

## Case Study

# Pre-Odorization or "Pickling" of New Natural Gas Pipe

By Isabelle Ivanov, Juraj Strmen and Les Jones

Natural gas, odorless on its own, is odorized in order for people to be able to detect gas leaks by sense of smell. When a new gas pipeline is commissioned, the line itself will absorb and react with the odorant, leaving the gas odorless at the outlet, which constitutes a safety hazard. The line will continue

to consume the odorant until it becomes saturated with odorant; only then will the odorized gas flowing through remain odorized until it reaches the end-users. In order to accelerate this process and be able to safely put the new line in service, it is recommended that installers pre-odorize or "pickle" the line. This article presents the case study of the pre-odorization of a new pipeline installed to service a residential subdivision in the city of Kitchener, Ontario, Canada. After initial static "slugging" of the line for three weeks, over-odorized natural gas was flowed through the line while odorant levels were monitored at the tail end of the pipe. The additional odorant was injected using a temporary odorant injection station. The pickling appeared complete and the line saturated when the odorant levels at the tail-end were maintained and comparable to those at the inlet, without additional injection being necessary to compensate for odorant loss. However, after a few months, odor fade again occurred. A bypass odorizer was installed to compensate for odor fade and to continue the process of saturating the pipe with odorant.

Following a natural gas explosion in a Texas school in 1937 where 298 children and teachers lost their lives, the U.S. and Canada legislated the use of odorant in natural gas to ensure detectability in case of gas leaks. The regulations state that gas distributed to end-consumers must be detectable at one-fifth of its lower explosive limit (LEL). The LEL of natural gas is 5% in air; therefore, the average person must be able to detect odorized gas at a concentration of 1% in air.

When a new natural gas steel pipe is installed, the porous inner wall of the pipe contains metal oxides (rust and mill scale) which will react with odorant, e.g. *tert*-butyl mercaptan (TBM) to produce disulfides which are less odorous than TBM. Therefore, perfectly odorized gas entering the pipe will be stripped of odorant as it flows down the pipe and will be left odorless at the

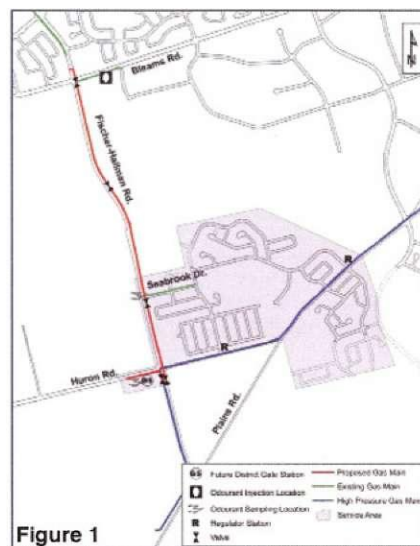
outlet, hence a potential hazard. For the safety of all end-users of the pipeline, a pre-odorization step is required to saturate the new line with odorant before commissioning the line for service, so that odorized natural gas entering the new line remains adequately odorized upon reaching end-users. The process of pre-odorizing or saturating the line with odorant is commonly called "pickling".

The City of Kitchener owns and operates the natural gas distribution system within the confines of the city limits in the municipal division that also operates its sister water distribution system. The natural gas distribution system supplies 60 000 residential, commercial and light-industrial customers. The majority of the distribution system operates at pressures below 60 psig, fed from a high-pressure distribution system generally operating in excess of 220 psig. This southwest Ontario utility receives its natural gas from the Union Gas transportation system at two locations within the southwest and central-west regions of the city.

In the spring of 2008 the Utilities Division of the City of Kitchener initiated a system reinforcement project to accommodate growth in the southwest sector of the city. The first phase of the project consisted of installing 1.7 miles of 12-inch steel pipeline. This proposed pipeline starts from the limits of the existing distribution system near the intersection of Bleams and Fischer Hallman Roads and proceeds south along the right-of-way of Fischer Hallman road to a location near the northern extents existing high-pressure distribution system at Huron Road (Figure 1). This existing high-pressure gas system is the current feed of natural gas for the southern portion of the city.

Future stages of the project will include installing a linking section of gas pipeline, establishing a district gate station at the southern limits of the project and downgrading the operating pressure of a portion of the high-pressure distribution system on Huron Road, and integrating it into the lower pressure distribution system of the city.

This pipeline project was preceded by two residential developments that were temporarily fed from two separate regulator stations directly connected to the high-pressure distribution system. The demands for natural gas generated



**Figure 1:** The highlighted area shows the subdivision serviced by the new gas line which is itself represented by the red line. The temporary injection unit was installed on Bleams Road, near the North end of the new pipe. Odor measurements were taken at the junction with Seabrook Drive (i.e. at the entrance of the residential subdivision) and at the fire hall located at the southern end of the new pipe on Huron Road. Odor levels were also monitored at several houses located on the periphery of the Seabrook subdivision.

from these residential subdivisions were beneficial in establishing some flow for the subsequent pre-odorization phase of the project.

It was recognized in the early planning stages of the project that pre-odorization would be necessary, primarily because the initial phase of the project was going to be a one-way feed for a relatively small sector of the distribution system.

Once the new pipeline was installed and commissioned, natural gas was introduced into the system at a location just east of Fischer-Hallman Road on Bleams Road, along with a slug of TBM that was allowed to sit under

no-flow conditions, as described further on.

Later, a large shipping container was modified and lowered over two risers, one each installed on the new pipeline and on the existing distribution system piping. The premise was that a rotary meter with an external volume corrector would be installed within the piping connecting the two risers. This would, in turn, allow the team to measure the exact volume of gas flowing into the newly commissioned distribution piping and establish a correlation to the amount of TBM to be introduced into the system during the second step of the pre-odorization process.

Throughout the entire process, the odorant levels were monitored at two locations on the pipeline, at the southern end and at the Seabrook Drive roundabout.

Three basic methods are available for pre-odorizing or "pickling" gas pipes:

1. **Injection of highly odorized gas** (over 40 ppm),

2. **Slugging**, i.e. pouring a bulk amount of liquid odorant directly into the pipeline and letting the pipe "pickle" for a prolonged period without any flow through the pipe.

**Table 1: Data on This Project**

Base Data:	
Volume of new pipe to be pickled	6,873 ft <sup>3</sup>
Length (and diameter) of new pipe	8,530 ft (Ø 12-inch) + 1,148 ft (Ø 8-inch)
Material of new pipe	Steel
Main line pressure	42 psig
Odor level of supply gas	0.25-1.50 ppm TBM
Process:	
0. Pipe condition at beginning of project	<ul style="list-style-type: none"> <li>• Full of N<sub>2</sub> at 40 psig</li> <li>• Steel pipe segments had been exposed to weather for two years prior to installation.</li> </ul>
1. Initial "slug" of TBM	<ul style="list-style-type: none"> <li>• 4 lbs of TBM - left in pipe for three weeks, with natural gas blanket at 8 psig.</li> <li>• Line was depressurized using activated carbon filters, flares, tiger torches</li> <li>• % gas was monitored at tail-end of pipe until N<sub>2</sub> was fully displaced by natural gas.</li> <li>• TBM concentration was measured at tail-end of pipe as &gt;15 ppm (using Dräger tubes and pump).</li> <li>• After three weeks, flared off over-odorized gas.</li> <li>• Found 0 ppm TBM at tail end of pipe: indicating pipe still not saturated.</li> </ul>
2. Continuous controlled injection of TBM	<ul style="list-style-type: none"> <li>• See Picture 1 for the temporary set-up housed in a marine container,</li> <li>• Initial dosage = 0.75 lbs/MMscf.</li> <li>• All gas flared at tail-end of pipe (1 MMscf). Meanwhile, residential subdivision fed by alternate supply,</li> <li>• Regular odor level checks at tail end of pipe,</li> <li>• Correlate input to output while taking into account retention time of about two hours in pipe.</li> <li>• Non-continuous process: injecting during work day, shut down at night and over weekend. Every morning, found low TBM levels due to overnight absorption by pipe.</li> <li>• Ramping up dosage to 10, 16, 50, 100 lbs/MMscf until measured excess TBM at tail-end. This took five days (Figure 2) and consumed altogether 15 lbs TBM.</li> <li>• Then, cut back on injection rate to let outlet TBM concentration stabilize at acceptable level near inlet concentration.</li> </ul>
3. Stop injection	<ul style="list-style-type: none"> <li>• Monitor outlet TBM.</li> <li>• When stable and close to inlet TBM (this took one day), switch residential subdivision to gas feed from this newly pickled line.</li> <li>• Remove temporary odorant injection system,</li> </ul>
4. Long-term monitoring	<ul style="list-style-type: none"> <li>• Monitor TBM daily (Dräger test and Odorator "sniff" test, Figure 3).</li> <li>• Slowly dropping over time indicating pipe still not fully saturated.</li> <li>• Eventually, after about 10 weeks, odor level dropped to unacceptably low levels.</li> </ul>
5. Make-up odorization	<ul style="list-style-type: none"> <li>• Installed a by-pass odorizer to compensate for odor fade (see Picture 2).</li> <li>• No constant supervision required. Only to adjust flow through by-pass odorizer with response to odor levels at end-users.</li> <li>• Able to maintain around 1 ppm mercaptan at tail end of pipe (Figure 4).</li> <li>• Still on-going at time of writing.</li> </ul>

**Photo 1:** Set-up of Temporary Odorant Injection System. A rented marine container was installed with a hole in the floor to give access to the risers at the beginning of the new underground gas line. A flowmeter and pressure gauges were installed to be able to calculate retention time to the tail-end of the pipe and to keep track of the volume of gas flared during the pickling process. A rented YZ injection system was installed (white cabinet) along with an odorant cylinder (white cylinder) and a scrubber for mercaptan vapors from the injection system (black drum)

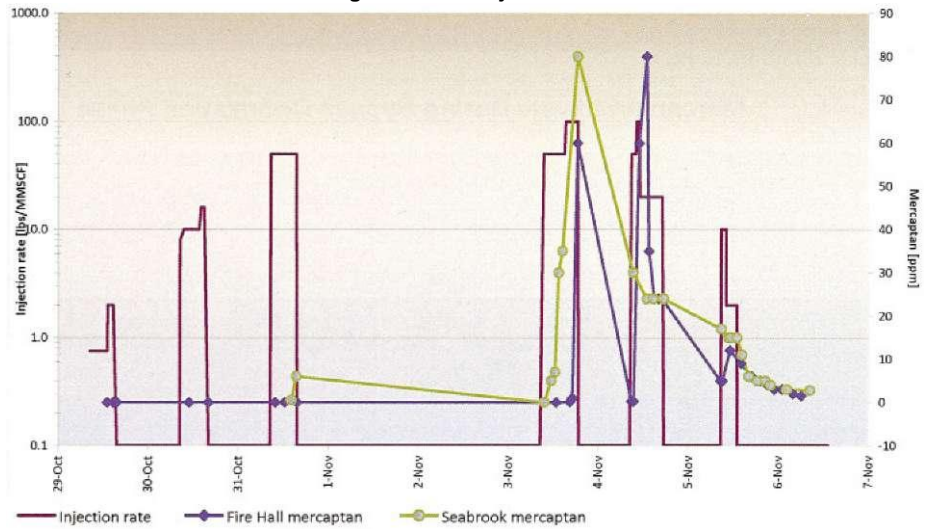




**▲Photo 2:** Bypass Odorizer. At the same site where the marine container stood months before, a King-Tool 3-B bypass odorizer was installed to compensate for odor fade still occurring in the new line. The odorizer is buried underground to minimize temperature variations of the liquid odorant and prevent it from boiling off. Only the level gauge, test ports and needle control valve remain above ground. The red handle seen on the main line is that of the gate valve which controls how much of the gas flow is diverted to the bypass.

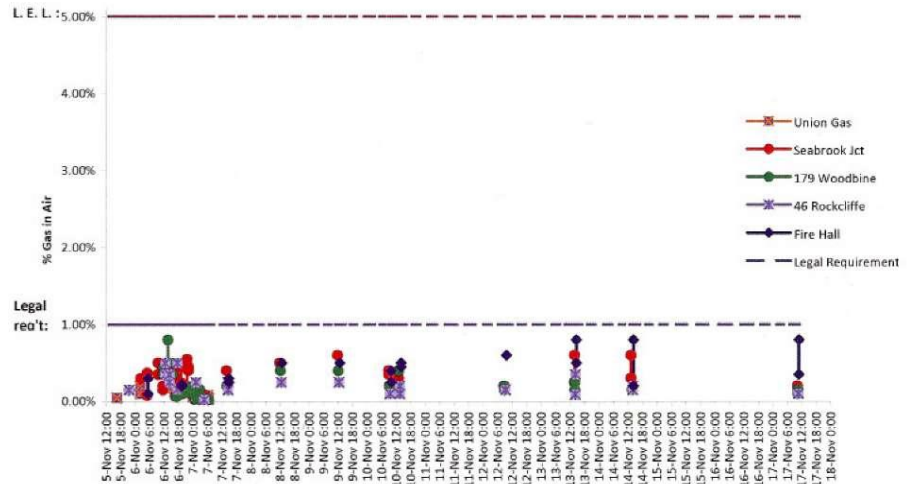
► **Figure 3:** Odorator "Sniff" Tests. Dräger tubes are a very convenient, precise and objective way of measuring mercaptan concentration, but the law requires sniff tests to be performed to properly assess gas detect ability as by an end-user. The regulations state that gas distributed to end-consumers must be detectable at one-fifth of its lower explosive limit (LEL) by a person with an average sense of smell, i.e. it must be detectable at 1% in air. Odorator tests were performed regularly by various technicians of the utility at various locations throughout the subdivision, and confirmed that the gas was properly odorized following the switch over to the new gas line, since it could be detected at less than 1% in air.

**Figure 2:** Odorant Injection Rate & Resulting Mercaptan Level During Controlled Injection Phase



**▲Figure 2:** Odorant Injection Rate And Resulting Odorant Level Trends During Controlled Injection Phase. The injection (red line) was not fully continuous due to work being interrupted at night and during the weekend (flaring required constant supervision). After TBM finally made it through to the tail end of the pipe (Fire Hall, blue line), it still dropped considerably overnight as shown by the measurements taken on the mornings of Nov. 4-5. Eventually, on Nov. 6, with no injection to supplement odorant to the supply gas, the odor level at the outlet stabilized and the subdivision was switched on to gas supplied via the new pipe

**Figure 3:** Odorator Tests - after Seabrook subdivision switchover to new gas line -



▼ **Table 2:** Results to Date

Process step	Amount of odorant used	Dosage	Mercaptan level obtained at pipe end	Duration
Initial slugging	4 lbs	440 lbs/MMscf	>15 ppm	3 weeks
Continuous injection except during nights and weekends.	15 lbs	0.75-2, 10-16, 50-100 lbs/ MMsf	2-3 ppm	5 days
Post-injection monitoring	0 lbs	0 lbs/MMscf	slowly dropped to nil	10 weeks
Bypass odorizer (ongoing at time of writing)	25 lbs and more	2 lbs/MMscf	0.25-3 ppm	16 weeks and more

**3. Continuous injection of controlled dosage of liquid odorant into the gas stream flowing through the pipe.**

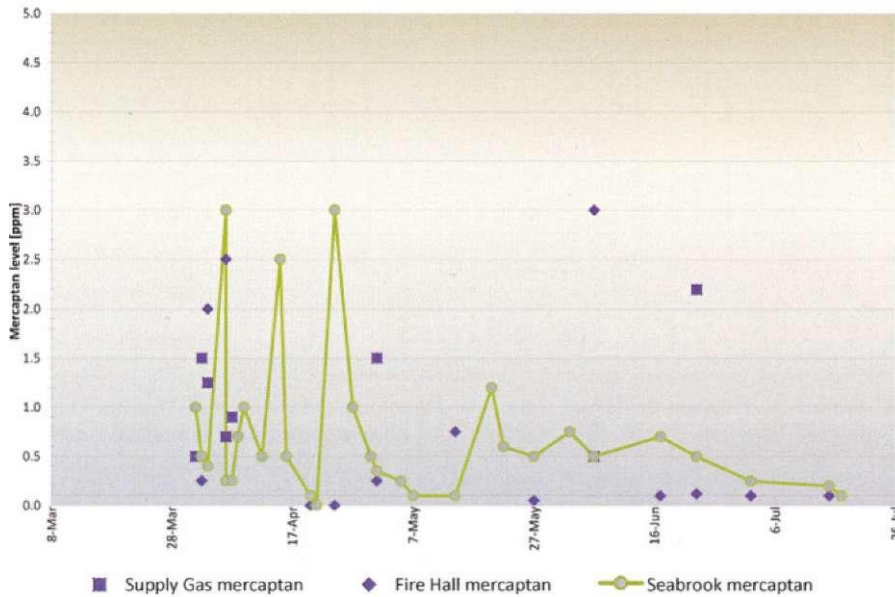
In the case of Kitchener Utilities, they purchase already odorized gas from Union Gas and redistribute it as-is to their end-users. They do not control the level of odorization of the incoming gas. Therefore, Option 1 was not applicable.

It was decided to initiate the pickling process with a one-time slug left in the pipe for a period of three weeks in order to leave time for the line to react with the excess odorant provided (Option 2). This step is passive in terms of labor and can easily be extended to allow for as much reaction as possible to take place.

**Figure 4:** Odorant Levels during Bypass Odorization Phase. Eventually, it was necessary to install a bypass odorizer to make up for odor fade still occurring in the pipe even after the initial pickling stages. The bypass odorizer does not provide data on dosage, but overall consumption over a given period of time can be assessed using the odorant level gauge on the odorizer. The control is not as fine as with a programmable injection system; the only control is the pressure drop in the main line: it relates to the proportion of the gas flow which will be diverted to the bypass to pick up odorant vapors.

After the slugging phase, a second phase was undertaken where liquid odorant was continuously injected into the gas stream at varying dosages (Option 3) until the outlet concentration obtained was satisfactory. This step was more labor-intensive as it required constant monitoring of the odorant levels and feedback action at the injection unit (Table 1).

**Figure 4: Mercaptan Levels During Bypass Odorization Phase**



**Conclusion**

This article has sought to describe the pickling of a new natural gas pipe, backed by actual data. Every pickling job is different, with respect to the length, diameter, material of the pipe, the gas flow rate going through it, and the type of odorant being used. However, it is our intention to provide a basic reference of the pickling requirements of a line such as the one described here, reporting the behavior of the line, the amount of odorant required to saturate the line, the dosages used and tail-end odorant measurements. *P&GJ*

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