Recovery of polyolefins from landfill samples for property evaluation and variability assessment

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Abstract

Plastic waste recycling is one of the major areas of concentration for the circular economy. In this paper, construction and demolition solid waste streams were randomly collected from US Northeast region in Spring and Fall seasons and processed to recover plastic and fiber subfractions. The samples collected for each seasonal stream were hand-sorted and size-reduced using hammer milling technique. The material underwent rocky trap and magnetic separation to remove ferrous and rocky impurities. The milled size-reduced samples were separated into plastic- and fiber-rich samples using an AMP robotic sorter which divided each stream into 2D shaped and 3D shaped sub-streams. The 2D and 3D plastic samples were then ground using a mesh size of ~ 3 mm, producing tow more stream classes: On-spec (size of about 3 mm) and Fine (size less than 3 mm). Polyolefin-rich samples were then obtained using water float/sink method. The float/sink separation results showed that at least 70% of plastic-rich streams is made of polyolefins, independent of season, shape, or size. Polyolefin samples were then melt homogenized by batch mixing and compression molded into tensile bars for mechanical testing. The testing and variability analysis were conducted on eight samples, based on season (Spring and Fall), shape (2D and 3D), and size (On-Spec and Fine), using a full factorial Design of Experiment. The statistical analysis of the tensile properties showed that the modulus (P values 0.9520, 0.0510), strength (P values 0.3380, 0.3370), and elongation at break (P values 0.2250, 0.7370) did not change significantly with season or size, respectively, using ANOVA. The shape (2D vs 3D), however, exhibited a significant impact on the mechanical performance of the recovered polyolefins with a *P* value (0.0001, 0.0261, and 0.0001 for modulus, strength, and elongation). The yield strength and tensile modulus of 3D samples were at least 10% and 21% greater than those of the 2D counterparts. The overall recovery protocol established here, together with the statistical analysis of variability, provides a stepping stone toward scalable recovery of polyolefin from landfill.

Keywords: Recycling, municipal solid waste, polyolefins, season, environmental, sustainable