Recycling PC/ABS: Environmental Assessment of Pyrolysis through Process Simulation and Life Cycle Assessment

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Polycarbonate and acrylonitrile-butadiene-styrene (PC/ABS) blend is one of the major plastic components in Waste Electrical and Electronic Equipment (WEEE) as structural elements. The main objective of this research study is to help understand the potential opportunities and shortcomings of applying pyrolysis processes to this specific plastic waste flow in terms of energy and materials balances, as well as environmental sustainability. Process simulation was done on commercial software. Process conditions and unit operations in the system analyzed are based on state-of-the-art considerations related to plastics pyrolysis in general and to the yields of PC/ABS in particular. Most relevant assumptions are made on the reactor level, in which conservative assumptions maximizing by-product production are made. Concerning the separation section, from these plastics, it is not possible to obtain a single oil product, since it would be composed of a wide variety of products without the possibility of being commercialized as one mixture, as in the case with plastic waste with high-content polyolefins. Single products separation is performed mainly through distillation. Based on the simulation mass and energy balances, a Life Cycle Assessment (LCA) is performed, comparing virgin chemicals substitution with products of PC/ABS pyrolysis. Within the assumptions of this research work, it seems that the pyrolysis of PC/ABS could be a possible way to decrease the environmental impact of virgin materials production, since all the impact categories analyzed give negative impacts. However, there is space for a finer estimation of many process parameters to improve the robustness of results, namely reactor yields, with the need for additional data about chemical kinetics occurring in the system since, at present, there is an absence of contributions in literature systematically analyzing the impact of temperature on products distribution. Pyrolysis processes could potentially help increasing the overall plastic recycling rates in Europe, even in case of plastics giving particularly inhomogeneous products as PC/ABS. However, separation section complexity may hinder its possible application. Proper understanding of best operating temperatures could help finding regions where specific components can be maximized, reducing separation complexity.

Keywords: *process simulation, life cycle assessment, pyrolysis, plastic waste, PC/ABS*