Washington University in St. Louis
School of Engineering & Applied Science

Energy, Environmental & Chemical Engineering

EECE Department Seminar

Friday, October 21, 2016

11:00am

Brauer Hall, room 12

The Challenges and Opportunities of Designing Pioneer Catalytic Technologies for Production of Sustainable Fuels and Chemicals from Biomass

ABSTRACT

In the past decade over $1.0 billion in private and public funds has been spent on the development of pioneer technologies for the conversion of lignocellulosic biomass into liquid transportation fuels and chemicals. Several of these technologies have failed at the commercial level and several of these companies have now gone bankrupt. The failure of these technologies is due to two fundamental reasons: 1. economic estimates under predicted the costs of these technologies; and 2. pilot and demonstration plants operated well below their designed capacity. In this presentation we will first present a predictive model on how to estimate the economics and operability of pioneer technologies. I will then discuss different approaches for the production of renewable fuels and chemicals that are being developed both inside the Huber research group. The objective of the Huber research group is to develop pioneer catalytic processes and catalytic materials for the production of renewable fuels and chemicals from biomass, solar energy, and natural gas resources. We use a wide range of modern chemical engineering tools to design and optimize these clean technologies including: heterogeneous catalysis, kinetic modeling, reaction engineering, spectroscopy, analytical chemistry, nanotechnology, catalyst synthesis, conceptual process design, and theoretical chemistry. Hydrodeoxygenation (HDO) is a platform technology used to convert liquid biomass feedstocks (including aqueous carbohydrates, pyrolysis oils, and aqueous enzymatic products) into alkanes, alcohols and polyols. In this process the biomass feed reacts with hydrogen to produce water and a deoxygenated product using a bifunctional catalyst that contains both metal and acid sites. The challenge with HDO is to selectively produce targeted products that can be used as fuel blendstocks or chemicals and to decrease the hydrogen consumption. We will then describe a multi-step catalytic approach for conversion of cellulose into 1,6-hexanediol and hemicellulose into 1,5 pentanediol. These α,ω-diols are high-volume (130,000 tons/year), high value ($4,600/ton) commodity chemicals used in the polymer industry. Cellulose is first converted levoglucosan which is then dehydrated into levoglucosenone (LGO) in the condensed phase with dilute acid using a polar, aprotic solvent. The LGO is then hydrogenated into dihydrolevoglucosenone, levoglucosanol, and tetrahydropyran-2-methanol (THPM). The THPM then undergoes selective C-O-C hydrogenolysis to produce 1,6-hexanediol using a bifunctional catalyst with > 90% selectivity to 1,6 hexanediol. The hemicellulose is converted into furfural which then undergoes a series of reactions to produce 1,5 pentanediol.

George Huber, Ph. D.,

Harvey Spangler Professor, Chemical Engineering, University of Wisconsin-Madison

George Huber is the Harvey Spangler Professor of Chemical Engineering at University of Wisconsin-Madison. His research focus is on developing new catalytic processes for the production of renewable liquid fuels and chemicals. He has authored over 120 peer-reviewed publications, including three publications in Science, and over 15 issued patents. In 2015 Thomson Reuters listed George as a "highly cited researcher" a title given to "the "world's most influential scientific minds" who rank in the top 1% most cited. He has been named one of the top 100 people in bioenergy by Biofuels Digest for the past 4 years. He is co-founder of Anellotech (www.anellotech.com). George did a post-doctoral stay with Avelino Corma at the Technical Chemical Institute at the Polytechnical University of Valencia, Spain (UPV-CSIC). He obtained his Ph.D. in Chemical Engineering from University of Wisconsin-Madison (2005). He obtained his B.S. (1999) and M.S.(2000) degrees in Chemical Engineering from Brigham Young University.

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