Development of a Remote External Repair Tool for Damaged or Defective Polyethylene (PE) Gas Pipe

Presented by
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Timberline Tool
Since incorporating in 1989, Timberline has been developing innovative tools used by natural gas utility operators to maintain and repair PE pipe.

In 1999, Timberline began developing tools specifically for repairing PE pipe in keyhole situations.

Timberline tools are currently being used by natural gas utility operators worldwide.
Remote External Repair Tool for 4-inch PE Gas Pipe

- External repair methods for PE pipe are being investigated at Timberline Tool and Oregon State University under a cooperative agreement with DOE/NETL.
- Current repair procedures require multiple excavations, isolation, and removal of the damaged section of pipe followed by fusing a new section of pipe into place.
- This project will develop a new methodology and tool for externally repairing damage or defects on PE pipe by applying a repair patch over the compromised area.
- This presentation reviews the initial design and development of the mechanical device and two chemical processes for repairing damaged PE pipe.
Background

Natural Gas Delivery System

• The use of PE pipe for natural gas transmission & distribution has been steadily growing in the U.S. and accounts for a majority of America’s natural gas distribution network.

• The current delivery system consists of 650 thousand miles of underground PE piping in service for over 30 years.

• It is important to keep the delivery system safe, reliable and efficient.
A Growing Need

Maintaining a Growing Infrastructure

The U.S. Department of Transportation forecasts a 50% increase in the demand for natural gas by 2020.

- Need improved tools for maintenance & repair of PE pipe to keep up with the expected growth.
- This project responds directly to this need.
- Goal is to help maintain the safety, reliability, and integrity of the U.S. natural gas delivery system.

Innovative Tool Technology
Operating Procedures

- Natural gas operators are turning to keyhole technology for increased safety and cost savings.
- Since 1999, Timberline has been developing PE pipe repair tools for use in keyhole application.
In 2003, Timberline received an award from the U.S. Department of Energy National Energy Technology Laboratory to develop a remote external repair tool for PE Pipe.

The focus of this research is to encapsulate the damaged area of the pipe and apply a chemical patch to permanently repair the pipe.

This project will develop a new method for repairing damaged or defective 4-inch PE pipe.
Repair Tool Team

Cooperative Agreement with the Department of Energy National Energy Technology Laboratory

Innovative Tool Technology
Repair Process

- Curved jaw fits the contour of the pipe as it closes.
- Allows operator to fully enclose the damaged section of pipe with the repair patch.
- Stops the flow of gas through the damaged pipe wall.
- Permanently repairs the damaged area.
Current repair procedures for PE gas pipe require multiple excavations, isolation, and removal of the damaged section of pipe followed by fusing a new section into place.
Repair Tool Design

- **Lightweight & portable**, constructed of aluminum for mechanical operation by a single person.

- **Remote operation** keeps operator away from leaking gas.

- **Top-down application** without the need to fasten the device under the pipe.

- **Operable in keyhole situations** without the need for squeeze-off.

- **Curved jaw design** allows for encapsulation of the pipe.

Innovative Tool Technology
Safety Benefits

- Remote, top-down operation keeps operators out of the trench.
- Minimal excavation creates a safer working environment.
- Repairs are completed faster.
Cost Savings

- Significant time & labor savings due to ease of application
- Significant savings by eliminating need for extensive excavation.
- Dramatically reduces costly pavement restoration.
- Increases productivity. Only one operator and one excavation required.
PE pipe will be repaired externally.

Repairs will be performed without shutting off the flow of gas.

A mechanical tool will apply the repair patch over the damaged area.

Patch will be chemically bonded.
Phase 1

- The project team will design, fabricate and perform in-house and field tests on one or more repair tool configurations to determine the best functionality, safety and reliability for the repair tool.

- Phase 1 will be completed March 2005.
Phase 2

The project team will use information gained in Phase 1 to guide the construction of one or more engineered prototype repair tools. In-house and field tests will be performed on these engineered prototypes and laboratory tests will be performed on repaired 4-inch PE pipe sections.

Phase 2 will be completed March 2006.
**Concept 1:** Polyethylene gel bonding uses a gel containing a bonding agent attached to a PE patch to join the surfaces of the PE patch material and the damaged PE pipe.

**Concept 2:** Polyethylene adhesives utilize structural plastic glues to join the surfaces of the PE patch and the damaged PE pipe.
Polyethylene gel bonding uses a gel containing a bonding agent attached to a PE patch to join the surfaces of the PE patch material and the damaged PE pipe.

Early shear test results show successful bonding of two HDPE samples.
Repair Concept 1

- Gel creates a relatively seamless joint.
- An ideal bond joint would be difficult to differentiate from this sample.

SEM Bonded Cross Section
Polyethylene adhesives utilize structural plastic glues to join the surfaces of the PE patch and the damaged PE pipe.

AD #1 and AD #2 cured at 80°C for 90 minutes in the Carver Press. One AD #1 sample cured at 80 °C for 24 hours in the Carver Press.
Sample 1 cured at 80°C for 90 minutes in Carver Press with 50 lbs pressure. Glass sphere broken during shear test. 1650x magnification.
Project Completion

- The completion of the project will involve construction of an engineered prototype for 4-inch diameter MDPE & HDPE pipe.

- Laboratory and field tests will be performed on the prototype and repaired pipe samples under well-defined testing and operating procedures of natural gas distribution systems.

- The effectiveness of the design will be reviewed and modifications made in preparation for commercialization of the tool.
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