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Determining limits and minimum requirements for materials and pipes for rough-beddable pipes made from PE 100-RC

Final Report

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Summary

As part of the DVGW research project G 3-01-14 entitled "Determining limits and minimum requirements for materials and pipes for rough-beddable pipes made from PE 100-RC", the research centres SKZ - KFE gGmbH (SKZ), KIWA Technology B.V. (KIWA) and TGM Kunststofftechnik (TGM) investigated accelerated test methods as well as alternative rapid test methods to characterise the resistance of highly crack-resistant PE materials and pipes against slow crack growth (SCG).

The following test methods were examined:

- Accelerated **FNCT** (Full Notch Creep Test) based on ISO 16770:2004
- Strain Hardening Test (**SHT**) according to ISO 18488:2015
- Cracked Round Bar (**CRB**) Test according to ISO 18489:2015
- **Point Load Test** according to PAS 1075:2009

For the **FNCT**, an accelerated procedure was developed that allows test times to be reduced quite significantly (by a factor of 10 to 15). In addition, a correlation between the accelerated FNCT and the conventional method was derived. For the accelerated procedure, comparison tests at the 3 research centres showed good repeatability and comparability. Tests on different PE grades (PE 80, PE 100, PE 100-RC) made it possible to establish minimum requirements for the accelerated FNCT on PE 100-RC.

For the **SHT**, the influence of different test parameters on the test result was investigated. The use of the SHT as a product test was also evaluated. Comparative tests between the research centres showed very good repeatability for the Strain Hardening Test at the respective laboratories and good comparability of the results between the laboratories. By investigating different PE grades and correlating the SHT with the other test methods, a minimum requirement for PE 100-RC could be derived.

The **CRB** tests showed very good reproducibility between different test stands and institutes. A number of tests on specimens taken from pipes and fittings were carried out successfully. Tests on different material grades allowed a clear ranking and a minimum requirement to be defined for PE 100-RC.

For the **point load test**, which is not a standardised test procedure, a process description was drawn up and submitted to the responsible ISO committee. Tests on different PE grades showed good repeatability within a test laboratory. PE 80 materials in particular had much longer times to failure than expected. Here the point load led to significant local plastic deformation, which meant that the influence of the point load was less pronounced. Overall, no accelerated procedure similar to the FNCT could be derived from the point load test results. Further research and test series will be necessary to evaluate the individual influencing variables (detergent, temperature, material type) and establish appropriate correlations.

Standardization of pipes made of PE 100-RC (i.e. under current conditions: standardization on the CEN and ISO level) can only be successful (in terms of replacing PAS 1075) if, in addition to primarily material requirements/tests (FNCT, SHT and CRB), it also contains a requirement/test clearly pertaining to the pipe performance (PLT or, if available, another

equivalent, indisputable test method). The test conditions and minimum requirements for PE 100-RC developed as part of the project for each of the methods are summarised in the following table:

Test	Test conditions	Minimum values for PE 100-RC	Comment
FNCT	Arkopal N 100, 80 °C, 4.0 MPa according to ISO 16770:2004	8760 h	brittle fracture
FNCT **FNCT**	Lauramine oxide 2 %, 90 °C, 4.0 MPa Lauramine oxide 2 %, 90 °C, 5.0 MPa	800 h 300 h	brittle fracture brittle fracture
SHT	according to ISO 18488:2015	50 MPa	
CRB	according to ISO 18489:2015	1,500,000 cycles at 12.5 MPa	
PLT	Arkopal N 100, 80 °C, 4,0 MPa according to PAS 1075:2009	8760 h	

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