**PET Recycling – Contributions Of Crystallization to Sustainability.**

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**Highlights**

* Chemical PET recycling allows to upcycle all types of waste PET plastic.
* The de-polymerization process breaks down the waste PET into its monomers, MEG and DMT.
* The monomers can be purified and re-polymerized into high purity, food-grade PET.
* Solvent-free melt crystallization of DMT removes all coloring and critical impurities.

**1. Introduction**

Polyethylene terephthalate (PET) is the most common thermoplastic polymer of the polyester family. It is a naturally transparent and semi-crystalline plastic widely used as a fiber for clothing, as an effective moisture barrier with wide applicability in bottling and packaging, and as an engineering plastic when it is combined with other materials. Some of the most important characteristics of PET include its resistance to water, its high strength to weight ratio, and its wide availability as an economic and recyclable plastic. PET was first polymerized in the 1940s by DuPont chemists looking to develop polymer materials for use as textile fibers. It is produced from the synthesis of mono ethylene glycol (MEG) and dimethyl terephthalate (DMT) or purified terephthalic acid (PTA). The former is a transesterification reaction that produces methanol as a by-product, whereas the latter is an esterification reaction that releases water.

Once the polymer is formed, it is very difficult to purify and for this reason, the purity of the starting materials is of high importance. Vacuum distillation processes are used to purify ethylene glycol, whilst DMT and terephthalic acid are conventionally purified by suspension crystallization. For DMT, the suspension crystallization plant and associated solvent recovery section typically account for 45% of the total investment costs [1]. Therefore, an improved DMT process has been developed, which replaces the suspension crystallization with solvent-free melt crystallization technology. This reduces both, investment and operating costs, and improves the operability and flexibility of the process. The resulting high-purity DMT has an excellent quality and color stability and is suitable for the manufacture of high molecular weight PET.

According to some reports, the current global polyester production is around 56 million tons, mainly for synthetic fibers (more than 60%). However, the demand for PET in the bottling and packaging industry, particularly for food and beverages, is growing and already accounts for roughly 30% [2]. In general, polymers are increasingly used in a variety of applications and have become a major concern in the marine environment because of their persistence at sea. Scientists estimate that more than eight million tons of plastic are being washed into the oceans every year [3]. Moreover, the cumulative quantity of plastic waste available to enter the ocean from land is predicted to increase even further. Finding solutions for the plastic debris problem is complex and requires a combination of recycling, closing the source and cleaning up what has already accumulated in the oceans. The current study will focus on the recycling routes of PET, with special emphasis on the chemical recycling of PET bottles by means of methanolysis.

This chemical recycling process degrades PET into two main reaction products, DMT and MEG, the starting materials for the transesterification process. The main advantage of this method is that the methanolysis can be installed in the existing polymer production line, since the DMT obtained has a product quality identical to virgin DMT [4]. In addition, MEG and methanol can be easily recovered and recycled. Moreover, purification of the DMT by melt crystallization will reliably remove critical impurities (e.g., water, glycols, alcohols and phthalate derivatives) that will have a negative impact on its conversion rate to PTA.

**References**

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