9-4-2014

Reaction Engineering Routes to Waste Gasification for Sustainable Living Environments

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Abstract

There is an increasing pressure to reduce waste generation and dependence upon fossil fuels in our society. The approach investigated in this project aims to address both concerns by formulating a low-temperature gasification process to process long-chain polymers typically found in municipal waste. Gasification routes which convert plastic and bio-waste into useful fuel syngas products has been extensively investigated. The novelty of the approach examined here consists on the use of a variety of catalysts, which can promote high conversion in gasification reactions at much lower temperature and pressure conditions. This route overcomes some of the financial and environmental shortcomings of typical gasification routes, such as incineration, currently in use as waste-management strategies. Utilizing a small batch reactor, the kinetics of several, predominantly polyethylene, waste simulants have been examined in the presence of both platinum and ruthenium-based catalysts. Using gas chromatography, the conversion of the carbon source was quantified and compared for the two different catalysts and different reaction conditions. Promising results were obtained, these results compare favorably with results found in the literature. A phenomenological model has been formulated to characterize the liquid phase gasification reactions and their interrelation with transport phenomena occurring in an heterogeneous reaction environment. Through the use of computational fluid dynamics (CFD), the effect of mixer speed on vortex shape has been modeled. These results are currently being incorporated into the model in the form of a detailed characterization of transport phenomena occurring during the gasification dynamics. Moreover, the refined model is anticipated to enable optimization of the reactor operation, and reducing or de-convoluting any transport limitation that may be affecting kinetic determinations.