

Reducing Environmental Impact and Total Cost of Operation in Natural Gas Odorization: Arida™, Nelo™, and Watchtower™

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Abstract

Natural gas odorization faces two persistent operational challenges. The first is environmental: pipeline conditioning traditionally requires flaring or incinerating odorized gas to prevent odor fade in new pipe sections, and contaminated odorant that has absorbed moisture is typically discarded as hazardous waste rather than recovered. The second is total cost of operation: manual field verification of odorant levels and manpower onsite during any odorization project are labor intensive.

MRR has developed three technologies addressing these challenges from different angles. Nelo eliminates flaring and venting during pipeline conditioning while also examines the ability to shorten the time onsite during project execution. Arida recovers water contaminated mercaptan odorant in the field rather than treating it as waste. Watchtower replaces manual field checks with remote odorant level monitoring, removing the guesswork from odorant delivery planning. Together these represent MRR's approach to reducing the environmental footprint of odorization while lowering the total cost of operation for utility clients. This paper describes the operational challenge behind each technology, its current deployment state, and the engineering work MRR has completed to bring it into field use.

Author's Note

The projects described in this paper are under active development. Some technical details have been intentionally omitted or generalized to protect proprietary methods and pending intellectual property. Readers interested in further detail are welcome to contact the author directly. Contact information is provided at the end of this paper.

Introduction

Odorization has been mandatory for natural gas distribution in North America since the 1937 New London disaster, and the practices built around it have matured into a stable, well-regulated discipline. However, as the gas utility industry has developed over the past decades, the odorization space has seen less innovation than other disciplines in moving and regulating gas. For example, regulations have developed in methane emission to meet federal environmental requirements, and a drove of innovation to support both leak detection and mitigation have emerged to support these requirements.

In the odorization space, the authors propose that there is opportunity to support the natural gas utilities in two areas.

The first is environmental. Pipeline conditioning, the process of preparing new or serviced pipe sections, has historically relied on flaring or incinerating gas that carries odorant. This destroys a significant amount of natural gas, and releases combustion byproducts in the process. Separately, water that contaminates odorant, nominally in injection systems and impedes proper injection capabilities, is conventionally disposed of as hazardous waste rather than restored to service.

The second is cost. Utilities verify odorant levels and perform conditioning largely through manual field labor. Every tank check, every conditioning job, and every waste disposal event carries a direct labor and disposal cost that scales linearly with the size of a utility's network, without much room for efficiency gains under current practice.

MRR's Nelo, Arida, and Watchtower projects were built to address these two problems, though not all three touch both problems equally. Nelo addresses the environmental problem directly by removing flaring and venting from the conditioning process, and is also being developed to shorten conditioning project time; its cost case relative to traditional methods is still being resolved and is discussed below. Arida addresses hazardous waste directly by recovering odorant that would otherwise be discarded, and has also demonstrated a meaningful cost advantage over incineration. Watchtower addresses cost directly by removing the guesswork from odorant delivery, with environmental and safety benefit as a secondary effect of avoiding injection system failures. The following three sections describe each project's background challenge, current operational state, and the technology MRR has built to address it.

Nelo

Background

Pipeline conditioning, often called pickling, prepares new or serviced pipe sections to properly retain odorant by intentionally exposing the pipe wall to odorant until rust and moisture stop stripping it from the gas. Conditioning is performed either offline, with the line isolated from service and gas flow fully controlled by the operator, or online, with the line remaining in service and gas continuing to move to customers throughout the process.

Depending on the design, pickling can take a long time and risk under/ over odorizing the public's gas or require flaring a significant amount of gas which has both environmental and potentially public perception impact.

Current Operational State

MRR has developed Nelo, a closed loop gas process, as a third conditioning method alongside the two established approaches. Nelo is applied in two ways. First, it can be layered onto existing online or offline conditioning procedures without changing their underlying mechanism. Nelo's proprietary absorption process can prevent flaring or incineration during standard offline pickling. The gas would be captured or moved eventually returning to the distribution network for public consumption.

Second, MRR is exploring a continuous flow variation to conventional pipeline conditioning, taking advantage of the best components of online and offline technology. Gas can flow without limitation to odorant injection, pickling a pipeline faster. Further, with multiple methods to handle the gas, the time to complete a pickling project is not limited to shut in periods or flow rate of public consumption. This Nelo methodology is expected to shorten total conditioning time relative to either traditional pickling method.

Please note, the author will update this paper with research and field data once intellectual property has been secured.

Technology Developed

The gas is treated through a proprietary molecular adsorption process at MRR's facility, validated in lab testing before field deployment. Procedure and equipment design are complete. A commercial scale skid is under construction at the time of writing, with deployment planned with a test client in the near term.

Arida

Background

Natural gas odorants are hydrophobic: comprising of a hydrocarbon architecture with an attached sulfur molecule. When water enters a storage tank, it does not mix with the odorant, it separates and settles to the bottom of the tank (the reader may consider oil and vinegar interaction). However, a limited degree of saturation still occurs between the two phases. That limited saturation is enough to raise the odorant's cloud point, the temperature at which it will freeze, above manufacturing specification (typically -45°C).

Water enters tanks through several common field mechanisms: incomplete drying of a tank following hydrotesting, use of pipeline gas as blanket gas during a pipeline hydrotest without isolating the tank, tank openings left unsealed prior to commissioning and exposed to rain or other elements, and prolonged use of wet blanket gas, which contaminates odorant more slowly but still causes failure over time.

Water contamination creates three distinct operational problems. First, in cold weather, water in an injection system can freeze; heat tracing mitigates this in moderate conditions, but in the coldest months, when gas demand and public risk are both highest, a frozen injection system can fail when it is needed most. Second, water occupying volume in a storage tank reduces the amount of usable odorant that can be stored. Third, because injection systems typically draw from a dip tube at the bottom of the tank, where water settles, operators may unknowingly inject water alongside odorant, requiring higher injection rates to maintain target gas concentration and placing additional mechanical stress on injection equipment.

Water contaminated odorant that fails specification is conventionally treated as hazardous waste and disposed of by incineration rather than restored to service, generating a recurring waste stream tied directly to normal odorant handling and storage rather than to any leak or spill event.

Current Operational State

MRR has developed Arida, a mobile drying and recovery technology Figure 1 that treats water contaminated mercaptan odorant and returns it to service rather than disposing of it. The field procedure removes free water from the contaminated odorant, treats residual contamination through a proprietary adsorption process, and returns the recovered odorant to the client's tank. MRR's first project utilizing this process treated two 3,000 gallon tanks of a commercially available odorant blend for a client, at approximately 56 percent of the cost of incineration and disposal. This figure reflects a single executed project on one odorant blend and is presented as an initial result.

Technology Developed

MRR developed a laboratory calibration method to determine moisture content in contaminated odorant and guide the drying process accordingly, along with a field procedure and dedicated equipment (the Arida skid) to execute recovery on site rather than requiring odorant to be shipped off site for treatment or disposal. The recovery process itself uses a proprietary adsorption method developed and validated by MRR.

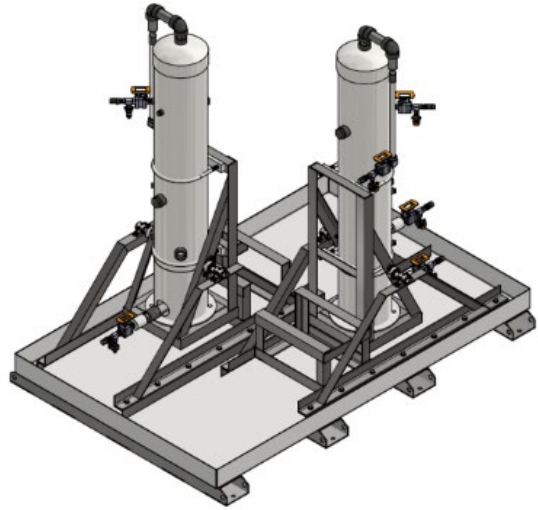


Figure 1: Arida Skid

Watchtower

Background

Odorant delivery logistics depend on knowing how much odorant is in a tank at the time of delivery. By law, the Department of Transportation (DOT) requires that any truck delivering hazardous materials have a Bill of Lading (BOL) accurate for delivery when a truck leaves the loading facility. Any deviations from actual with the BOL delays delivery and increases the cost of logistics, increasing the cost of the odorant.

There are two common logistical challenges all utilities face. In the first, an urgent need for odorant is reported, but upon arrival the tank is found to be partly or mostly full, making the trip unnecessary. In the second, the delivery volume is misjudged, a client requests 100 gallons but only 50 are needed, or 200 are needed and the truck does not carry enough, requiring a second trip to complete the delivery. Both scenarios stem from the same root cause: odorant delivery has conventionally been planned without reliable visibility into actual tank levels, forcing delivery volume and timing to be estimated rather than known.

Some odorization equipment already has a degree of level telemetry, most commonly on more sophisticated injection systems. Bypass odorizers are frequently installed in remote, isolated locations and typically lack any form of electronic level measurement, leaving delivery planning for these sites dependent entirely on technician visits or client reporting. Bypass odorizers in remote locations are the primary target for this project.

Current Operational State

MRR has developed Watchtower, a remote monitoring platform designed with the goal to improve odorant inventory management efficiency. It is recognized that regular site visits are required for utility operations to ensure the safety and security of their assets, there are challenges when estimating required volumes for delivery, notably when long lead times during peak seasons lead towards uncertainty in forecasting. Watchtower was built to enable route optimization of odorant deliveries, and to ensure that operations can more accurately represent future odorant levels. Figure 1 and Figure 2 highlight the current iteration of the software users would interface with. The value of improved visibility and more accurate inventory management provides 1) a lower cost to deliver odorant 2) higher confidence in injection rates 3) visibility into variability in odorant dosage over time.

Watchtower was designed to integrate into any existing odorant tank. The most straightforward case is integration with a Rochester style float gauge, common on propane style tanks used in injection systems as shown in Figure 5 below. Figure 3



Figure 2: Watchtower Installed on 6B Kingtool, Buried

indicated an installation on a Kingtool style buried tank. This same setup can be used on any vertical magnetic vertical float gauge. Additional integrations tested, but not yet deployed, include differential pressure as would be seen where a visual sight glass is utilized as level indication.

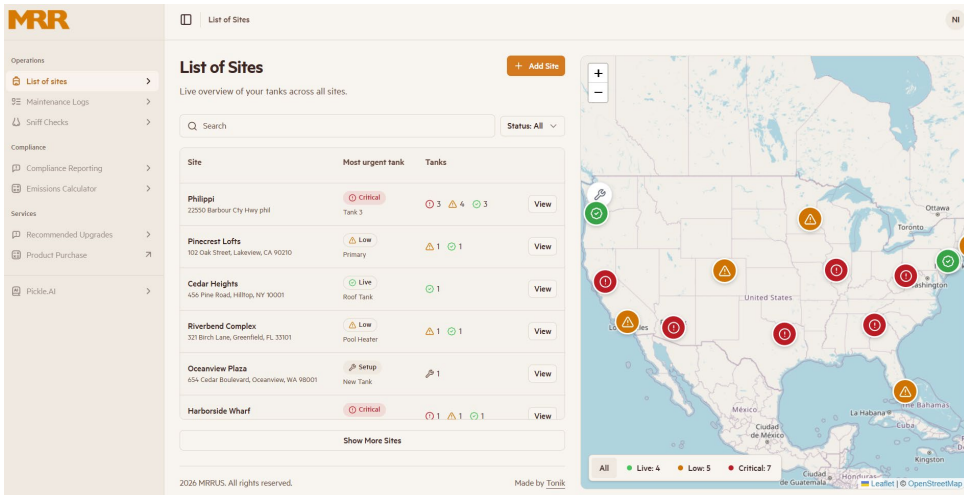


Figure 3: Watchtower Screenshot - Asset Summary (Mock Data)



Figure 4: Watchtower Screenshot - Site Level Results (Mock Data)



Figure 5: Watchtower Installed on 500 gal Bulk Tank

Technology Developed

MRR has built a SaaS platform that ingests odorant level data from field mounted sensors and centralizes reporting for utility operations teams, replacing the estimate driven delivery model with direct visibility into tank levels for equipment types that previously had none. Development has proceeded in stages, beginning with a minimal software layer to validate the core monitoring concept before adding operational features.

Summary and Next Steps

Arida, Nelo, and Watchtower are each moving from initial validation toward broader field deployment. Arida has proven recovery at scale, and the next step is to extend the process to larger and more complex drying applications. Nelo has completed lab validation and equipment design, and the next step is field testing and validation of the new pickling procedure with a commercial client. Watchtower has proven remote level monitoring on individual assets, and the next step is to build toward a dedicated odorant management platform that supports delivery planning across an operator's full network rather than site by site monitoring alone. MRR will publish updated results and field data for each project as intellectual property protection allows.

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