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Towards a biomass based polymer industry: Synthesis, characterization and process optimization of bioderived renewable polyesters

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The polymer industry is likely to encounter environmental problems arising from excessive usage of petrochemical sources and will therefore be required to shift towards bio-based processes. Polyesters represent an exciting area for renewable feedstocks to be considered due to their wide variety of applications. Interesting carbohydrate-derived monomers for polyesters include 2,5-furandicarboxylic acid (FDCA) which is a high value derivative from hydroxymethyl furfural (HMF), itself obtained from the dehydration of C5 and C6 sugars. 1,5-pentanediol (PTO), a potential product from the hydrogenation of furfural is a hydration product from hemicellulose. Also, succinic acid (SA) can be obtained from fermentation. Despite the imminent growth of the biomass derived polymers, the process engineering research for these polymerizations is scarce, which limit their industrial use. Herein this work, we have successfully synthesized poly(1, 5-pentylene succinate) (PTS), poly(1,5-pentylene 2,5-furandicarboxylate) (PTF) and poly(1,5-pentylene 2,5-furandicarboxylate-co-1,5-pentylene succinate) (PTFTS) by a two-step process involving polycondensation and azeotropic distillation. 1H NMR confirmed the polyesters' structure and GPC was used to measure molecular weight. The thermal properties were determined by DSC and TGA. Also, the kinetic parameters of differential rate equations were estimated. Finally, we performed the simulation in ASPEN Plus™ for different configurations and solved a multiobjective optimization polyesterification problem by the -constraint method to obtain the optimum operation conditions and evaluate the performance in terms of sustainability indicators. To the best of our knowledge, this is the first time a comprehensive work involving synthesis, characterization and process optimization has been presented for this type of polyesters.

Biography

Mónica Lomelí-Rodríguez has obtained her degree in Chemical Engineering from Universidad Iberoamericana México in 2008 and Master's degree in Advanced Chemical Engineering from King Abdullah University of Science and Technology (KAUST) in Saudi Arabia where she focused in combustion technology and kinetics at the Clean Combustion Research Center in 2011. She has been working as a Process Development Engineer with the Innovative Plastics Division of SABIC before enrolling Tony Lopez's Research Group in Catalysis for Sustainable Chemistry in the University of Liverpool. Currently, she is pursuing her PhD in Biomass Derived Polyesters Synthesis and Reaction Engineering.

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