Life-Cycle Assessment of chemical recycling of mixed plastic waste

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Significant amounts of mixed plastic waste (MPW) currently end up in incineration plants and landfills. It is important that such waste be managed appropriately in line with circular economy principles. One emerging option for managing MPW is chemical recycling via pyrolysis. Pyrolysis processes aim at closing the loop by breaking down the plastics into their monomers or delivering gases and condensates which can be fed into the existing chemical processing streams. This study from BASF and Sphera uses Life Cycle Assessment (LCA) to compare the environmental impacts of pyrolysis of MPW with the established waste management alternatives in Germany. 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 where the primary output materials are ethylene and propylene which are used to make numerous chemical products. Pyrolysis oil sourced from BASF partners has been used on pilot scale in a running BASF production network. Primary data from a pyrolysis plant was collected and used for LCA modelling and result calculations. Overall, the results show 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 of MPW streams.

Keywords: Circular carbon economy, chemical recycling, environmental evaluation by life cycle assessment (LCA), mass balance approach, plastics waste, pyrolysis