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Modeling Slow Crack Growth under Thermal and Chemical Effects for Fitness Predictions of High-Density Polyethylene Material

Authors : Luis Marquez, Ge Zhu, Vikas Srivastava

Abstract : High-density polyethylene (HDPE) is one of the most commonly used thermoplastic polymer materials for water and gas pipelines. Slow crack growth failure is a well-known phenomenon in high-density polyethylene material and causes brittle failure well below the yield point with no obvious sign. The failure of transportation pipelines can cause catastrophic environmental and economic consequences. Using the non-destructive testing method to predict slow crack growth failure behavior is the primary preventative measurement employed by the pipeline industry but is often costly and time-consuming. Phenomenological slow crack growth models are useful to predict the slow crack growth behavior in the polymer material due to their ability to evaluate slow crack growth under different temperature and loading conditions. We developed a quantitative method to assess the slow crack growth behavior in the high-density polyethylene pipeline material under different thermal conditions based on existing physics-based phenomenological models. We are also working on developing an experimental protocol and quantitative model that can address slow crack growth behavior under different chemical exposure conditions to improve the safety, reliability, and resilience of HDPE-based pipeline infrastructure.

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