Development of Recycled Polypropylene-Based FIBCs Through an Innovative Product Design Enhancing Load-Bearing Performance

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Abstract

Flexible Intermediate Bulk Containers (FIBCs) are widely used in industrial and logistics applications. In line with the European Green Deal and circular economy policies, increasing the use of recycled raw materials in plastic products has become an important requirement. However, FIBC fabrics produced from post-consumer recycled polypropylene (rPP) exhibit reduced mechanical properties compared with virgin polypropylene, particularly in lifting loops, seams, and load transfer regions, limiting the safe load-bearing capacity of the container. This loss of performance is generally compensated by increasing fabric grammage; however, this approach increases product weight, raw material consumption, and production costs while reducing the environmental and economic benefits of recycled materials.
In this study, an integrated manufacturing approach was developed to achieve high load-bearing performance without increasing fabric grammage. In the first stage, post-consumer FIBC waste was cleaned by pre-drying and hot washing. During extrusion, antioxidant additives were incorporated to suppress thermo-oxidative degradation and improve process stability. In addition, a pre-drying step at 90 ∘C prior to tape extrusion reduced moisture-induced process fluctuations.

In addition to material optimization, lifting loop and seam designs were improved. Alternative lifting loop configurations were evaluated to enhance load transfer and reduce virgin raw material consumption while maintaining performance. Furthermore, critical sewing parameters, including needle type, sewing thread properties, stitch length, and seam alignment, were optimized to minimize strength losses in seam regions.
Accordingly, PP tape formulations containing post-consumer recycled granules were developed, and FIBC prototypes containing at least 30 wt.% recycled polypropylene were successfully manufactured. The proposed approach is expected to increase the use of recycled polypropylene while maintaining load-bearing performance, reducing raw material and energy consumption, lowering the carbon footprint, and contributing to sustainable packaging production.

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