The Development of a Permanent, Mechanical Repair Sleeve for Plastic Pipe

Contract No. 03-NT41880.000

Technology Assessment Review

June 2004

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Introduction

Currently, there are no fittings available for the permanent repair of plastic gas pipe. *The Development of a Permanent, Mechanical Repair Sleeve for Plastic Pipe* project addresses the need for such a fitting, as current repair and replacement techniques are costly and time consuming. This technology assessment review addresses the background of the project, current repair practices, as well as relevant past work regarding mechanical fittings for plastic gas distribution systems.

Background

When a steel gas pipe is gouged or ruptured, the typical repair technique is for a welder to repair the damaged pipe by welding a steel repair sleeve, commonly termed as a "pumpkin", or full-encirclement fitting over the compromised area. However, in the plastic industry, there are no fittings currently available to mirror this process on polyethylene pipe (PE) that can act as a permanent repair. If the damage is significant, in terms of percentage of wall loss, the entire damaged section of pipe may need to be cut out and replaced with new pipe. In addition, if the damage consists of pipe breach, then the damaged section (gouge) must be isolated with line stopping or squeezing equipment in order to perform the repair. Multiple excavations may be required in order to safely isolate the blowing gas area, which takes considerable time, expense, and effort.

To address this need, GTI has formed a project to develop a repair fitting for damaged plastic pipe. The project's objective is to develop a mechanical repair sleeve for gouged or breached plastic pipe that a technician can simply bolt on to the pipe over the damaged area with blowing gas. GTI has an action plan so that the developed repair sleeve will act as a permanent repair to the damaged main. Researchers aim to develop a simple, robust device that is insensitive to the exact size, shape, and location of the damaged pipe area. The repair sleeve will be rated for mains operating at pressures up to 60 psig. Additionally, the device needs to be inexpensive, lightweight, easy to use and quick to deploy.

Based on past GTI studies, the following is a list of some of the costs associated with leak repairs and excavation/restoration practices for the natural gas industry:

- Leak repairs of plastic pipe:[1]
  - Mains: Nearly 50,000 repairs per year
    - Costing $23.6 million per year
    - Almost $500 per leak (avg.)
  - Services: Nearly 210,000 repairs per year
    - Costing $45.3 million per year
    - $215 per leak (avg.)
- Pavement restoration:[1]
  - Bellholes: Over 675,000 excavations per year
    - Costing $19.80 per square foot = $290 per bellhole
    - Total costs associated with bellhole excavations are nearly $200 billion

Current State of Technology

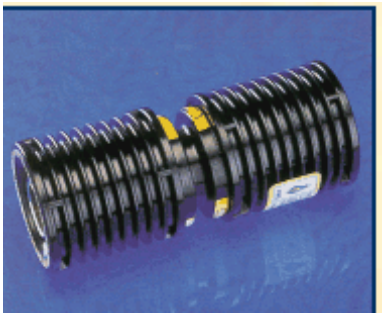
The following are various repair techniques to damaged plastic distribution pipe:

Cut and Replace

The most common practice for repairing a damaged plastic gas main is replacement. During this process a temporary bypass may need to be built spanning over the area that will be isolated. The main is then stopped or squeezed on both sides, safely away from the damage if the pipe is ruptured and there is blowing gas, and then the damaged portion is cut out and replaced with a new piece of PE piping.

There are several different methods that are utilized for connecting the replacement PE piping to the existing infrastructure including mechanical fittings (see Figure 1 below, R.W. Lyall's LYCOFIT® double ended fitting[2]), heat fusion joining, and / or electrofusion fittings. Nevertheless, the replacement of the damaged pipe portion does require the main to be completely shut down. This process is even more cumbersome when flow is required to keep customers downstream of the damaged area to be kept "live". This would then require a bypass to be installed and subsequently impacting both costs and labor.

Figure 1



In order to accommodate the squeeze off tooling and bypass fittings, at least three excavation sites, including the excavation to replace the damaged pipe, are required. In the cases of electrofusion and heat fusion, once the damaged portion of pipe is removed and the new piece of pipe installed, the utility must wait for the rough handling time to pass (typically 30 minutes) before removing the bypass and returning the main into service.

Installation of a Tee over the Damage

Another additional repair alternative is available for very small gouges or depressions into a pipe. A service tee or high-volume tee could be placed over the damaged area. However, the circumference and diameter of the damage must be less than the circumference and diameter of the tee's cutter. This enables the tee's cutter to remove the damaged area as an entire coupon, thus removing the damage. However, this tremendously limits the types and sizes of defects that can be effectively repaired.

Variable Length Repair Sleeve

The repair product is currently being developed by the New York Gas Group, (NYGas/NYSEARCH). The Variable Length Repair Sleeve will utilize electrofusion as its joining process. Its objective is "to develop an adjustable length plastic pipe repair sleeve that repairs damages at various lengths[3]. " Initial prototypes are to be for 4" polyethylene pipe with a rating up to 124 psig[3]. The product is not commercially available at this time.

Band Clamps

Band clamps, like the one made by Mueller Co.[4] shown in Figure 2, are utilized on both steel and plastic pipe as temporary repairs for leaking pipes. However, the key issue is that the repair is only temporary and the damaged section of main must be either permanently repaired, typically by the cut and replace method. If the pipe is made out of steel, then a full-encirclement fitting may be welded over the damaged pipe if the fitting can accommodate the entire damaged area.

Figure 2

Figure 2

Tapered Screw Plugs

Another mechanism used to repair steel pipe is to utilize a tapered steel plug. The plug is screwed into the hole in the pipe and then is welded into place.
While this repair technique works for steel pipe, it is not available to use on plastic piping. Below, Figure 3 is an example of a tapered screw plug that is commercially available by Mueller and Co. [5]

Figure 3

The Mueller Magic Box[6]

Mueller and Co. offers the Magic Box (Figure 4) as an additional tool for repairing scraped or gouged plastic main without having the need to shutdown the flow of gas. The Magic Box is bolted over the damaged section of pipe that is to be cut out and replaced using the Box's technology. Under live conditions, the Magic Box cuts out the damaged section of pipe and moves a new replacement piece inline with the existing main. The replacement pipe is then electrofused into place making the repair complete. The Magic Box can repair two, three and four inch plastic pipe, as

well as fuse in the respective size valve. The installation of the Magic Box is not suitable for third-party damaged ruptures under a blowing gas condition.

Figure 4

DA Export's Electrofusion Repair Sleeve[7]

In Europe, DA Export offers an electrofusion repair fitting (Figure 5) for PE pipe. This repair fitting can be installed on a pressurized pipe that has been gouged or on a non-pressurized gas main that has been breached. However, the product is only available in European pipe sizes and must be modified to accommodate the U.S. market.

Figure 5

Related Work

To achieve the objectives of the project, GTI completed a literature search identifying the prior work in the area of mechanical fittings commonly used in the pipeline industry. The most promising off-the-shelf devices were identified and manufacturers were contacted for additional details. The literature search provided multiple companies that could potentially work with GTI to accomplish the goals of the project.

R.W. Lyall and Company was determined to be the most capable company and best fit for the project. GTI has partnered with R.W. Lyall and Company on the conceptual designs to fabricate a working prototype.

As a result of the literature search, in addition to locating fitting manufacturers, GTI obtained an article from the *Pipeline and Gas Journal* entitled "Band Clamp Repair for Damaged Plastic Pipe". This article describes the Wisconsin Gas Company's approach to repairing damaged plastic gas mains with stainless steel band clamps. Their repair clamps were tested to the standards required of fittings for plastic pipe:

- Leak testing at 2 psi to 100 psi[2]
- Quick burst tests per ASTM D 1599[2]
- Sustained pressure tests per ASTM D 1598[2]

Early leak and quick burst tests conducted on 2-inch pipe with through wall slits indicated the repair clamps would be able to repair significant damages. It was determined analytically and empirically, that the clamps would be able to be used on damages up to one third of the circumference of the pipe. However, the long term performance and the ability of these clamps to effectively mitigate the Slow Crack Growth (SCG) failure mechanism have yet to be proven.

Conclusion

Current methods of repairing damaged plastic gas piping, such as replacement, leave great room for improvement. These methods are time consuming and expensive, and leave local distribution companies with few alternatives. There exists no commercially available fitting that a utility can use to repair damaged plastic gas pipe under a blowing gas condition. This project aims to deliver a fitting that will be able to be installed quickly and safely on plastic piping systems as a permanent, reliable repair method.

References

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