Title: Evaluation of thermal, spectroscopic and compositional methodologies for quality control of recycled HDPE resins.

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Abstract:

Plastics materials have experienced an exponential growth in production and use over the past decades, which will be doubled soon. This leads to the generation of tonnes of plastic waste each year, particularly since most plastic products come from single-use applications. Under this scenario, plastic recycling becomes even more relevant to reducing plastic waste and facilitating the transition to a Circular Economy.

Regarding the industrial use of plastics, polyolefins remain among the most demanded resins, accounting for about half of the total plastics produced every year worldwide[1]. Within this group, high-density polyethylene (HDPE) is widely used for construction products, cosmetic bottles and specially food packaging. Moreover, polypropylene (PP) is widely used in the packaging of consumer goods, plastic components for various sectors, including the automotive and textile industry. The widespread use of these resins in various sectors makes PE and PP the most discarded plastics each year, which are commonly found in municipal solid waste (MSW), as part of the light fraction obtained from plastic waste streams. Because of the similar density of both resins, it is difficult to perform a precise separation process, which usually lead to significant cross contamination in recycled polyolefins samples, around 4–5 wt. % of HDPE in recycled PP, and 8–10 wt. % of PP in recycled HDPE. The presence of PP in HDPE, even in small amounts, severely affects its performance and applicability in industry, since these two polymers are hardly miscible[2].

In this work, a variety of techniques were evaluated for quantifying the level of PP contamination in several commercial samples of recycled high-density polyethylene (rHDPE). Common techniques for thermal and compositional characterization such as thermal analysis represented by differential scanning calorimetry (DSC) and spectroscopic analysis techniques like Fourier-transform infrared (FTIR) spectroscopy[3] exhibit significant limitations for precise PP quantification, thus compromising the quality assurance of rHDPE resins. In this regard, the determination of the chemical composition distribution (CCD) of polyolefin by high temperature interaction chromatography techniques[4] could be a good alternative for accurate determination of cross-contamination in recycled HDPE samples. The results presented in this study are highly promising and reliable to improve the quality of rHDPE resins and therefore making them a more realistic alternative to virgin resins[5].