Master Thesis, 2011.

Aging behavior of novel polyolefin compounds for heat stores

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ABSTRACT

Based on a commercially available polyolefin grade (designation: P00) with a long-term (25 years) service time of 80°C twelve formulations (P01 to P12) were prepared by systematic variation of four different stabilizers, which exhibit a lower tendency for migration and loss of stabilizer at elevated temperatures. The compounds were extruded to 2 mm thick sheets. Tensile test specimen were cut along extrusion direction and exposed in hot water and in hot air at elevated temperatures of 115, 125 and 135°C. After exposition for up to 6 months the specimens were characterized by thermoanalytical and mechanical methods (Differential Thermal Analysis (DTA), tensile testing). From the DTA traces and the stress/strain-curves aging sensitive values (oxidation temperature (TOx) and strain-at-break (εB)) were deduced and evaluated.

For all investigated grades no significant embrittlement (significant drop in strain-at-break) was found after exposition in hot water or in hot air at 115 and 125°C. In contrast, the oxidation temperature was reduced slightly depending on the polyolefin grade and the aging condition. Hence, it can be concluded that after exposition in water or air at 115 and 125°C chemical changes took place. However, for all polyolefin grades the end of induction period was not reached.

After exposition at 135°C for 6 months some of the polyolefin grades were significantly embrittled associated with a drop in oxidation temperature below critical values of 210°C for hot air exposition and 230°C for hot water exposition. From the differences in the critical oxidation temperatures it can be concluded that the aging mechanisms in hot water and hot air are different. The investigations clearly revealed that some compounds (e.g., P03, P04) are more sensitive for chemical degradation in air environment, while others (e.g., P11) hot water at 135°C is more critical. Solely, for the compound P08 a significantly improved aging behaviour (no embrittlement after 6 months in water or air at 135°C) was deduced compared to the reference compound P00.