ACCELERATED AGING OF POLYETHYLENE PIPE GRADES IN CHLORINE DIOXIDE AND HYPOCHLORITE SOLUTION

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Polyolefin resins have been extensively used in water distribution piping system for many decades due to their numerous advantages. To keep a high quality of water, chlorine based disinfecting agents are typically applied to treat and maintain the high quality of potable water. Considering the intense oxidative ability of these substances, in long-term application it is crucial to determine their influence on the degradation of the pipes. In order to accurately analyze the long term influence of disinfectants, a new exposure device was developed at Polymer Competence Center Leoben GmbH (PCCL), which allows a stable and well controlled exposure in solutions of chlorine dioxide (ClO_2) or sodium hypochlorite (NaOCl). Three polyethylene (PE) pipe grades were selected for various accelerated aging experiments applying diverse disinfected aqueous medium to determine the effect of ClO_2 and NaOCl on material degradation. Compression molded specimens with 1 mm thickness and 15 mm thick block samples were exposed to 10 and 1 ppm of ClO_2 at 60 and 40 °C, as well as to 100 ppm NaOCl solution at 60 °C. The analyses of mechanical, chemical structural, morphological properties and the consumption of active antioxidants after certain aging periods showed a clearly distinct aging mechanism for each oxidizing agent. After specified exposure times 50 µm thin films were sectioned from the surface of the block specimens up to 500 µm depth. Based on the determination of material properties in various distances from the surface such as Oxidation Onset Temperature (OOT), Carbonyl Index (CI) indicated that material ranking based on their resistance against ClO_2 could be possible. Furthermore to investigate the enhanced surface degradation oxygen and chlorine content were determined by X-ray Photoelectron Spectroscopy (XPS) at different depth of one chosen block specimen. Increased amount of oxygen and chlorine atom in a 300 µm surface layer were detected, confirming a significantly accelerated oxidative material degradation. The findings of this study demonstrate that the analyses of various material properties at different depths of block specimens is a valuable tool for understanding the effect of disinfectants on material degradation.