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compounding & extrusion
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Contact
Kathrin Fleuchaus
Marketing Communications
Coperion GmbH
Theodorstrasse 10
70469 Stuttgart, Germany

Phone +49 (0)711 897 25 07
Fax +49 (0)711 897 39 74
kathrin.fleuchaus@coperion.com
www.coperion.com

Press Release

Chemical Recycling of Mixed Plastic Waste

Coperion Supplies Twin Screw Extruder to Ghent University for Chemical Plastic Recycling

Stuttgart, June 2021 – Coperion is supplying an extrusion system to Ghent University in Belgium for comprehensive research and development tasks in chemical recycling of mixed plastic waste. Coperion designed this laboratory system, built upon a ZSK 18 MEGAlab twin screw extruder, especially for chemical recycling of post-consumer waste within a throughput range of 1-10 kg per hour. Along with the extruder, it includes a feeder from Coperion K-Tron as well as a vacuum unit.

Plastic waste, especially packaging waste, is generally a mixture of materials with a high degree of contamination. Recycling this raw material is usually difficult, as sorting and cleaning of waste is in many cases neither economically viable nor technically feasible. Chemical recycling is a promising process to recycle these material streams into chemicals, waxes or liquid energy carriers.

As a trailblazer in the development of chemical recycling of plastic waste, Ghent University has laid the foundation for many forward-looking developments in the field that are paving the way to more sustainability in the plastics industry. Chemical reaction engineering in general and the kinetics of chemical reactions are major axes of the research done at the Laboratory for Chemical Technology (LCT) of Ghent University. These include, among other applications, optimization of existing industrial processes and development, intensification and scale-up of novel technologies aimed at minimizing waste streams and energy consumption.

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Twin Screw Extrusion for Efficient Energy Addition

Coperion's twin screw extruder technology is particularly well suited for chemical recycling of plastics. After post-consumer waste, either shredded or compacted, is reliably added to the extruder's process section by the Coperion K-Tron feeder, a great deal of mechanical energy is introduced into the material in shortest time thanks to the continuous surface renewal as well as intensive dispersion and shearing along the twin screws.

Within about 30 seconds, a homogeneous, highly devolatilized melt with a temperature of up to 350°C is produced, into which the energy has been introduced very efficiently.

Further materials, such as catalysts, can be added and mixed in as needed. In some cases, residual water or chlorides from PVC are introduced into the extruder in minute quantities along with the plastic waste. Both are reliably extracted via vacuum devolatilization on the extruder's process section.

Twin screw extruders possess numerous advantages that are especially beneficial in chemical recycling. The technology covers a broad range of throughputs. On larger ZSK extrusion machines, throughputs of up to 20 t/h can be realized using this process. Polymers of various viscosities are reliably plastified thanks to the highly effective mode of operation of the twin screws. Plastic energy dissipation takes place in no time. When needed, corrosion and wear protection of all product-contact parts within the process section can assure long extruder lifetime even when processing very aggressive materials.

Reclamation of Raw Materials

Within the reactor, the melt, which was previously heated to up to 350°C in the twin screw extruder, is further heated. At up to 500°C pyrolysis of the polymers takes place, the splitting of polymer chains into shorter units in an oxygen-free environment. The pyrolysis of polymers utilizes the random scission mechanism, where free radicals are generated. At the same time, chain reactions are initiated which lead to cracking polymers into a broad mixture of hydrocarbons in liquid and gaseous phase. The most important factors for driving this process are residence time, temperature, and the type of pyrolysis agent.

Most of the inorganic components of the post-consumer waste remain in the reactor's sump and are removed. The polymers' organic hydrocarbons evaporate. They are transformed into

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monomers, petrochemical raw materials, or synthesis gases and then processed further in a distillator into marketable products such as oil, heavy fuel, or waxes.

Chemical recycling is a very active research topic at Ghent University. Even though it is already shown that mechanical recycling of plastics is an easy method of plastic valorization, certain limitations were encountered due to the impracticality of waste separation. However, with chemical recycling, these limitations may be overcome.

The Coperion ZSK twin screw extruder will be part of a new setup for chemical recycling at Ghent University. It will be among others coupled to a vortex reactor; thus the molten plastic will flow directly into the reactor. Different technologies for the conversion of plastic waste to chemicals may be applied like catalytic pyrolysis and thermo-chemical processing (cracking).

“We are proud to be able to support the renowned Ghent University with our expertise and technology in their research and development activities involving chemical recycling. We see chemical recycling as a trailblazing process for reclaiming raw materials from mixed plastic waste. With this process we will succeed at preserving our valuable resources in the long term. As soon as the recycling system featuring the ZSK twin screw extruder is in operation at the Ghent University, it will also be available to our customers for testing,” said Jochen Schofer, Business Segment Manager for Recycling & Direct Extrusion at Coperion.

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About Coperion
Coperion is the international market and technology leader in compounding and extrusion systems, feeding and weighing technology, bulk materials handling systems and services. Coperion designs, develops, manufactures and maintains systems, machines and components for the plastics, chemicals, pharmaceutical, food and minerals industries. Within its two divisions – Polymer and Strategic Markets / Aftermarket Sales and Service – Coperion has 2,500 employees and nearly 30 sales and service companies worldwide. Coperion K-Tron is part of the Polymer division of Coperion. For more information visit www.coperion.com or email info@coperion.com.

About Ghent University and the Laboratory for Chemical Technology (LCT)
Ghent University was founded in 1817. It is found within a top 100 university in the world. With more than 47,000 students and 15,000 staff members, Ghent University is one of the biggest universities in Belgium. LCT integrates chemical science and engineering in its research on catalysis, polymerization, kinetics, reactor design and process design. LCT is part of the Department of Materials, Textiles and Chemical Engineering within the Faculty of Engineering and Architecture and member of the Centre for Sustainable Chemistry (CSC) of Ghent University directed by Prof. Kevin Van Geem. LCT aims at research excellence and bottom-up innovation in the framework of technological, industrial, and societal challenges.

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Editor contact and copies:

Dr. Jörg Wolters, KONSENS Public Relations GmbH & Co. KG,
Im Kühlen Grund 10, D-64823 Gross-Umstadt
Tel.: +49 (0)60 78/93 63-0, Fax: +49 (0)60 78/93 63-20
E-mail: mail@konsens.de, Internet: www.konsens.de

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Due to its intensive dispersion and devolatilization output, Coperion's ZSK twin screw extruder is extremely well suited for energy-efficient chemical recycling of mixed plastic waste.

Photo: Coperion, Stuttgart

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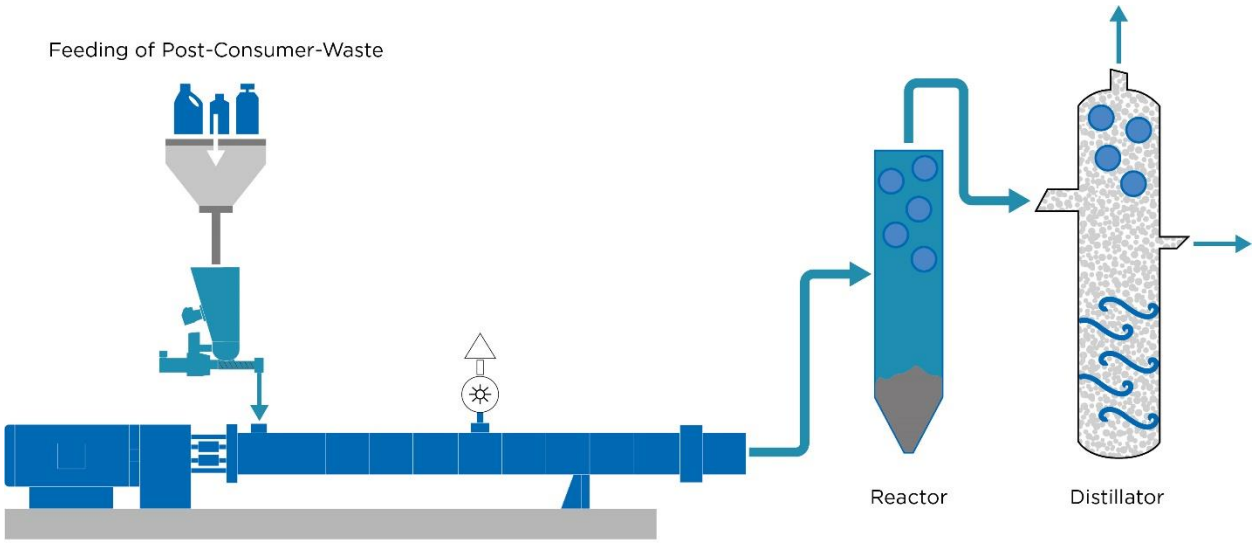

Twin Screw Extrusion – Dispersion, Degassing, Introduction of Energy

Chemical recycling is a promising process for recycling mixed plastic waste, both technically and economically.

Image: Coperion, Stuttgart