



# Slow Crack Growth (SCG) testing for PE100 RC compounds

## PE100 RC Resin Performance

RC (Resistant to Crack) compounds resist Slow Crack Growth (SCG) at least 16x better than standard PE100 compounds. Where PE100 compounds are typically achieving 500hrs SCG resistance during accelerated testing, PE100 RC compounds resist cracking for at least 8760hrs under the same conditions. Accelerated testing at high temperatures provides an indication of the projected crack rate at 20°C. Roughly speaking 8,760hrs of accelerated testing equates to a PE pipe under constant stress for 100 years in ground.

Slow Crack Growth, defined by its name, is the time taken for a crack on the surface of the PE pipe to tear its way through the pipe wall as a result of constant stress being applied. This stress can be from internal pressure, or external ground load (as in gravity drainage pipes) and applies to all plastic pipes as the most common form of long-term failure mode. Failures are typically characterised in the 5-25year range, so occur long after the contractor has handed over the project, leaving the liability with the pipe owner.

In Hong Kong pipes are generally installed using the excavated material as backfill, pavement, rocks, broken concrete are all part of backfill and these press onto the pipes surface, creating stress cracks on the inside of the pipe. There are cases of PE water pipes installed in 2005 (before PE100 RC was used in Hong Kong) that have displayed SCG failures as a result of such rock impingement after 8 years' service.

RC compounds provide the end user with significant performance advantages including no requirement to use graded bedding materials surrounding the pipe to achieve a 100 year operating life. Significantly higher tolerance against damage during installation and re-excavation when installing other services and dramatically reduced likelihood of failure due to rock impingement.

The main problem is suppliers claiming their material is PE100 RC when it is not, leaving the owners with the future failure cost. To prevent this both the Water Supplies and Drainage Services Departments implemented site testing programs in 2011 and 2017 respectively which take randomly selected samples of pipe delivered to site and subject these samples to testing under PAS 1075:2009-04

WSD PS 22.09 and DSD Appendix 5A Sampling and Testing of PE pipes delivered to site Clause 11.1.1 stipulates the testing requirements using the ACT test method

## Performance testing of pipes made from RC Compound

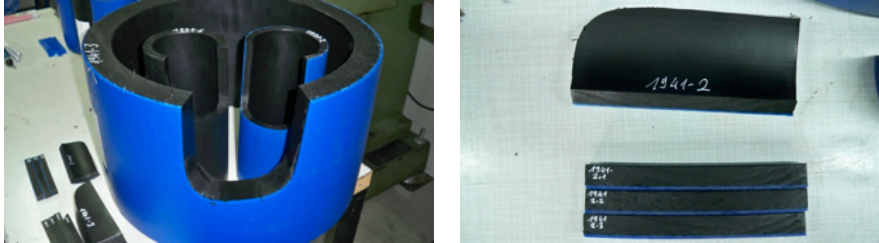
New forms of accelerated testing that meet PAS 1075 are correlated to ISO 16770 FNCT in 160 hours, meaning results are available within 1 week of the samples going on test. **Hessel Ingenieurtechnik** in Germany are offering the ACT (Accelerated Crack Testing) results for PE100 RC within 160 hours (as opposed to 3300 hours of ISO 13479). Alternate rapid tests also correlated to ISO 16670, such as "Strain Hardening method" and "Round Crack Bar method" are close to commercialisation.

A small pipe sample (shown below) cut from a pipe end is all this is required to be sent by courier to Germany, where three strips will be cut from each sample and subjected to testing. Results are typically indicated within 10 days, with a formal report following.

SCG testing is the ultimate performance check on PE pipes, if the compound has been tampered with in anyway such as the addition of recycled materials or others no RC compounds, the sample will simply not pass the ACT test.

## APPENDIX

Typical coupon samples for testing:

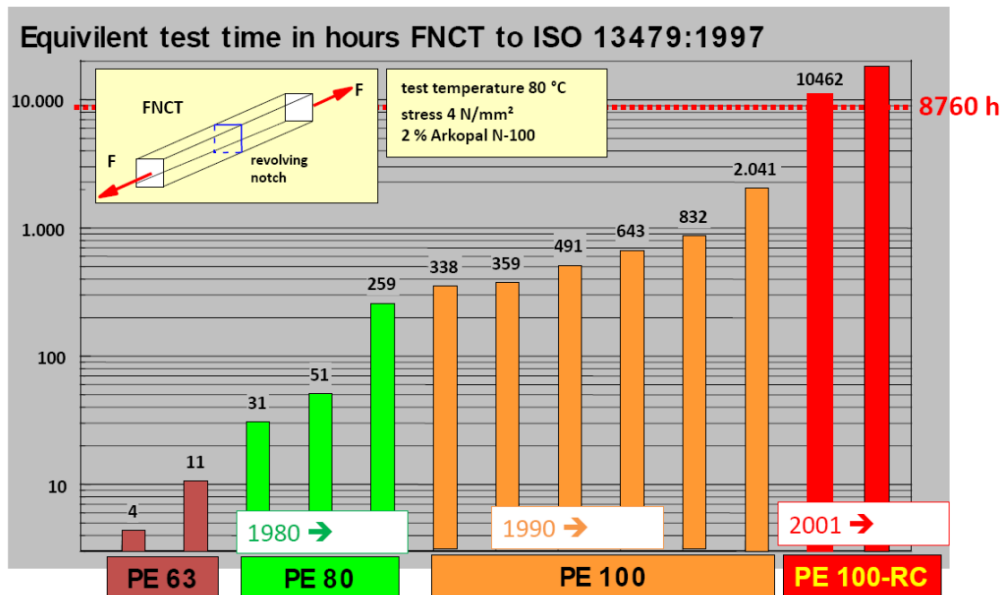


The reason for material substitution from PE100 to PE100RC is obvious when you consider the degree of improvement in the SCG resistance in the chart below. This chart compares polyethylene compounds crack resistance improvement using a Full Notch crack accelerated test at 80Deg C which is calibrated to the Full Notch Crack Testing in ISO 13479:1997 over the last 40 years.

The cost of PE100 RC vs. non RC compounds is only a few %, however the benefits to the pipe owner are enormous, for this reason WSD & DSD both require PE100 RC compounds to be used for all pipes

Since year 2000, studies of PE pipelines with service lives in excess of 20 years started to show long term failure modes (such as slow crack propagation) which had not been considered before. Gradually these studies evolved into compound development and test methods to determine the compounds performance and eventually into manufacturing standards to cover them. (**note:** the Y axis is test time in hours and is a logarithmic scale). Using ISO 9080 extrapolation, 8,760 hours @ 80°C equates to 100 years @ 20°C.

### PE RESIN EVOLUTION IN SCG RESISTANCE 1975-2010



Resistance against stress-induced cracking of polyethylene

source: HESSEL Ingenieurtechnik

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