Tandem µ-reactor-GC/MS for online monitoring of aromatic hydrocarbon production via CaO-catalysed PET pyrolysis

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React. Chem. Eng. 2 (2017) 776-784

Abstract:

The present work demonstrates the online monitoring of aromatic hydrocarbon production via a two-step CaO catalyzed pyrolysis of poly(ethylene terephthalate) (PET), employing tandem µ-reactor-gas chromatography/mass spectrometry (TR-GC/MS). PET produces high-boiling terephthalic acid (TPA) during pyrolysis, which hinder the online monitoring of PET pyrolysis. In this work, TR allowed for independent control of the PET pyrolysis and CaO catalytic reaction with a very small sample loading (<1 mg) and split injection into the GC/MS (split ratio 100:1) system; thus, the fatal line clogging by TPA could be avoided. Thus, we successfully demonstrated the effect of CaO basicity on the time- and temperature-dependent dynamic production of aromatic hydrocarbons. Strongly basic CaO accelerated the decarboxylation of PET pyrolyzates to afford useful aromatic hydrocarbons such as benzene, toluene, and styrene with 99.7% selectivity in the oil. In contrast, weakly basic CaO enhanced benzophenone production in preference to benzene formation. The poor deoxygenation ability of the weakly basic CaO increased the concentration of oxygen-containing compounds in the oil. Finally, the time- and temperature-dependent dynamic pathways and the mechanism involving strongly basic/weak basic CaO were established. These findings allow for a clearer understanding of the nature of the PET catalytic pyrolysis, which will be helpful for advancing PET recycling. Furthermore, the novel methodology—online monitoring of a two-step pyrolysis-catalytic upgrading process involving high-boiling compounds—will gain the highest demand in the fields of green chemistry and reaction engineering.

* Excerpted from online journal website (Click the title)

Frontier Labs Products used:

Tandem µ-Reactor (RX-3050TR), UA+-1, UADTM