EFFECTS OF TOLUENE-METHANOL MIXTURE ON MECHANICAL AND STRUCTURAL PROPERTIES OF HDPE PIPE

L. Alimi, K. Bedoud, K. Chaoui

Abstract : The aging of pipes is an economic and technical challenge for drinkable water and natural gas networks. The degradation of HDPE pipes depends on factors such as age, laying and service conditions, environmental temperature, fluids and soils corrosiveness, density and traffic loads. In service, polymer structures are often exposed to aggressive environmental stresses such as UV's, oxygen, acids, bases and solvents, affecting the nature of the material as well as its microstructure, physical status and chemical composition. Various studies have presented results on HDPE pipes embrittlement, focusing on cracking phenomena under environmental stress cracking, creeping and fatigue cracking. The weakening of the material usually resulted from mechanical behavior modifications which made it unable to withstand loads without breaking under normal service conditions. In this study, we attempted to assess the effects of an equimolar toluene-methanol mixture while considering exposure to air and water as references. Morphological properties such as crystallinity, crystalline lamellae thickness and the oxidation induction time (OIT) are studied using differential scanning calorimetry in order to establish the extent of degradation using DSC. Mechanical tests and thermal analysis show that toluene-methanol mixture is much more absorbed by the resin compared to water, i.e. the degradation is very pronounced. In terms of mechanical properties (E, ?y and ?f), the nominal values collapsed. In addition, the study shows the evolution of these parameters as a function of pipe thickness in order to get an idea about structural heterogeneity across pipe wall. An increase in the crystallinity together with crystalline lamellae thickness is observed which is confirmed by literature for other organic solutions. This phenomenon is known as chemical-crystallization due to the shrinkage of the amorphous phase during possible chain segmentation process.

Keywords : HDPE; Environmental effect; Aging; Mechanical properties; Crystallinity; OIT