Polyethylene – The Optimum Gas Pipe Material

Polyethylene (PE) pipes were introduced to the gas industry in the late 1960's, offering corrosion resistance, resistance to the effects of gas constituents, ease of installation and cost-effectiveness. British Gas (BG) commenced using PE in 1969 and the Gas & Fuel Corporation of Victoria (G&FC) in 1973. Jointing techniques are butt fusion, electrofusion, socket fusion, and mechanical joints. They have enabled system properties of joints to be the same as for pipes.

BG evaluated High Density Polyethylene (HDPE) and Medium Density Polyethylene (MDPE), opting for MDPE, but in Australia the older "first generation" HDPE was initially used because of local manufacture of raw materials and concerns about the reliability of supply of imported polymers. Although MDPE was known to confer superior properties in terms of resistance to crack growth and long-term strength, G&FC, along with Allgas and Sagasco, continued to successfully use "first generation" HDPE. The transition to MDPE commenced during the 1980's.

During this period, Australian Standards AS 1463 for PE compounds, and AS 1667, AS 2718 for PE pipes, AS 1460 for fittings, plus AS 3723 for installation, were used as the basic specifications. Because AS 1463 specified the requirements relevant to HDPE, the use of MDPE to this specification provided additional security. The Standards were developed primarily by members of AGA (Australian Gas Association) and PIA (Plastics Industry Association), the forerunner of PACIA and AusPoly.

Subsequently, PE almost totally replaced metallic pipe materials within the material's size and pressure range, such that in 1988, G&FC reported annual usage of 280 km of Class 250 (250 kPa) and 1162 km of Class 575 (575 kPa) in sizes up to 50mm.

At the same time, it was reported that the failure rate was approximately 200 to 300 p.a., with the highest percentage in 1983 being due to point loading (64%), whereas the highest percentage in 1986 was due to mechanical damage (66%). Mechanical damage and point loading have accounted for the vast majority of identified PE pipe failures over the period reported. (AGA Operating Seminar, March 1988, The Use of Plastics Pipes in the Gas and Fuel Corporation, by Michael Ebdon). The reduction in point loading failures was attributable to improved installation standards and the use of thicker walled Class 575 HDPE pipe, with its improved resistance to localised loads, such as rock impingement.

In 1989, BG commenced use of PE 100 HDPE for higher pressure applications (up to 7 bar) and larger diameters, the key attributes being improved long term strength, stress crack resistance, and resistance to rapid crack propagation (RCP).

In 1991, PIA addressed the need for national specifications to cover the new materials and developed PIA 11590 so that industry could adopt this advanced specification whilst Australian Standards were being redeveloped.

In 1993, new Australian Standards, AS 4130(Int) and AS 4131(Int) were introduced for PE pipes and compounds to incorporate the new grades and appropriate performance requirements. However, these Standards did not address fuel gas applications and subsequently, in 1995, AS/NZS 4130 and AS/NZS 4131 were introduced, covering all pressure applications, including fuel gas.

In 2001, AGA and AusPoly members participated in the revision of these Standards to again reflect the latest developments.

Test requirements were increased to reflect the improved material properties, especially for PE 100 grades, with minimum critical pressure for RCP raised to the equivalent of 38.6 bar at 0° C. In addition, resistance to slow crack growth requirements were increased for both PE 80 and PE 100 in order to reflect requirements of the U.K. gas industry and latest ISO proposals. These increased levels provide further assurance of long-term performance under adverse conditions, such as surface damage and localised loading.

AS/NZS 4130:2002 introduced requirements for stripes and jackets, reflecting widespread practice in both gas and water industries.

In 2008, Standards Committee AG-008 developed AS/NZS 4645, *Gas Distribution Networks*, to replace existing outdated Standards. AS/NZS 4645 is in three parts – Network Management, Steel Pipe Systems, and Plastics Pipe Systems. Part 1 deals with performance-based requirements, whilst parts 2 and 3 deal with means of compliance to part 1. Although part 3 includes requirements for PE, PVC, and PA (polyamide), the predominant material is PE (PE 80 and PE 100), chosen for its balance of properties and range of fittings and jointing systems.

PE 100 materials are frequently used in Europe and Scandinavia for fuel gas applications at pressures up to 10 bar, with both pipes and fittings available in PE 100 material. In Australia, high pressure (up to 10 bar) installations have been in operation in NSW, Tasmania, and QLD. since 2000.

For distribution systems, PE 100 has increasingly become the material of choice.

In summary, developments in polyethylene pipe and fitting materials continue to improve already outstanding properties and afford the asset owner confidence in long term durability and system life. ENA and PIPA members are at the forefront of technology in this area and continue to enable access to the latest developments and resulting economic efficiencies.

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