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Pre-treatment of plastic waste: Efficient removal of plastic additives based on alternative solvents

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PURPOSE OF THE ABSTRACT

360 Mt, which is anticipated to rise four-fold by 2050. Packaging is the dominant sectoral use of plastics globally accounting for 42% in 2016. However, plastics present a short life cycle generating large amounts of waste with high prevalence in the environment due to their lower biodegradability, becoming one of the most pressing environmental issues. The European Commission is encouraging a Circular Economy for plastics based on closed-loop recycling. However, to date, plastics recycling remains a great challenge due to the relatively low quality of the recycled material, since most of the recycling processes developed cannot deal with these additives present in the plastic matrix, and so the recycled products end up in lower grade applications. Furthermore, the application of volatile organic solvents for additives removal is the preferred choice. In this work, a pre-treatment technique (dissolution/precipitation) using alternative solvents was investigated to remove additives from plastic packaging waste, contributing to an easier plastic recycling process, while minimizing the environmental impacts of the process. The plastic waste used in this study was packaging of high-density polyethylene (HDPE) with two different colors, i.e., blue and orange. Limonene was used as alternative solvent to solubilize HDPE, and the volatile organic compound toluene was also applied for comparison purposes. After the HDPE dissolution a wide range of alcohols (mono-, di-, tri-alcohols) were used as anti-solvent in order to maximize the purity of the polymer recovered. The use of limonene as solvent for the plastic dissolution, in combination with polyalcohols with an intermediate alkyl chain length and a large number of hydroxyl (OH) groups, were found to work best as anti-solvent (1,2,3-propanetriol and 1,2,4-butanetriol), resulting in the removal of up to 94% and 100% of the blue and orange pigment, respectively. Finally, three extraction cycles were performed, demonstrating that the solvent and anti-solvent could be recovered and reused, assuring the process's economic feasibility and sustainability viability. This pre-treatment provides a secondary source of raw materials and money for the recycling process, potentially improving the quality of recovered polymers and assisting in the development of a cost-effective and sustainable recycling process.

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FIGURES

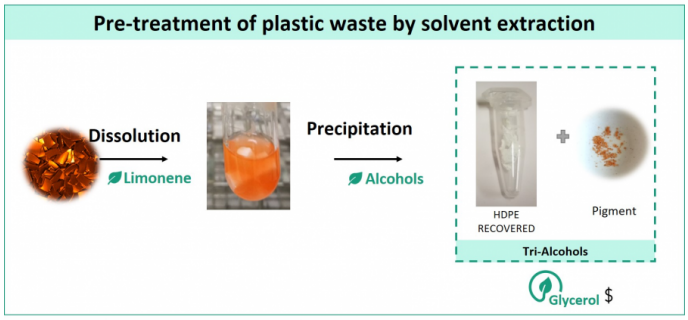

FIGURE 1

Figure1.

Schematic representation of the pre-treatment process developed to remove orange pigment from HDPE using the dissolution/precipitation technique.

FIGURE 2

KEYWORDS

high-density polyethylene | circular economy | solvent extraction | pigments

BIBLIOGRAPHY