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PLASTICS INDUSTRY PIPE ASSOCIATION OF AUSTRALIA LIMITED

INDUSTRY GUIDELINES

POP016

High Stress Crack Resistant & Raised Crack Resistant PE100 Materials

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High Stress Crack Resistance and Raised Crack Resistance PE100 materials

High Stress Crack Resistant (PE100 HSCR) and Raised Crack Resistant (PE100-RC) are PE100 materials which offer greater resistance to slow crack growth than regular PE100. This is particularly important where the pipe is prone to damage during installation.

Currently there is no established Australian standard defining high stress crack resistant PE 100 materials and up until recently there was no international standard. As an interim measure to define the parameters characterising PE100 HSCR grades Table 1 – PE100 HSCR Compound Performance was developed. Integration of PE100-RC into international standards is currently in progress with ISO/DIS 4437 "Plastics piping systems for the supply of gaseous fuels - polyethylene (PE) - Part 1-5" being published in September 2020. ISO 4427 "Plastics piping systems for water supply and for drainage and sewer under pressure – polyethylene (PE) - Part 1-5" is currently being updated. The PE100-RC performance requirements are given in Table 2.

PE100 HSCR and PE100-RC materials are equivalent.

High Stress Crack Resistant PE100 HSCR

Prior to the International Standards Organisation (ISO) defining the nomenclature to describe this range of PE100 materials PE100 HSCR has been applied.

PE100 HSCR compounds must conform to both AS/NZS 4131" Polyethylene (PE) compounds for pressure pipes and fittings" and the requirements listed in Table 1below. Compounds meeting all these requirements will be identified in POP004 "Polyethylene Pipe and Fittings Compounds" as PE100 HSCR.

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Table 1
PE100 HSCR Compound Performance

TEST	STANDARD	SAMPLE	MINIMUM PERFORMANCE
Notched Pipe Test (NTP)	ISO 13479-2009	Solid wall SDR11 pipe	>5,000 hrs
Full Notch Creep Test (FNCT) See Note 1	ISO 16770-2004	Compression moulded plate	>8,670 hrs at 80°C or by correlated acceleration testing procedure as specified in Note 1
2 Notch Creep Test (2NCT) see Note 3	EN 12814-3:2014	Solid wall pipe	>3,300 hrs at 80°C or by correlated accelerated testing procedure as specified in Note 3
Point Load Test (PLT) see Note 2	DIN PAS 1075 2009	Solid wall pipe 110 SDR 11 pipe	>8,760 hrs at 80°C or by correlated acceleration testing procedure as specified in Note 2

NOTES:

1. The FNCT can be undertaken in its long-term or accelerated (ACT) form ie: Long-term: time to failure > 8760 hrs; 80°C; 4 N/mm^2 tensile stress, 2% Arkopal N-100 surfactant. Accelerated: time to failure > 400 hrs; 90°C; 4 N/mm^2 tensile stress, 2 % NM 5 surfactant and 90°C.
2. Point Load test can be undertaken in its long-term or accelerated (PLT+) form ie: Long-term: time to failure > 8760 hrs; 80°C; 4 N/mm^2 tensile stress, 2% Arkopal N-100 surfactant. Accelerated: time to failure > 450 hrs; 90°C; 4N/mm^2 tensile stress, 2 % NM 5 surfactant.
3. The 2 Notch Creep Test can be undertaken in its long term or accelerated (2NCT+) form ie: Long-term: time to failure >3300hrs; 80°C, 4N/mm^2 tensile stress, 2% Arkopal N-100 surfactant. Accelerated: time to failure >195hrs; 90°C; 4N/mm^2 tensile stress, 2% NM5 surfactant.
4. If visual identification of the pipe is required or a UV layer is to be used, the striping or jacketing compound used in the manufacture of the pipe must be manufactured using a base resin of a compound that qualifies as a PE100 HSCR as per Table 1.
5. Monitoring quality assessment is to be conducted in three-year intervals with compulsory Notched Pipe Testing and one of the other testing procedures from Table 1 as decided by the manufacturer of the material.
6. Attention is drawn to the requirement for the PE100 HSCR manufacturer to have an established ongoing Quality Assurance procedure related to the slow crack growth resistance performance. The frequency of the sampling and testing plan and the test procedure are the responsibility of the PE100 HSCR resin manufacturer.
7. Solid wall pipe in the context of this document is defined as a single extruded layer of PE100HSCR material.

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Raised Crack Resistant PE100-RC

EN and ISO have now defined the performance criteria for PE100-RC materials (raised crack resistant). Minimum mechanical requirements of PE100 and PE100-RC are the same in the ISO standards with exception of the Slow Crack Growth resistance (SCG) Due to the same MRS (minimum required strength), the dimensions of pipes related to outer diameter, wall thickness and SDR are the same for PE100 as for PE100-RC.

PE100-RC compounds must conform to both AS/NZS 4131 and the requirements listed in Table 2 below. Compounds meeting all these requirements will be identified in POP004 as PE100-RC.

Table 2
PE100-RC Compound Performance

TEST	STANDARD	SAMPLE	MINIMUM PERFORMANCE
Accelerated Notched Pipe Test (ANTP)	ISO/DIS 13479-2020	Solid wall DN110 SDR11 pipe	>300 hrs @ 80°C & 9.2 Bar. Water in nonylphenol (See Note 1)
Accelerated Full Notch Creep Test (AFNCT)	ISO 16770	Compression moulded plate	≥550 h at an interpolated ref-erence tensile stress of 4 MPa or ≥300 h at an interpolated ref-erence tensile stress of 5 MPa @90°C & lauramine oxide (See Note 2).
Strain Hardening Test (SHT)	ISO 18488	Compression moulded tensile test bar	<Gp> ≥53MPa @80°C , sample thickness = 300µm
Crack Round Bar Test (CRB)	ISO 18489	Round bar 14mm diameter	≥1.5 x 10^6 cycles at an interpolated stress range ($\Delta\sigma_o$) 12.5 MPa @23°C in air, sinusoid 10Hz

NOTES:

1. Nonylphenol ethoxylate (CAS number 9016–45–9) with a trade name of Arkopal N100 is used for this test with a concen-tration for testing of 2%. aqueous solution.

2. Lauramine oxide (CAS number 85408–49–7) is commercially available as Dehyton PL. The dilution of the lauramine oxide in the product shall be taken into account when calculating the concentration of 2 wt%. For example, when Dehyton PL is used, it is already diluted to 30 wt%. Therefore, 6,67 wt% of Dehyton PL is needed to obtain 2 wt% lauramine oxide.

REFERENCED STANDARDS

AS/NZS 4131 - Polyethylene (PE) compounds for pressure pipes and fitting

EN 1555 – Plastics piping systems for the supply of gaseous fuels – Polyethylene (PE) – Part1-5

EN12201 – Plastics piping systems for water supply, and for drainage and sewerage under pressure – polyethylene (PE) – Part 1-5

EN 12814-3:2014 - Testing of welded joints in thermoplastics semi-finished products. Tensile creep test

DIN PAS 1075 (2009-04) - Pipes made from polyethylene for alternative installation techniques - Dimensions, technical requirements and testing

ISO 4427- Plastics piping systems for water supply and for drainage and sewer under pressure – polyethylene (PE) - Part 1-5

ISO/DIS 4437- Plastics piping systems for the supply of gaseous fuels - polyethylene (PE) - Part 1-5

ISO 13479:2009 – Polyolefin pipes for the conveyance of fluids -- Determination of resistance to crack propagation -- Test method for slow crack growth on notched pipes

ISO 16770 Plastics **-** Determination of environmental stress cracking (ESC) of polyethylene - Full-notch creep test (FNCT)

ISO 18488 – Polyethylene (PE) materials for piping systems – Determination of Strain Hardening Modulus in relation to slow crack

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