Degradation behavior and lifetime assessment of novel PP liner materials for thermal energy storages

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Pit thermal energy storages (PTES) are of high relevance for reduction of the overall energy demand [1]. A polymeric liner is essential for sealing of the large hot water storage. While polyethylene (PE) has been established for temperatures up to 80°C [2], novel polypropylene (PP) based materials for maximum temperatures of 95°C are under development. The main objective of this study was to assess the ageing behavior of novel PP liner materials and to estimate their lifetime depending on the temperature profile of the PTES. Random PP-R copolymers differing in their formulation and stabilization were investigated. Ageing experiments were carried out at temperatures from 65 to 135°C on 100 µm thick micro-specimens [3]. Hence, diffusion-limited effects were negligible. Fourier transform infrared spectroscopy (FTIR) was employed to monitor the deterioration of stabilizers. Moreover, the time-to-embrittlement was determined by tensile testing. The best performance was obtained for a PP-R grade with a triple stabilizer package. In contrast to the PP-R base polymer with phenolic antioxidants, no transition in the ageing behavior was observed at around 100°C. By extrapolation of embrittlement times to service-relevant temperatures and by consideration of cumulative damages [3, 4], superior lifetime values exceeding 30 years were deduced for the optimized PP-R grade.

Keywords: Pit thermal energy storages, degradation behavior, polypropylene, ageing behavior, lifetime estimation

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