



CIRKULAR+™ ADDITIVES FOR POST-CONSUMER RECYCLED EXTRUSION BLOW MOLDED BOTTLES

Polypropylene (PP) and Polyethylene (PE) collectively represent nearly half of converter demand for polymers in the EU28¹, primarily for packaging applications. High density polyethylene (HDPE) is used in various end markets such as toys, milk bottles, shampoo bottles, and pipes. 61% of the HDPE used in packaging is used to manufacture blow-molded bottles. However, recycled post-consumer plastic derived from rigid packaging falls short, only meeting 8% of the demand for HDPE and 3% of the overall plastic demand. This is not sufficient to comply with the minimum recycled content targets mandated by legislation².

Challenges in Developing Extrusion Blow Molded Bottles with Recycled HDPE

Extrusion blow molded (EBM) bottles are typically used for detergents, cleaning products, cosmetics, and personal care applications. These bottles typically feature an EBM HDPE body and an injection-molded PP cap. Due to their closely matched densities, separating these polymers poses a significant challenge during the recycling process. Consequently, post-consumer recyclate from blow-molding applications often contains PP contaminants in HDPE, leading to poor mechanical properties, especially in impact resistance. This decline in performance is attributed to the poor compatibility of the polymer blend constituents.

A large quantity of recycled HDPE (rHDPE) has PP content exceeding 2%, resulting in contamination that renders rHDPE unsuitable for EBM applications. This limitation significantly hinders the potential for rHDPE reuse in bottle manufacturing.

Until an improved sorting and mechanical recycling infrastructure is established to deliver cleaner streams of rHDPE on a large scale, converters and brand owners will continue to face challenges in meeting their recycled content goals. The inability to consistently develop articles using mechanically recycled HDPE plastic at consistent rates will impede progress toward sustainable practices in the industry.

¹ Plastics Europe (2018), *Plastics – the Facts 2018*. Available at: <https://plasticseurope.org/wp-content/uploads/2021/10/2018-Plastics-the-facts.pdf>

² Eunomia Research (2023), *Defining Recyclate Quality Target specifications to Improve Plastic Packaging Circularity*. Available at: <https://eunomia.eco/reports/defining-recyclate-quality-target-specifications-to-improve-plastic-packaging-circularity/>

³ Eunomia Research, Plastics Recyclers Europe (2022), *HDPE & PP Market in Europe: State of Play*. Available at: <https://www.plasticsrecyclers.eu/wp-content/uploads/2022/10/hdpe-pp-market-in-europe.pdf>

CIRKULAR+ AS A COST-EFFECTIVE & TECHNICALLY VIABLE SOLUTION FOR EBM BOTTLES



CirKular+ Performance Enhancement Series presents a promising solution to facilitate broader use of rHDPE in extrusion blow molded bottles. This includes cases where rHDPE contains PP contamination, without compromising on aesthetics and processability in a standard EBM machine. By overcoming the challenges associated with PP contamination, CirKular+ offers a viable pathway towards sustainable packaging solutions without sacrificing performance or production efficiency.

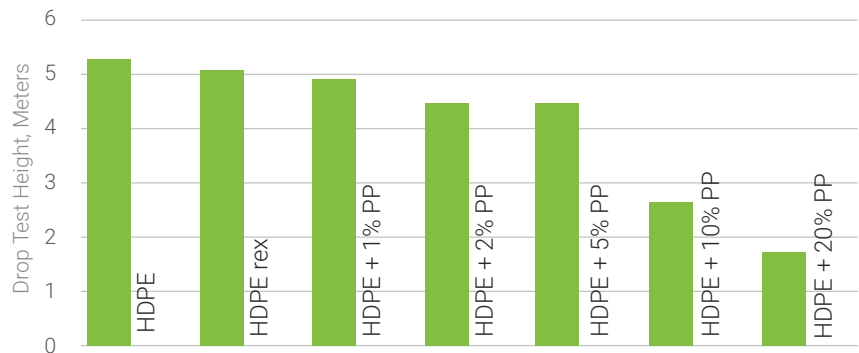
Key Benefits of CirKular+ for PCR EBM Bottles

- ▶ Significantly improved drop performance (by up to 20%) at very low loading levels
- ▶ Minimal impact on stiffness of rHDPE
- ▶ Achieve desired aesthetics
- ▶ Processable through dry blending directly into existing EBM equipment
- ▶ Recyclable design
- ▶ Maximized PCR content in EBM bottles
- ▶ Positive environmental impact with low CO₂ and plastic waste reduction
- ▶ Tax incentives with recycled materials*

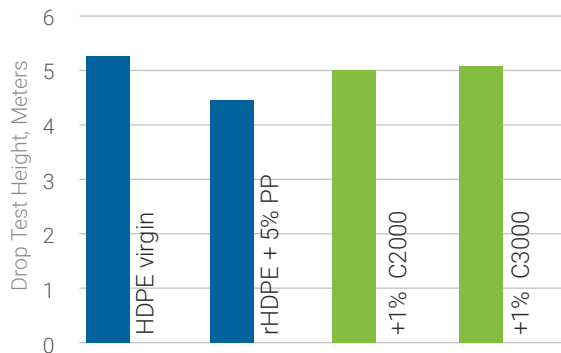
* Relevant for the European countries with taxes on virgin materials – consult your tax advisor

1 Liter Bottle Drop Test

Recycled HDPE contaminated with >2% PP shows decreased drop test resistance

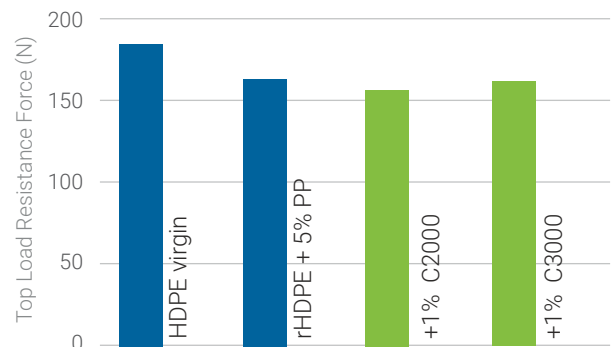


Drop Test Performance Room Temperature



1% C2000 or C3000 can increase drop test resistance of rHDPE contaminated with 5% PP

Top Load Performance



1% C2000 or C3000 shows minimal impact on stiffness of rigid packaging

KRATON CORPORATION

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