Evaluation of Stress Corrosion Properties of Pultruded Glass Fiber/Polymer Composite Materials

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Abstract

A series of stress corrosion experiments were performed on 12 pultruded glass fiber composite materials (two fibers in six different matrices) commonly used in high voltage composite insulators. In this study two types of glass fibers were investigated, namely E-glass and ECR-glass. The tests were performed in nitric acid solutions (pH 1.2) using constant K I specimens that were specifically designed for the stress corrosion testing of unidirectional fiber/polymer matrix composites. The effect that the magnitude of the applied load had on the stress corrosion fracture process was investigated using acoustic emission (AE) methods. Post-test analysis of the test samples revealed that when the specimens were subjected to static loads ranging from 71.2 to 124.6 N in the presence of nitric acid, planar cracks formed and propagated perpendicular to the fiber direction without generating a significant degree of fiber debonding or pullout. The results showed that the E-glass/ polymer unidirectional composites were not immune to stress corrosion cracking in nitric acid. On the other hand, the ECR-glass/polymer composites showed no evidence of stress corrosion formation under any of the loading conditions considered. Furthermore, the test results clearly demonstrate that the constant K I stress corrosion tests are a suitable experimental method for evaluating stress corrosion properties of unidirectional glass fiber/ polymer matrix composites. In particular, by using the constant K I specimen geometry, the crack propagation rates in the composites under the stress corrosion conditions can be very accurately determined.