

Absorption Behavior of Some Acids During Chemical Aging of HDPE-100 Polyethylene

Authors : Berkas Khaoula

Abstract : Based on selection characteristics, high-density polyethylene (HDPE) extruded pipes are among the most economical and durable materials as well-designed solutions for water and gas transmission systems. The main reasons for such a choice are the high quality-performance ratio and the long-term service durability under aggressive conditions. Due to inevitable interactions with soils of different chemical compositions and transported fluids, aggressiveness becomes a key factor in studying resilient strength and life prediction limits. This phenomenon is known as environmental stress cracking resistance (ESCR). In this work, the effect of 3 acidic environments (5% acetic, 20% hydrochloric and 20% sulfuric) on HDPE-100 samples (~10x11x24 mm³). The results presented in the form ($\Delta m/m_0$, %) as a function of \sqrt{t} indicate that the absorption, in the case of strong acids (HCl and H₂SO₄), evolves towards negative values involving material losses such as antioxidants and some additives. On the other hand, acetic acid and deionized water (DW) give a form of linear Fickian (LF) and B types, respectively. In general, the acids cause a slow but irreversible alteration of the chemical structure, composition and physical integrity of the polymer. The DW absorption is not significant (~0.02%) for an immersion duration of 69 days. Such results are well accepted in actual applications, while changes caused by acidic environments are serious and must be subjected to particular monitoring of the OIT factor (Oxidation Induction Time). After 55 days of aging, the H₂SO₄ and HCl media showed particular values with a loss of % mass in the interval [0.025-0.038] associated with irreversible chemical reactions as well as physical degradations. This state is usually explained by hydrolysis of the polymer, causing the loss of functions and causing chain scissions. These results are useful for designing and estimating the lifetime of the tube in service and in contact with adverse environments.

Keywords : HDPE, environmental stress cracking, absorption, acid media, chemical aging

Conference Title : ICAEMM 2023 : International Conference on Advances in Engineering Materials and Metallurgy

Conference Location : Rome, Italy

Conference Dates : September 11-12, 2023