Flotation separation of poly (ethylene terephthalate and vinyl chloride) mixtures based on clean corona modification: Optimization using response surface methodology

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ABSTRACT

Postconsumer polyethylene terephthalate (PET) has potential applications in many areas of manufacturing, but contamination by hazardous polyvinyl chloride (PVC) in common waste streams can reduce its recyclable value. Separating collected PET-PVC mixtures before recycling remains very challenging because of the similar physicochemical properties of PET and PVC. Herein, we describe a novel flotation process with corona modification pretreatment to facilitate the separation of PET-PVC mixtures. Through water contact angle, surface free energy, X-ray photoelectron and FT-IR characterization, we found that polar hydroxyl groups can be more easily introduced on the PVC surface than on the PET surface induced by corona modification. This selective wetting can suppress the floatability of PVC, leading to the separation of PET as floating product. A reliable mechanism including two different hydrogen-abstraction pathways was established. Response surface methodology consisting of Plackett-Burman and Box-Behnken designs was adopted for optimization of the combined process, and control parameters were solved based on high-quality prediction models, with fitting from significant variables and interactions. For physical or chemical circulation strategies with PET purity prioritization, the validated purity of the product reached 96.05% at a 626 W corona power, 5.42 m/min passing speed, 24.78 mg/L frother concentration and 286 L/h air flow rate. For the energy recuperation strategy with PET recovery prioritization, the factual recovery reached 98.08% under a 601 W corona power, 6.04 m/min passing speed, 27.55 mg/L frother concentration and 184 L/h air flow rate. The current work provides technological insights into the cleaner disposal of waste plastics.

KEYWORDS

Waste plastic; Flotation; Surface modification; Corona discharge; Optimization

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