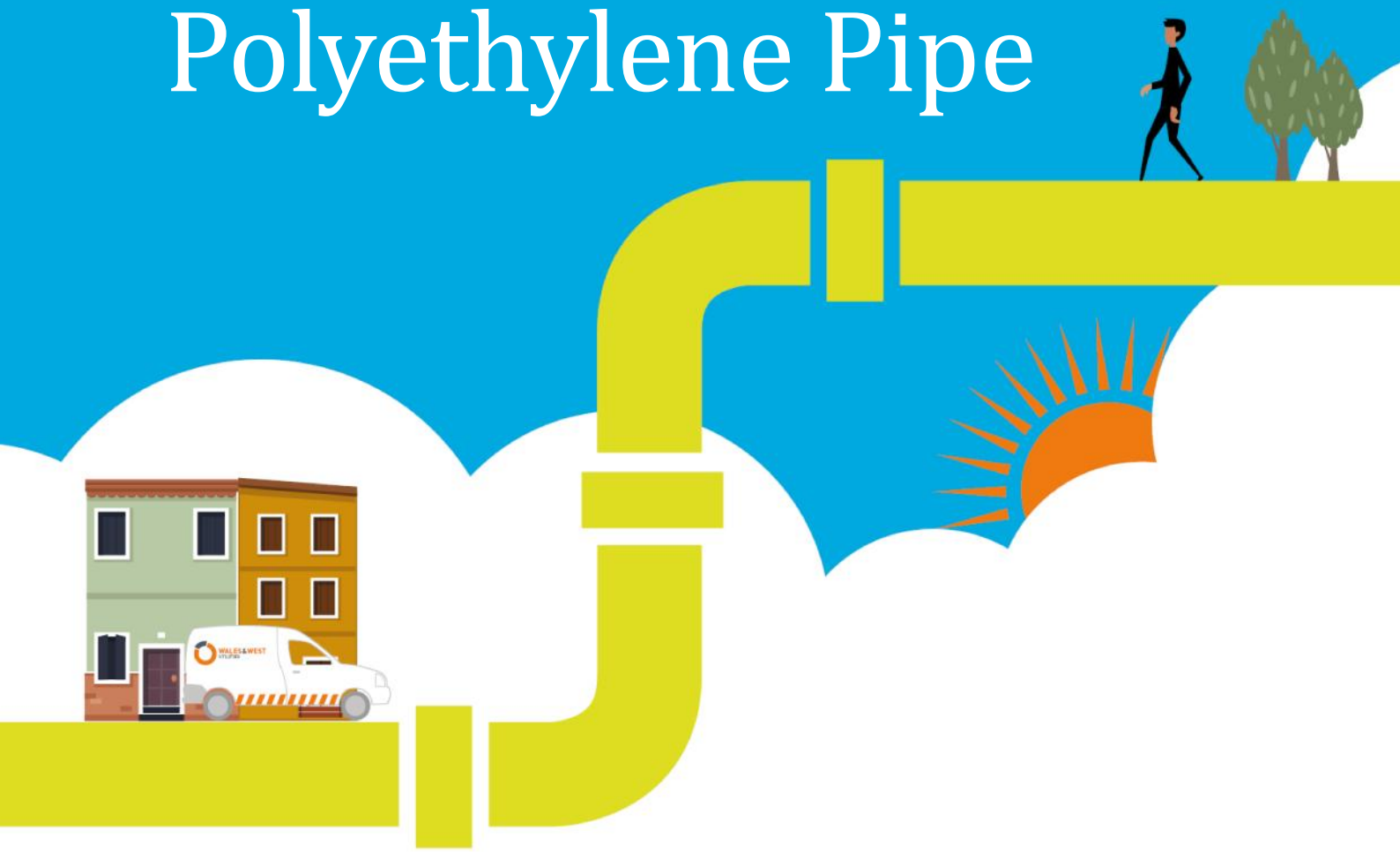
Assessing Permeation of Gas through Polyethylene Pipe



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Introduction

Gas Distribution Networks (GDNs) regularly review the Shrinkage and Leakage model (SLM) to further enhance the reporting of Shrinkage gas. During 2017 we regularly met with interested parties through the Shrinkage forum[1] to help identify opportunities for improvement of the SLM and also discuss matters directly related to the evaluation of Shrinkage Gas. Towards the end of the year, we published an annual report[2] for consultation with interested parties which included our planned commitments to review areas of the SLM and published our 2018 approach.

Our Commitment	2018 Approach	Potential Impact on Shrinkage Modelling
Following discussions with Stakeholders GDNs will investigate the potential impacts of PE permeation.	GDNs will review the calculations within the model to determine whether PE permeation is inclusive within the current leakage rates. If this factor is found to be absent from the current rates, GDNs will engage with industry experts to review the impact of PE permeation on the Shrinkage and Leakage model.	If it is concluded that a separate PE permeation rate should be applied to the calculation of fugitive emissions from PE pipes, then this will result in an increase in total leakage although this is anticipated to be a relatively small amount due to the nature of this factor.
We will further investigate the accuracy of the existing MP Leakage calculation.	GDNs will engage with industry experts to determine the preferred approach for refreshing the MP Leakage calculation.	Feedback from the AUG expert suggests that pressure and leakage are proportional to one another, however, MP leaks are more likely to be rectified sooner. Any proposed change will target improvement to the MP leakage calculation.
We will continue to investigate the opportunity of reflecting the benefits of Remediated Pipes in the SLM.	GDNs are currently finalising the overall remediation capture process and ensuring all associated supporting evidence is available, with a view to developing an industry consultation on a modification to the SLM.	Remediation is a process for maintaining our pipe assets with minimal impact on our customers. If it is proven that remediation is effective in driving down leakage, future Shrinkage calculations may include a correction for remediated mains in order to improve the accuracy of the SLM.
We will review the suitability of the existing Own Use Gas calculation within the SLM.	We will continue to investigate the results of low carbon preheating trials and determine if they can be used as a basis for revising the Own Use Gas (OUG) calculation. We will also consult industry experts to understand if other methods of calculating OUG are available.	Whilst the results of the low carbon preheating trials have still to be fully reviewed, it is anticipated that the estimates of OUG will change.

Figure 1 - Summary of 2018 GDN Commitments

As part of the GDNs approach for 2018, we are committed to reviewing the leakage rates within the SLM to ensure any impact of the permeation of gas through polyethylene (PE) pipe is accurately reflected. The GDNs will engage with industry experts to review the impact of PE permeation on the current SLM.

[1] https://www.gasgovernance.co.uk/sf
[2] https://www.gasgovernance.co.uk/Shrinkage/Consultations

Executive Summary

Gas Permeation through PE refers to the diffusion of gas through the wall of the pipe and is affected by factors such as the differential pressure between the fluid within the pipe and the surrounding atmosphere, the wall thickness of the pipe, density of PE and temperature. Approximately 75% of total Medium pressure and Low pressure mains in the UK gas networks are of PE material, therefore it is imperative that gas permeation through gas pipelines is reviewed to ensure its impact is accurately reflected in the current SLM.

The view of GDNs is that decay tests previously carried out include the impact of permeation and this study seeks to test that assumption.

The report published following the National Leakage Test 2002/3[3] (NLT) describes the method used to carry out the 849 leakage tests on different sections of gas mains and services. The report details the test procedure and confirms that the sections of mains and services which were being tested were subject to being capped and isolated, with the rider from an upstream section of the network not under test conditions, would be connected to the test section in order to maintain pressure and prevent depressurisation. The leakage test method which was used was the Pressure Decay Method. This method measures the decrease in pressure within the pipe which is a consequence of gas exiting the pipe irrespective of the route i.e. gas escaping through joints, permeation etc.

The pressure in the main was not allowed to decay prior to the leakage test being carried out therefore ensuring that the test conditions matched those the pipe would see in service. As a result, the GDNs are certain that permeation of gas through the wall of PE pipes was captured during the NLT 2002/3 and subsequently the current leakage rates which are used in the SLM include gas permeation.

Current Leakage rates

National Leakage Test 2002/3

The current SLM uses leakage rates defined from the 2002/3 National Leakage Test Programme (NLT) where 849 sections of pipe were tested for leakage. Following these tests, leakage rates were defined for the various pipe materials and diameters. As a result the leakage rate attributed to PE pipes are 63.51 cubic metres of gas, per km, per annum.

[3] Report on the 2002/3 National Leakage Test Programme, Kirsty Nelson, Advantica Limited

The methodology used for the NLT to determine the rate at which gas leaks from the sections of pipe included the process of capping and isolating sections of pipe followed by pressurisation of the section to 30 mbar. Whilst the section of main was capped and isolated, a rider from the upstream main (pipe not under test conditions) was used to maintain a steady pressure within the test main to prevent the test section depressurising. Following the capping and isolation of the test section, the pipe pressure was allowed to decay due to leakage whilst the pressure and temperature was continuously recorded.

Diffusion of gas through PE pipe takes a considerable amount of time to occur. As the pressure in the main was not allowed to decay prior to the test, the rate of diffusion of gas through permeation of the PE pipe would remain constant. This ensures that the test reflects the appropriate 'in-service' conditions for the pipe leakage test.

On the contrary, if the section of pipe which was under test conditions was subject to depressurisation prior to the test being carried out, this may have disturbed the process of permeation which could have had a minor impact on the leakage results obtained.

The test method, a Pressure Decay method, measured the reduction in pressure of the pipe during the test period, which would include the reduction of pressure which resulted from the permeating gas through the pipe wall. Given the evidence of the test procedure and methodology, the GDNs conclude that permeation of gas through the wall of PE pipes was captured during the NLT 2002/03 and that the current leakage rates which are used in the SLM include gas permeation.

Energy UK report

The Energy UK report[4] references permeation of gas through PE pipes with estimates greater than the current leakage rates for total leakage through PE mains. The figures quoted within the report suggested that over the course of a year, 1km of 2" PE pipe will account for slightly more than 450 cubic metres of permeated gas, a quantity which greatly exceeds the current leakage rate of 63.51 cubic metres per km, per year. This estimation was carried out based on tests done at much higher pressures and temperatures and then extrapolated down to lower pressures, assuming a direct correlation. The GDN's have commented on these claims in a response to the Energy UK report[5].

Permeation of gas through PE pipe under low pressure conditions (25-75 mbar) would be extremely difficult to measure due to the very small quantities estimated to diffuse through the pipe wall using the current technology. It's likely that any such tests that are completed under alternative conditions

[4]https://www.gasgovernance.co.uk/sites/default/files/ggf/Energy%20UK%20GRG%20shrinkage%20study%20FINAL.pdf
[5]https://www.gasgovernance.co.uk/sites/default/files/ggf/Joint%20GDN%20Response%20to%20Energy%20UK%20GRG%20Shrinkage%20Study_0.pdf

i.e. higher pressures and temperatures with the results extrapolated down, would not reflect reality due to the contrasting results this would indicate in comparison to the extensive tests carried out during the NLT.

Manufacturer data

The GDNs approached the manufacturer to review the data which is held by them for permeation of gas through PE pipe. The manufacturer provided a model which included data derived from Crank & Glicksman thereom and also the American Gas Association. The GDNs carried out analysis of their network using the data provided and concluded that permeation accounts for a small proportion of leakage gas with a calculated proportion of less than 0.01% of total leakage. The calculated quantity of leakage gas caused by permeation through PE pipe indicates a value of less than 0.1% of the current leakage rate of PE which is in use within the SLM, the remainder of the PE leakage rate being compromised of other leakage as evidenced in the NLT report.

Conclusion

The GDN's are committed to enhancing the reporting of Shrinkage gas. As part of the 2017 commitments, we reviewed whether the current leakage rates which form part of the calculation of Leakage gas include the quantity of gas which has permeated through the wall of PE pipes. Upon reviewing the NLT 2002/03 report, it is clear that prior to the leakage test being carried out on a section of pipe, the pressure in the section was maintained using a rider from an upstream part of the network which was not under test conditions. This allowed the pressure in the test section to remain pressurised therefore allowing for permeation of gas to take place during the course of the pressure decay test. To conclude, the GDNs feel that permeation of gas through PE pipe is currently included within the current leakage rates which are used within the current SLM.