OTD Operations Technology Development

PIPE MATERIALS, REPAIR & REHABILITATION

PROJECT No. 2.14.e
SUMMARY REPORT

Guidelines / Best Practices for Scraping PE Pipe and Fittings

In this project, researchers developed a functional set of improved, up-to-date guidelines for scraping PE pipe and fittings. The guidelines take into account current tooling and scraping practices while addressing the variables associated with fusion execution.

Project Description

While procedures and training for polyethylene (PE) pipe fusions have been enhanced over the years, failures still occur. In response, in recent years investigations have addressed multiple issues and installation practices.

Research shows that there are detectable differences in heat-fusion performance between scraped and abraded pipe surfaces. Failure analyses demonstrate wide variation in scrape appearance and consistency that were major contributors, if not the cause, of fusion bond failures. The effectiveness and repeatability of the scrape has a correlating impact on the ability to produce consistent, long-lasting fusions and are influenced by current practices, depth of scrape, scraper tool designs and effectiveness, pipe ovality, pipe curvature, process-supporting equipment/hardware, and installation conditions.

For this project, researchers evaluated scrapers and techniques in order to develop a set of guidelines for PE pipe and fittings.

Testing of a pencil scraper on a 1/2-inch plastic tubing.

Deliverables

The deliverable from this project includes a comprehensive set of PE fusion guidelines/best practices.

Benefits

This investigation and the resulting guidelines will create a greater understanding of PE fusion variables and practices that can lead to better fusion consistency and performance.

This investigation may also result in the development of standards and/or guidance documents for manufacturers to reference.

Technical Concept & Approach

For this project, a comprehensive approach was taken where the influence of all processes and materials used in creating a joint are acknowledged and understood. To achieve this goal, researchers developed a process map relating the various elements involved in creating a joint.

The scope of work was comprised of testing the scraping performance of eight commonly used scrapers at three different temperatures, and evaluating the ability of the scrapers to remove the maximum oxidation layer and contaminants, such as bentonite powder, a common contaminant found in horizontal direction drilling installations and representative of other soil (silicate) contaminants.

Initially, the research team conducted a survey to address current fusion practices employed by utilities and equipment manufacturers. Researchers also reviewed information gathered from previously conducted projects to gain a better understanding of the current state of use in the industry.

The testing matrix included qualitative and quantitative comparative approaches via physical, chemical, and instrumental analyses and simulations based on standard industry methods using statistically significant test specimen quantities.

Some of the techniques employed included:

- Optical and scanning electron microscopy to characterize and document the scrape surface characteristics
- Peel, bendback, and pressure testing of select fusions, and
- X-ray and/or Computed Tomography (CT) for electrofusion characterization.

Results

Various scrappers were tested. The scraping tools and fusions review included small-diameter pipes as well as other larger pipe diameters. An electrofusion coil to test electrofusion gap sensitivity was designed specifically for this project.

The project team used eight scrapers, three pipe ovalities, three temperatures, and three replicates per testing condition, for a total of 216 scraping runs.

Analyses of field failures of electrofusion fittings found that there are differences between scrapers with respect to surface contamination removal. In light of this finding, the selected scrapers were tested on pipe with known surface contamination.

Commercial pipe re-rounding apparatuses were modified to produce specific ovalities.

Issues regarding minimum and maximum scraping depths were specifically addressed. Based on maximum oxidation depth found in prior works, the following minimum scraping depths can be specified:

- 0.0063 inches (0.0126 inches of pipe diameter) for pipes yellow medium-density PE pipes, and
- 0.004 inches (0.008 inches of pipe diameter) for black high-density PE pipes.

Maximum scraping depth as pertaining to electrofusion fittings depends on the fitting design and must be assessed on a per-fitting basis, but must never exceed 10 percent of the pipe wall thickness. Heat-fusion saddles are much less sensitive to gaps caused by excessive scraping as they are forced onto the pipe during heat soaking and joining.

The results of the scrape-depth testing showed that all scrapers can achieve a sufficient scrape depth; however, rotary-type scrapers provide better scraping quality compared to handheld scrapers, in both scraping depth and coverage. Additionally, in most cases rotary scrapers require only one scraping pass to achieve sufficient scrape depth and coverage (as long as they are manufactured to meet the minimum scrape depth), while handheld scrapers require several passes to do the same. Although rotary scrapers typically function consistently between scrapes, they are prone to misalignment that can lead to intermittent scraping; therefore, operators should be properly trained in the use and maintenance of such tools.

Oval pipe (up to ~5%) did not appear to adversely affect scraping depth. The test results showed that spring-loaded scrapers generally follow the outer diameter of the pipe and, therefore, appreciable re-rounding by scraping may or may not occur. The pencil scraper did consistently re-round the pipe due to its fixed blade and cavity. The influence of pipe ovality on electrofusion quality is directly related to the gap sensitivity of the fitting and the fitting's dimensional tolerances – therefore, sensitivity to ovality must be evaluated on a per-fitting basis.

Contamination-removal testing showed that scraping alone does contribute to the removal of surface contaminants; however, this contribution is variable and not sufficient by itself. The surprising result of the contamination-removal testing was that only the handheld "paint-scraper" type scraper removed 100% of the bentonite powder in all test runs. Other scrapers had some runs where all contamination was removed and other runs where contamination remained or resettled in the fusion zone.

The findings of the testing conducted in this project led to a suggested pipe-cleaning procedure where the pipe is thoroughly washed and cleaned prior to scraping (washing and cleaning should go beyond the area to be scraped) and then minimizing the opportunities for contaminating the scraped area of the pipe. The minimum and maximum scrape depths should also be followed to ensure that oxidation in the pipe wall is removed.

Status

This project is complete. The Final Report was issued in August 2017.

For more information:

Maureen Droessler
Vice President, Operations
Operations Technology Development, NFP
Phone: 847/768-0608
maureen.droessler@otd-co.org