Chemical Engineering Colloquium

November 29, 2023

Goddard Hall Room 227
12:00 PM – 1:00 PM

Harnessing the Interplay Between Mass Transfer and Chemical Kinetics for Waste Upcycling

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The development of enabling technologies for efficient production of renewable fuels and chemicals is projected to grow over the next decades. Upcycling under-utilized waste resources into high-value products has attracted significant interest. Many thermochemical and biochemical waste conversion approaches have been explored, but the interplay between mass transfer and chemical kinetics in these systems has not been thoroughly explored, investigated, and harnessed. In this talk, three examples will be introduced to illustrate how mass transfer–chemical kinetics coupling can be manipulated in waste conversion technologies. Pyrolysis of high-density polyethylene (HDPE) will be used as the first example. Our results show that even for such a simple system, the evaporation of volatile products has a significant effect on the resultant product distributions, where the Damköhler number can be used to estimate the fate of each species in the system. The fundamental interplays between two immiscible macromolecular components in a binary copyrolysis system will then be discussed using mixtures of cellulose and a synthetic plastic as model feedstocks. It was found that the mixing of the two phases has a major impact on their synergy during copyrolysis, where three molecular-level interactions were discovered based on our experiments and density functional theory calculations. Finally, an in-situ product removal concept will be illustrated on how a membrane reactor can selectively remove a target product in enzymatic hydrolysis of polyethylene terephthalate (PET) to increase the product yields without compromising the environmental impacts of the process.

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