WHITE PAPER

REALISING THE ADVANTAGES OF SQUEEZE-OFF AS A PIPE ISOLATION METHOD

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Find out how to maximise the lifetime of polyethylene pipe networks following flow-stopping using the squeeze-off technique

Utility companies throughout the world are tasked with the secure delivery of gas or water to homes and businesses on a continuous basis. To minimise service interruptions, the industry is fast replacing its pipeline infrastructure with high density polyethylene (HDPE) piping.

Among the many advantages of PE as a material for pipelines – including flexibility and resilience – the ease, speed and cost-implications of maintenance and repair are worthy of consideration.

Only pipes manufactured from PE can withstand the forces of "squeeze-off" – a procedure used to shut off the gas or water flow by compressing the pipe walls. Although not commonplace, there is a risk of damaging the pipe material during squeeze-off that could lead to field failures.

The risks can be mitigated by selecting PE piping made from resins with high stress crack resistance (HSCR) and by following best-practice procedures.

THE GAS OR WATER FLOW IN A POLYETHYLENE (PE) PIPE DISTRIBUTION SYSTEM CAN BE QUICKLY SHUT OFF FOR MAINTENANCE OR REPAIR BY SQUEEZING THE WALLS OF THE PIPE TOGETHER. THIS "SQUEEZE-OFF" PROCEDURE IS WIDELY USED BY PIPELINE ASSET OWNERS DUE TO ITS SPEED, SIMPLICITY, AND LOW-COST. HOWEVER, THE STRESS THAT THE PIPE SUFFERS DURING THE PROCEDURE CAN POTENTIALLY LEAD TO CRACK-INITIATION AND BRITTLE FAILURES.

It is possible to prolong the lifetime of PE pipelines by using a product manufactured from a resin that has been specifically developed to resist post squeeze-off failure. The latest class of PE100 resins have many times greater stress crack resistance than standard resins, resulting in increased pipe service life, lower maintenance costs and reduced replacement rates.

WHY IS THE USE OF SQUEEZE-OFF VALUABLE FOR PIPELINE ASSET OWNERS?

To repair pipe made from materials such as cast iron, steel or PVC, complex and expensive engineering designs are employed to avoid major disruption. This includes the installation of valves to stop gas or water flow. In contrast, due to the elasticity of the polymer, a simpler squeeze-off isolation technique can be used with pipe manufactured from PE. By compressing the pipe between two parallel rounded bars upstream and downstream of the fault, the damaged section of the pipe can be isolated quickly. Post-repair, the system is ready for use once the compressed section of pipe has been released.

Swift flow-stopping of utility pipe networks:

- Improves safety by stemming leakage of flammable gases
- Reduces water damage from burst mains pipes
- Minimises disruption and inconvenience, which is especially important within city or urban environments
- Lowers ongoing maintenance and repair costs

PRACTICAL CONSIDERATIONS OF SQUEEZE-OFF

Specially designed mechanical or hydraulic tools are used to fully compress PE pipe walls in order to cut off the flow of gas or water within the pipes, as shown in Figure 1.

> THE EXCEPTIONAL SLOW CRACK GROWTH RESISTANCE OF NEW PE100 RESINS PROVIDES ASSET OWNERS WITH GREATER CONFIDENCE AND AN ADDED SAFETY MARGIN WHEN UTILISING SQUEEZE-OFF.

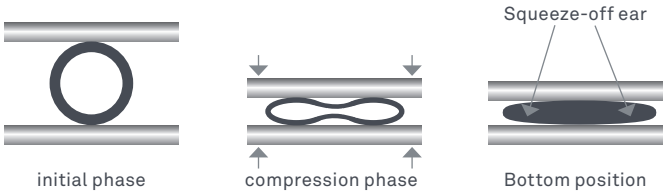

Figure 1. Principles of the squeeze-off technique

Executing squeeze-off incorrectly can damage or deform the pipe causing a concentration of stress in the pipe wall. If the forces are great enough to cause a crack to initiate, the crack may eventually propagate through the pipe ending in a brittle failure. To reduce the risk of failure, pipeline asset owners issue standard method documentation to ensure the best current practice is followed. In addition, the Water Services Association of Australia's (WASA) Polyethylene Pipeline Code [1] includes a section on recommended squeeze-off practice for water pipes, while ASTM International method F1041 advises on squeeze-off of PE piping used for gas distribution [2].

Standard procedures provide guidance on the following key aspects of the technique:

- Position of the squeeze tool in relation to any fittings in order to avoid damaging the pipe wall or fittings.
- The rate of compression is important as too much stress applied too quickly can lead to micro-tears within the pipe wall.
- The rate of release of the squeeze-off tool is even more important to allow even dispersal of the stress during squeeze-off release. This prevents damage from slow crack growth – a precursor to brittle failure.
- Close inspection of the pipe pre- and post-squeeze-off for signs of damage e.g. cracking or splitting. Squeeze-off should never be carried out at a site of potential weakness.
- On release of the squeeze, the pipe should be re-rounded if necessary and replaced if there is any indication of damage.
- Clear marking and recording of the location on the pipe that was compressed so that the same point isn't subject to squeeze-off in the future.

DEVELOPMENTS IN PE RESINS SINCE THE 1960s

Squeeze-off was first applied to high density PE pipe in the 1960s. Although very few field failures of PE piping have been reported, there is the potential for slow crack growth to initiate where the squeeze-off tool has been positioned on the pipe. Subsequent material developments have therefore concentrated on improving the resistance of the PE to slow crack growth at stress-concentrated sites. As indicated in Figure 2, the latest PE100 resins with high stress crack resistance (HSCR) exceed the time to failure requirements of the class multiple times. They also have many times greater stress crack resistance than standard PE100 resins.

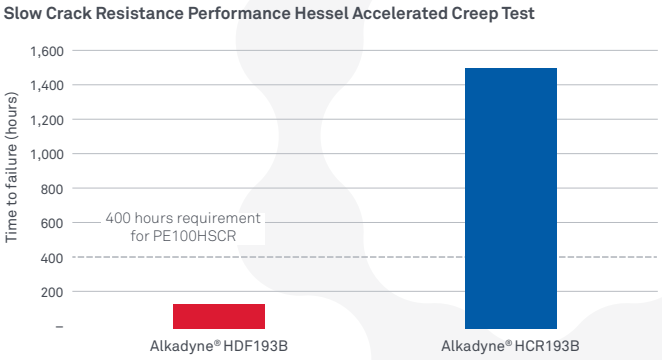

Figure 2. Relative resistance to slow crack growth of two grades of PE100 resins

HOW TO MITIGATE RISKS ASSOCIATED WITH INSTALLATION AND SQUEEZE-OFF

Installing new PE pipe networks or replacing existing pipelines is an extremely expensive undertaking that often causes inconvenience to the public.

Pipe made from the latest class of PE100 HSCR resins is highly resistant to slow crack growth, even under harsh handling conditions. The enhanced slow crack growth resistance of these new resins provides an extra level of confidence whenever squeeze-off is used to manage pipeline flows during planned or emergency maintenance. The avoidance of needing to replace the squeezed off pipe eliminates cost and reduces disruption to the community.

HOW THE RESIN SUPPLIER CAN HELP

QENOS has developed Alkadyne® HCR193B – a new class of PE100 grade resin with stress crack resistance many times greater than standard PE100 resin. Developed in partnership with Australian pipe manufacturers, Alkadyne HCR193B has increased resistance to slow crack growth initiation caused by the presence of stress concentrators. The exceptional resistance to slow crack growth of Alkadyne HCR193B provides asset owners with greater confidence and a greater safety margin when utilising squeeze-off.

Based in Australia, Qenos manufactures a range of world-class Alkadyne® PE100 polyethylene grade resins for use in pressure pipes. The company has also invested in a large pipe pressure testing facility where pipe is extruded for testing, and then subjected to high pressures and heat for up to three years.

REFERENCES

1. WSA 01-2004 Polyethylene Pipeline Code Version 3.1, www.wsaa.asn.au/
2. ASTM F1041 – 02(2016). Standard Guide for Squeeze-Off of Polyolefin Gas Pressure Pipe and Tubing, www.astm.org

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