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ResolVe – New Life for Polystyrene Waste

Plastics in the Environment – Sources · Sinks · Solutions

The plastic polystyrene (PS) offers many advantages. Light, strong, water-repellent and with very good insulation properties when foamed, it can be used in a wide variety of applications, such as in sanitary and construction applications, as housing material in electronic devices and toys and for packaging. However, the disadvantage is that currently there exists no comprehensive recycling system for polystyrene. The joint research project ResolVe is addressing this problem. The partners are developing a logistics and plant concept based on chemical recycling that enables the economical reuse of polystyrene waste as a raw material for high quality new plastic products.

Chemical Recycling as Basis for Closed Loop Concept

Current recycling methods are based on material or thermal recycling of plastic waste. However, these do not represent a closed and sustainable cycle. The recyclates obtained from material recycling do not usually meet the high standards required for food packaging with regard to the purity of materials and their properties. Furthermore, many used plastics are only suitable for thermal recycling, since the quality of the material flows after sorting is not sufficient for other recycling methods.

As early as the 1980s and 1990s, intensive research was conducted regarding processes for raw material and chemical recycling of plastic waste. Raw material processes disintegrate plastics to their basic chemical components – the monomers – from which plastics can best be reprocessed. However, technical problems and economic reasons – e.g. unsuitable material flows – have thus far hindered industrial applications. Growing quantities of plastic waste, which are increasingly found in oceans and water bodies, have now led to renewed interest in raw material recycling.

The joint research project ResolVe therefore focuses on chemical recycling through thermal depolymerization: Plastics (polymers) are broken down into their basic components using heat. These can then be used to produce new plastics for any application. This creates a closed loop system. In the packaging sector, polystyrene is the only standard plastic for which thermal depolymerization works so that its individual components – styrene monomers – can be recovered. In this way, the depolymerization of polystyrene differs substantially from the pyrolysis decomposition of other packaging plastics leading to an undefined mixture of substances. In addition, depolymerization as a form of raw material recycling does not demand high material purity. This means that many consumer wastes can be used, including those that were traditionally only recycled thermally.

High-Quality New Products from Polystyrene Waste

The process that the researchers in the ResolVe project intend to develop consists of a multi-stage process: First, a relatively pure concentrate has to be produced from the polystyrene waste. For this purpose, the waste is cleaned, sorted and shredded. In the second step, the prepared material is thermally decomposed in a suitable extractor, for example an extruder which is commonly used in plastics processing. The styrene monomers are then separated from by-products, cleaned, and can be directly reprocessed into new, high quality polystyrene comparable to virgin material. Other basic materials for plastics, such as ethane, propene or benzene shall also be obtained from other products resulting in the process. Initially, the project partners are testing the depolymerization on model substances and waste samples on a laboratory scale.

Laboratory reactor with attached condensation unit for the depolymerization of polystyrene

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Developing Integrated Recycling Concepts

In addition to technical questions, ResolVe is also addressing other more general topics related to polystyrene recycling. In dialog with waste disposal companies, complete concepts for the recycling of plastic waste are being developed. To this end, the project partners are capturing the most important real material flows – including plastic waste from waters – and taking respective samples to determine their suitability for chemical recycling. Existing contacts to other research groups dealing with the collection of marine plastic waste are used for this purpose. The researchers are developing specific logistical concepts for the material flows so that high recycling rates can be achieved.

A polystyrene fraction from the German dual system of waste collection is sorted manually.

Research Focus
Plastics in the Environment – Sources • Sinks • Solutions

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