properties of odorants, odorant spill response and odor control, knowledge of various odorization systems, DOT and CDL rules and regulations.

The tank truck and receiving tank should be grounded and only non-sparking tools should be used during connection and disconnection of hoses.

All equipment must be verified prior to operation (compressor, filter, flare, pressure gauges, liquid level gauges on receiving tank and tanker truck tank)

The integrity of the valves and receiving tank should be inspected prior to filling.

To avoid overfilling odorant tanks, if the liquid level gauge on receiving tank is not functional, odorant transfer should be stopped. Tank level gauges should be fixed and odorant transfer then resumed.

Odorant tanks are typically filled to no more than 80% by volume.

DOT tank age should be verified to make sure that tank is not past its expiry date.

Firefighting equipment must be inspected and ready for use during each odorant delivery.

Personal protective equipment (FR clothing, chemical protection gloves, glasses, safety shoes) must be worn. SDS sheets must be consulted prior to work for odorant specific PPE. A spill kit would contain additional PPE for use in an odorant spill clean-up.

Odorant transfers should not be done in extreme weather (high winds, hail, lightning, etc) that would increase the risk to operator safety.

Closed-loop systems (e.g. compressor) are preferred to non-closed-loop systems (e.g. flaring, carbon scrubbing).

Odorant vapors should never be vented to the atmosphere.

After the odorant transfer is complete, all tools should be cleaned with odor-kill liquid sprays to eliminate fugitive natural gas smells that may generate leak calls in the surrounding area.

Olfactory fatigue is possible if fugitive vapors are present for more than 30 minutes. In this case, the operator may not smell the natural gas odorant anymore, and may be increasing the risk of causing leak calls during his delivery. If odorant is detected, the smell should be eliminated (e.g. tighten a fitting to stop a vapor leak) prior to continuing the work.

Utility responsibility for a safe odorant transfer

In order to minimize liquid spills, the utility should maintain the odorant tank, valves, PRV, and liquid level gauge in good working order.

The liquid and vapor valves should be properly labeled.

The odorant tank should be in a secondary containment.

The tank must be properly grounded.

The access to the tank should be free of obstruction and free of snow and ice accumulation to prevent trips and falls.

Documentation on the product delivered should be readily identified on the tank. SDS sheets should be inside the odorant building or odorizer cabinet.

Consequences of spills

Natural gas odorant spills or vapor releases are highly undesirable for the following reasons:

- Health and safety of the operator is put at risk. The TWA (Time Weighted Average) maximum allowed concentration for an 8- hour period is 0.5 ppm for TBM-based odorants. Odorant spills can generate 20 ppm or more in the surrounding area. Spills inside a closed odorization building would result in higher concentrations.
- The odorant density is higher than that of air. Vapors would have a tendency to travel at ground level as far as 1-10 miles away from the site before being diluted under threshold values. The smell of odorant would generate leak calls, putting the public at risk.
- Liquid and vapor releases pose a fire risk.
- Liquid spills could also have negative impacts on the environment if the odorant were to migrate underground or spill into waterways.
- Odorant spills often yield a business disruption as the company mobilizes resources for the cleanup effort.

- The costs of remediation are very high

Natural gas odorant spills require an immediate response. Odorant spills generate highly negative public relationship issues, and ultimately put the reliability of natural gas delivery in question.

The most effective way to prevent odorant spills consists in training of operators, maintenance of equipment and periodic risk assessment of odorization equipment and procedures.

Conclusion

Natural gas odorant transfers play an integral role in the sale and delivery of odorants to client tanks. This paper illustrates the importance of operator training, odorant-specific tools and procedures to complete safe and odor-free odorant transfers.

The consequences of odorant spills are highly undesirable due to the health risks to the operator and negative impacts to the surrounding community if false natural gas leak calls generate community health concerns.

The costs related to spill clean-up far outweigh the costs of training and maintenance, and do so by a factor of about 10-100, depending on the size of the spill.