

Technical Note EP-67

In Search of a New Stress Cracking Surfactant for HDPE Geomembrane Testing

The ASTM D5397 SP-NCTL test for assessing the stress cracking resistance (SCR) of HDPE geomembranes specifies that the detergent (surfactant) to be used in the stress cracking baths is Igepal™ CO-630. Unfortunately Igepal™ CO-630 has now been classified as a priority pollutant in European Union (EU) and Canada.

In recent years the European Chemicals Agency (ECHA) has included octylphenoxypolyethoxyethanol group surfactants, which includes Igepal™ CO-630, in the Candidate List of substances of very high concern in the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) scheme. The REACH regulation addresses the production, import and use of chemical substances and their potential impacts on human health and the environment.

The issue with Igepal™ CO-630 is that if disposed in sewers and waterways it is harmful to fish where it can act as an endocrine hormone disrupter and a mutagen. As such the EU no longer allows the sale of Igepal™ CO-630 due to ecotoxicity issues.

The ECHA has now included Igepal™ CO-630 in the substance group in the Authorisation List mandating the manufacturers of this detergent and user industries replace this detergent by the “sunset date” which was January 4, 2021, thereby affecting EU manufacturers such as Rhodia and Solvay, importers, and downstream users, as well as non-European manufacturers exporting their products into the EU.

Since the inclusion of Igepal™ CO-630 in the candidate list of substances of very high concern chemical companies, as well as geosynthetic research groups are in need of an alternative detergent which must at the same time be eco-friendly and effective.

Ideally, a Igepal™ CO-630 replacement should generate minimal process change to NCTL-SCR experiments and produce comparable stress crack times. Therefore, an alternative detergent should have physico-chemical properties similar to Igepal™ CO-630, should be readily soluble, easy to remove, have a similar critical micelle concentration (CMC), eco-friendly and not degrade to toxic phenolic metabolites.

Igepal™ CO-630 has been used for decades as the surfactant of choice in many studies on environmental stress cracking of polyethylene. It has been used widely to test the SCR of geomembrane and pipes. This liquid has two significant effects: a) It accelerates crazing by plasticizing the amorphous region of the bulk polymer; and b) it accelerates the fracture of the craze by plasticizing the crystalline region of the fibrils.

ExcelPlas has been researching alternative detergents for the NCTL stress cracking test. It has found the following two detergent are potential replacement options namely:

- Arkopal™ N-100 from Clariant/Hoechst (CAS no. 9016-45-9)
- Dehyton™ PL from BASF based on Lauramine oxide (CAS no. 85408-49-7)

Arkopal™ N-100 surfactant (nonylphenoxypolyethoxyethanol) has already been used in test stress cracking for example, 2% Arkopal N-100 surfactant is used in the Full Notch Creep Test (FNCT) test at 80 deg.C specially designed for evaluating the Slow Crack Growth (SCG) resistance of polyethylene used in pipe applications.

Similarly Dehyton™ has also been used for the Full Notch Creep Test (FNCT) test specially designed for evaluating the Slow Crack Growth (SCG) resistance of polyethylene used in pipe applications. The test is carried out according to the international ISO 16770 standard, using a square bar of material previously notched on all faces in coplanar way. A constant stress is applied on the specimen at 80 °C in a solution of Lauramine oxide (Dehyton™ PL).

Note however that both the Arkopal™ N-100 and the Dehyton™ PL will require the NCTL-SCR test to be run at a higher temperature than the current 50 deg.C. Temperatures of 65 and 70 deg.C with these surfactants show promise to potentially give comparable test times to that of Igepal CO-630 at 50 deg.C.

Notes:

Igepal™ which is a registered trademark of Rhodia and is an octylphenyl-polyethylene glycol. Its official 'IUPAC' name is octylphenoxypolyethoxyethanol.

IGEPAL CO-630 the non-ionic surfactant used in HDPE stress cracking bath is now as of 2021 becoming harder to purchase with restricted supply in many countries because it can cause long lasting harmful effects to aquatic life.