Chemical Recycling - Beyond Thermal Use of Plastic and other Waste
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Concept Development for Plasma-assisted Chemical Recycling of Problematic Wastes

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Abstract

In addition to material recycling as the preferential utilization route, chemical recycling is an important option for many types of waste due to their heterogeneity, complexity and low quality. A promising approach to chemical recycling of wastes is the use of plasma-assisted processes. Plasma applications are attractive because they enable the electrification of chemical processes by direct integration of renewable, CO_2-neutral electricity into the reactor interior without space-limited heating surfaces. Different types of plasma can be utilized for recycling-related process steps, like vitrification of fly ash or slag from waste incineration plants, cracking of heavy hydrocarbons, heat supply for endothermic gasification reactions and so on. Plasma-assisted processes show significant advantages compared to competing recycling technologies in handling with different problematic wastes. Examples for such wastes are medical residues, hazardous industrial wastes, mixed composite materials with high melting point. In addition, plasma applications are suitable for the conversion of ash-rich wastes with low calorific value since they allow a combination of allothermal and autothermal process management.

The aim of the presented work was to develop a concept for the plasma-assisted treatment of problematic wastes. It includes an overview of the state-of-the-art plasma technologies realized in pilot and commercial scale for thermal treatment and chemical conversion of wastes, as well as a detailed comparison between different plasma technologies regarding their characteristics and technical limitations. The goal was to provide findings and insights from the plant engineering point of view, and to develop different conceptual designs of plasma facilities. Main focus was placed on modular design, the configuration of the plasma reactor, and the use of additive manufacturing (3D-printing) technologies for the design of critical reactor components and plasma torch parts.

Finally, several research and industry projects for plasma-assisted chemical recycling of problematic wastes, which use a new plasma test facility in the Center for Efficient High-Temperature Processes and Materials Conversion located at the TU Bergakademie Freiberg, will be briefly presented.