

Evaluation for Impact of “Rework”

This research program was conducted to evaluate the impact of the use of “rework” on the long-term performance of polyethylene pipe used for gas distribution. While the use of clean and uncontaminated rework has been a safe and cost-effective plastic-pipe production method, users of plastic gas piping systems have expressed the need to learn more about rework’s impact, if any, on long-term performance.



Project Description

Rework — also called “regrind” — is a common practice in the manufacture of polyethylene (PE) pipes, where scrap pipe generated during the production of gas pipe is re-introduced as a portion of the final product.

The objective of the plastic pipe rework program was to define rework source materials and establish requirements for the management, control, and use of rework materials. Furthermore, researchers tested and evaluated the short-term and long-term performance properties of ASTM D2513 PE gas pipes produced with rework materials, and, based on the results, reviewed and confirmed performance requirements.

Program participants include Operations Technology Development, NFP; Gas Technology Institute; the American Gas Association Plastics Material Committee Steering Committee; and the Plastics Pipe Institute.

As part of the program, participants formed a key stakeholder group consisting of leading organizations representing gas utilities, regulators, and pipe manufacturers. Through this group, a program was established to develop technical data relating to the long-term performance considerations raised by the end users, and to conduct a program with the manufacturers to educate the gas industry on the responsible use of rework materials.

Deliverable

The main objective of this program was to determine the relative impact of the use of rework on the integrity of piping materials in terms of dielectric breakdown, Slow Crack Growth (SCG) resistance, and Rapid Crack Propagation (RCP) considerations.

Comprehensive data was developed to accurately address production-processing parameters and their respective impact on the long-term performance of piping materials.

Benefits

Results of this program will help enhance the safety, reliability, and overall integrity of the plastic piping distribution network.

Background

Title 49, Part 192 of the Code of Federal Regulations and its respective subparts governs the minimum requirements for the safe use of plastic piping materials. Additional requirements to ensure the mechanical and physical properties are governed by ASTM D2513 specification — incorporated through reference in Part 192 Appendix A. The requirements contained within ASTM D2513 and its respective referenced standards adequately help to characterize material properties and product performance (short-term and long-term) pertaining to the use of rework. However, in-plant quality controls are not addressed within ASTM D2513 and therefore questioned by some end-users (gas utility companies).

Although the use of rework material with PE resins used for gas piping applications has not been identified as a mechanism or vehicle for failure (as there is no means to differentiate between pipes produced with and without rework), industry advisors noted that more needs to be learned about the impact of the use of rework material on overall PE gas piping system performance.

Technical Concept & Approach

Through the program, researchers worked with pipe manufacturers to produce parametrically controlled pipe specimens for testing and evaluation. These specimens varied by percentage of rework and cleanliness procedures. Three different pipe sizes in medium-density PE pipe (PE2406), a uni-modal high-density PE pipe (PE3408), and a bi-modal high-density PE material with varying levels of rework were utilized for testing purposes.

The project employed a wide variety of specimen testing methods in order to:

- **Characterize Dielectric Breakdown** by measuring the released energy associated with discharge at voids, contaminants, or anomalies in the wall thickness.
- **Characterize Slow-Crack-Growth Resistance** to better understand the relative impact of contaminants, in-homogeneities, and other anomalies within the pipe wall and their correlation to SCG resistance characteristics.
- **Determine Resistance to Rapid Crack Propagation and Critical Pressure and Temperature** through similar testing noted above and a recently standardized procedure known as S4 testing, where a short length of pipe, typically seven pipe-diameters long, is filled with compressed air or water to a pre-assigned constant internal pressure and temperature, and then subjected to an impact at one end with a sharp chisel. Provided the internal pressure is sufficient, a fast running axial crack is produced. By performing a series of individual S4 tests with systematically varied internal pressures, the minimum pressure for which a fast-running crack is possible (or, equivalently, the maximum pressure for which no propagation occurs) can be bracketed.

Based on the data generated as part of this overall program, Gas Technology Institute (GTI) — with input and guidance from the stakeholder group — developed appropriate wording to amend ASTM D2513-06 requirements.

Results/Status

All relevant testing to characterize the three main areas of concern have been completed. Consensus-based final recommendations to improve workmanship and rework levels have been developed by the rework steering committee. These respective recommendations have been incorporated into key industry documents, including ASTM D2513-06, the AGA Plastics Pipe Manual, and the Plastics Pipe Institute TN-30 document. This is a significant achievement aimed at ensuring standardization across the industry.

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