Pyrolysis of plastics: Dehalogenation via stepwise pyrolysis and metal sorbents

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Pyrolysis is a perspective way of recycling plastics into virgin polymers. However, due to the variety of plastic types and included additives, the pyrolysis of plastic wastes is a complex process that yields products of different quality. In order to process pyrolysis products into new polymers, it is necessary to remove halogens, especially Cl and Br, that may cause corrosion of technology, inactivation of catalysts, and deterioration of products. This study aimed to understand the dehalogenation mechanisms and achieve dechlorination of liquid products from a model plastic mixture, containing PVC. Different pyrolysis settings and sorbents were used to decrease the Cl content below the set limit of 10 ppm. It was observed that it is not feasible to use sorbents directly in the reactor (in-situ) as the captured Cl is released over higher temperatures yielding even more Cl in the products. Introducing the step at 350 °C (stepwise pyrolysis) proved to be a crucial part of the process. The introduction of reflux extension provided unexpected dehalogenation by decreasing the time of HCl in the hot reaction zone. Required Cl content was reached via a combination of stepwise pyrolysis, reflux extension, and sorbents ($Ca(OH)_2$, Fe_3O_4-Si) in a separated bed (ex-situ) at 300 °C. Results have direct implications for designing an efficient pilot plant or modifying current technologies without a dehalogenation procedure.