Northeast GAS ASSOCIATION
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Technology Brief

Creating Rapid Crack Propagation in PE Pipe

Description: **To determine the influence of pipe material, diameter and wall thickness Rapid Crack Propagation (RCP) resistance on modern day PE Pipe.**

Status: **Currently in testing phase, destructively testing and measuring arrest or propagation in PE pipe samples per full scale testing parameters**

BENEFITS

Modern day thermoplastics used in polyethylene (PE) gas pipe possess greater strengths and improved failure capabilities than may be realized by current calculation methods and standards. The AGA Plastics Material Committee and ASTM plastic sub-committees are interested in determining these true capabilities and capacities. The full benefit of maximum use of these PE pipes may not be recognized until actual validation correlation testing is performed.

Safety and system integrity are improved through validation testing. RCP is influenced by the inherent pipe material chemistry, diameter and wall thickness. Validation testing by actual Full-Scale Testing (FST) defined in ISO 13478 and Small-Scale Steady State Testing (S4) defined in ISO 13477 may better reveal the properties of this material's RCP resistance.

RCP validation may add additional confidence in the continued installation and operation of PE pipelines.

BACKGROUND

A critical design concern for piping systems is to assure that the operating pressure does not exceed the limits of the material that could generate a failure caused by RCP. RCP in plastic pipe is a very infrequent but brittle failure phenomenon in which a long, typically longitudinal crack occurs with rapid speed, releasing large volumes of gas in a very short time. Over the past decade, the two standardized test methods, FST and S4, have been developed to characterize the RCP resistance of PE piping materials.

Present standards regarding buried PE pipes for natural gas use makes the assumption that there is no correlating influence of RCP to the PE material or pipe geometric characteristics. However, Phase I validation tests revealed that there are correlating influences to RCP from PE material properties.

Figure 1: Crack Propagation Results in MDPE Pipe During Full Scale (Extreme) RCP Testing

This has significant implications for overall safety and system integrity. In recent studies, it has been suggested that modern MDPE

materials have S4 critical pressure of 15 psig resulting in a maximum allowable operating pressure (MAOP) of 60 psig when correlation formulas are applied. In contrast, the FST test for the same material resulted in an MAOP of 92 psig. Therefore, premature industry adoption of the existing S4 test and correlation formulas for RCP could limit distribution design ratings for natural gas pipelines.

By accepting the S4 correlation inconsistency, certain distribution companies using MDPE in excess of 60 psig may need to reduce pressures and revise their design practices in the future. This situation may worsen if the full impact of brittle failures on PE pipe is not known as the infrastructure ages. It will create an inability to fully capitalize on new PE materials and their capability to accommodate higher pressures.

The final analysis of the Phase I results revealed that the combined outcomes of the S4 Test and FST indicate the current ISO 4437 correlations are not accurate for the modern generation of PE materials. The current ISO 4437 correlations are overly conservative, leading the pipeline engineer to over design a PE pipe system.

TECHNICAL APPROACH

Phase I tested differing material of similar geometry PE pipe by performing FST and S4 testing to compare and contrast the RCP capacity. Figures 1 and 2 illustrate the FST and S4 test results. Phase II will test similar material with differing geometries of PE pipe for further investigation by testing through FST and S4. These analyses will further reveal the validity of the S4 correlation formulas and their relationship to the FST test results specifically for influencing characteristics in pipe geometry.
Revised RCP guidelines will be developed from the combined Phase I and II work proposed. Test results shall be prepared for submittal to industry groups AGA, PMC and ASTM with recommendations for adoption and revisions to current standards.

PROGRAM STATUS

Phase I is complete, with testing having confirmed the influence of differing PE material on RCP resistance. Phase II testing is ongoing; testing the unknown significance of geometry on RCP resistance.

Highlights

- Full scale RCP verification testing of PE pipe
- Improved testing criteria for manufacturers
- Improved standards for testing of PE pipe
- Improved confidence for PE pipe users

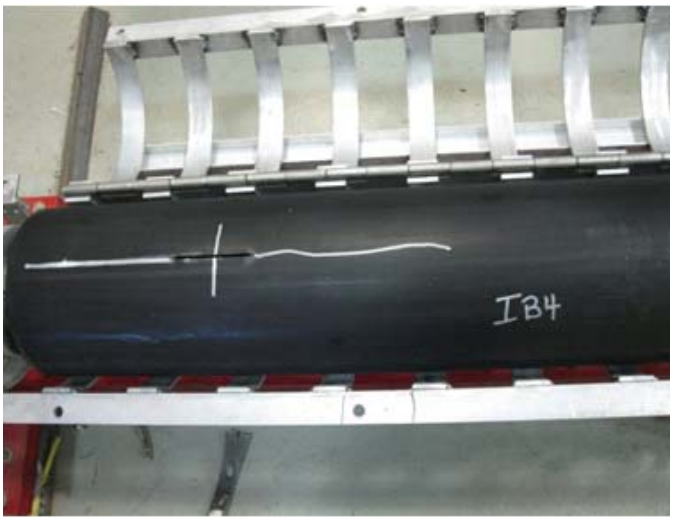

Figure 2: S4 test for RCP performed on HDPE pipe

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