SOLVENT-BASED DEPOLYMERIZATION OF POLYOLEFINS AND OTHER WASTE PLASTICS FRACTIONS – COMPARISON TO STATE-OF-THE-ART TECHNOLOGIES

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Introduction

Chemical recycling of pure and mixed waste plastics has undergone extensive research for decades. Decreasing available disposal volumes and political pressure towards reduction of landfilling, high crude oil and thus feedstock prices have always been economic and ecological incentives for the development of recycling technologies.
Major companies in chemical and oil and gas industry developed a range of different technologies. Complex, CAPEX-intense reactor designs, such as fluidized beds and rotary kilns were applied to overcome process difficulties originating from high viscosity and low thermal conductivity of polymer melts. High temperature applications and elaborated catalysts produced the favored products but also caused high operation costs. Simpler and more cost efficient designs led to poor and inconstant product qualities and low throughputs.
Early papers and articles written in the beginning 1990s have already described the challenge of making the technology cost effective. 20 years later, crude oil prices rose to about a five-fold, plastics world production increased by some 180% and landfill bans were put in place in various countries.
This set of changed economic conditions can finally lead to the economic viability of depolymerization technologies.

Methods and Data, Description of Case Study, etc.

After intense literature studies and discontinuous laboratory tests a continuous bench-scale pilot plant was designed and constructed. The aim is to find process parameters for ideal cracking conditions into favorable products. Process data is used to set up simulation models in order to validate the economic and technical viability of the process and to allow scale-up approaches.
A moderate process temperature and pressure design favors energy efficient operation; the non-catalytic solvent based process avoids margins losses through catalyst regeneration or a spent catalyst application.
In order to study the base depolymerization kinetics and process behavior, pure virgin polyolefin granulates and their mixtures were used as feed stock materials for the first test series. Later, several pretreated waste plastics fractions were fed to the unit to study the robustness of the process towards impurities.

Results

This new process provides an economically viable solution for the chemical recycling of preferably polyolefins. The solvent-based technology enables an upscalable reactor design and controllability of reaction and flow conditions throughout the cracking unit.

Conclusions and Findings

This work presents technical calculations of the process based on experimental results from the performed pilot plant tests. Economic considerations assuming an upscaling to a commercial size unit and its integration in an existing refinery are attached. The found conclusions are compared to state-of-the-art technologies.