

Abstract

Chemical Recycling of PA6 from Discarded Fishing Nets Using Choline Chloride–Ethanolamine (ChCl:MEA) as Deep Eutectic Solvent (DES) [†]

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The widespread use of synthetic polymers in the fishing industry—particularly polyamide 6 (PA6) used for fishing nets—has led to a substantial accumulation of plastic waste in marine ecosystems, since damaged or obsolete fishing gear is commonly discarded into the ocean. Consequently, recovery and upgrading routes are being explored for their valorization. Chemical recycling has emerged as a sustainable pathway for upgrading waste nets to commercially relevant chemical building blocks, such as ϵ -caprolactam, thereby supporting the circular economy strategies.

This study is centered on the depolymerization of fishing nets through solvolysis using deep eutectic solvents (DES), specifically a mixture of choline chloride with monoethanolamine (ChCl:MEA) under mild conditions. In this context, the catalytic effect of 4-(dimethylamino)pyridine (DMAP), reaction times, net-to-DES ratio, and temperature levels were evaluated in order to identify suitable conditions and parameters in a statistical design of experiments (DoE). The process was carried out in a round-bottom flask batch reactor under an inert nitrogen atmosphere operated with an ethylene glycol-cooled reflux condenser. Following the solvolysis, the crude reaction mixture was filtered to assess the conversion. In addition, its degradation progress was monitored using attenuated total reflectance Fourier-transform infrared (ATR-FTIR) spectroscopy by identifying the functional groups associated with PA6 chain scission.

A central composite design with three factors with two replicates was used to identify the optimal depolymerization conditions, considering (1) %Net/DES, (2) %DMAP/Net, and (3) the ChCl:MEA molar ratio in the DES, while keeping the temperature and reaction time constant at 156 °C and 2 h, respectively. The optimal parameters were established, leading to an 80% conversion, therefore showing the promising effectiveness of DES-based solvolysis as a viable solution for the chemical recycling of PA6 fishing nets.



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