WHITE PAPER

IMPROVING PE PIPE DIMENSIONAL STABILITY

Dr. Predrag Micic
(Product Development Executive)
October 2015

Find out how to facilitate speedy installation by manufacturing pipes with tight dimensional tolerances

Pipe symmetry and wall thickness variation are key determinants of the speed and efficiency of the installation process. Field based rework to accommodate pipe manufacturing issues adds significant time and effort to the installation task and brings the potential to delay project delivery and increase costs. A high melt strength PE resin has the ability to resist the influence of gravity in the molten state and is less likely to deform under its own weight. This property allows high extrusion throughput particularly where cooling time is limited, supports high dimensional stability and enables the manufacture of large diameter and thick walled pipes.

POLYETHYLENE PIPE IS UNIQUE IN THAT THE WELDED JOINTS ARE AS RESILIENT AS THE REST OF THE STRUCTURE. SECTIONS OF PE PIPE ARE ROUTINELY WELDED TOGETHER INTO STRINGS THAT ARE SEVERAL HUNDRED METRES LONG AND THEN PULLED UNDERGROUND THROUGH A CLOSE FITTING TUNNEL IN CHALLENGING TRENCHLESS APPLICATIONS. CLEARLY THE PIPE NEEDS TO MEET A SET OF DEMANDING PERFORMANCE REQUIREMENTS TO BE ABLE TO ACHIEVE THIS LEVEL OF STRENGTH AND USABILITY.

A cylinder is the strongest structure for withstanding internal and external pressures. To perform at its best, polyethylene pipe must be manufactured as a cylinder, symmetrical about the centre axis and with uniform wall thickness, as dictated by the relevant product and installation standards.

The standard dimension ratio (SDR) defines the ratio of the outside diameter (OD) of the pipe to the wall thickness and is indicative of the strength of the pipe wall. Standards and specifications further define the requirement for the cross-sectional symmetry and the uniformity of the pipe wall thickness.

It is critical that a pipe is manufactured within a specified dimensional tolerance to meet the requirements of the intended application.

FACTORS THAT AFFECT DIMENSIONAL STABILITY

Pipe resin represents the majority of the variable cost of a length of polyethylene pipe and so it makes economic sense to manufacture pipe to order wherever possible and avoid building up large inventories of extruded pipe. However large infrastructure projects such as irrigation networks and energy projects such as the development of mines or coal seam gas consume large quantities of polyethylene pipe over a relatively short period of time in order to meet project budgets. It is therefore critical to ensure speed and accuracy in the pipe extrusion process to meet project delivery demands without being slowed down by rework or needing to carry an excessive amount of inventory.

Pipe manufacturers in Australia have the capability of manufacturing pipe of up to 2 metres in diameter and with a wall thickness of around 120 millimetres. Such a pipe will contain many hundreds of kilograms of material per metre of length. At the point of exit from the die of the extruder, the resin temperature can be in excess of 200 degrees Celsius.

> PIPE SYMMETRY AND WALL THICKNESS VARIATION ARE KEY DETERMINANTS OF THE SPEED AND EFFICIENCY OF THE INSTALLATION PROCESS

As polyethylene is a relatively poor conductor of heat, the pipe loses temperature very slowly as it leaves the extrusion line and can begin to sag under its own weight. The outer surface cools first and sets, while the inner material remains heated and malleable, potentially leading to ovality and variation in wall thickness around the circumference of the pipe over a relatively short space of time.

A pipe that fails to meet the requirement for symmetry and consistency in wall thickness will be rejected, causing delays in the pipe production process with subsequent implications on the pipe delivery and downstream project completion.

THE INFLUENCE OF THE RESIN ON DIMENSIONAL STABILITY

Different materials have different inherent strength in the molten state and this is also true of different types of polyethylene. The particular polyethylene resin used in pipe manufacture can greatly influence the amount by which the product will deform during the cooling stage.

A resin that has the property of being able to resist the influence of gravity in the molten state is characterised as having high melt strength. Melt strength is the measure of how much force is required to deform the molten resin. The higher the melt strength the higher the force is required to cause deformation and the more resistant the molten material is to deforming under its own weight.

A high melt strength resin will assist in applications with a requirement for:

- high extrusion throughput, where cooling time is limited
- high dimensional stability such as in trenchless applications where maximum joint contact area is required to ensure high tensile strength in the pipe string, and
- large diameter and thick walled pipes with heavy mass that presents a cooling challenge

A resin that assists in readily achieving the required level of dimensional stability enables production to come up to speed quickly and with predictable results. This in turns enables delivery to plan against tight project deadlines.

INSTALLATION AND WELDING

As with any complex system, the quality of the finished pipe network is reliant on the performance of its weakest element. For polyethylene pipe, the installation stage is integral to the overall performance and service life of the project.

Pipe symmetry and wall thickness variation are key determinants of the speed and efficiency of the installation process. Variations can create problems as the welding operators endeavour to line up the pipe sections to match the variations in wall thickness. With pipe lengths weighing up to several tonnes this is not the simplest or safest procedure. Alternatively ignoring variations in pipe dimensions and welding the thick wall and thin wall sections together could compromise the geometric strength of the pipe and the longevity of the network.

The clamping systems in modern butt welding machines ensure that the outer surface of the pipe is held in a circular shape for welding. Variations in wall thickness will therefore lead to misalignment between the inner surfaces of the pipe. The Plastics Industry Pipe Association of Australia (PIPA) industry guideline POP014 specifies that the difference in pipe wall thickness between the thicker and thinner section must not exceed 10% of the thickness of the thicker pipe wall. The common field procedure to overcome misalignment due to excessive wall thickness variation is to use a router to reduce the thicker portions of the pipe wall at the inside surface to match the dimensions of the opposing pipe and align the pipes to make a compliant weld.

This type of field based rework adds significant time and effort to the installation task and brings the potential to delay project delivery and increase costs. Such wastage can potentially be avoided by employing appropriate manufacturing practices and specifying a high melt strength resin.

HOW THE RESIN MANUFACTURER CAN HELP

Qenos Alkadyne® HDF145B PE100 resin has an extremely high melt strength, making the product suitable for the production of both large and small pipes. Extrusion can be performed at speed, with high accuracy and dimensional stability.

Qenos manufactures in Australia a range of world-class Alkadyne® PE100 polyethylene grades for use in pressure pipes, delivering outstanding performance throughout the manufacturing and installation stages.

Qenos

Qenos | Ingenious Transformations

Disclaimer

Qenos Pty Ltd
471 Kororoit Creek Rd
Altona Victoria 3018 Australia
Phone 1800 063 573
ABN 62 054 196 771
–
qenos.com