Abstract

Title: Chemical Recycling – Technology overview and the status of LCA evaluation

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Introduction

The climate crisis challenges require to not only be resource efficient, but also to use resources in a climate friendly way. In the case of recycling of plastic waste, a set of technologies gains high attention from different stakeholders in industry, politics, NGOs and academia: chemical recycling. Such recycling processes aim at closing the loop by breaking down the plastic waste into their monomers or delivering even smaller chemicals which can be feed into the existing chemical processing streams.

Methodology

A proven way to analyse and assess products and processes regarding their environmental impact is Life Cycle Assessment (LCA). BASF has published a holistic LCA study for circular systems, where a LCA scope definition for circular systems was proposed of which pyrolysis can be a part of. Three case studies are assessed to cover different perspectives for pyrolysis: to get rid of plastic waste and compare with other disposal methods like incineration or to produce chemical products and compare with their conventional virgin or mechanically recycled counterparts. For the latter perspective, the mass balance approach is applied. Pyrolysis oil is fed into the steam cracker as one of the largest chemical plants. The primary output materials of the process are ethylene and propylene. These are used to make numerous chemical products.

Results and Interpretation

With the pyrolysis technology, mixed plastic waste that is currently difficult to recycle can be utilized. The study was done from Sphera, a leading LCA consultant. Pyrolysis oil sourced from BASF partners has been used on pilot scale in a running BASF production network. A variety of high-performance products was made, e.g. cheese packaging, refrigerator components and insulation panels.

Primary data from a pyrolysis plant was collected and used for LCA modelling and result calculations. Overall, the results show based on the made assumptions and the defined scope that pyrolysis can serve as a high value waste management option regarding climate change and material efficiency. In two case studies, pyrolysis was shown to be the preferred option regarding climate change impact and resource use. Pyrolysis is preferred over incineration as an end of life treatment route of mixed plastic waste and is also preferred over fossil-based naphtha for production of virgin-grade plastic feedstock. The results show also that there is no significant difference in climate change results for recycled plastic products from pyrolysis and mechanical recycling, if mixed plastic waste is used.