UCI Samueli School of Engineering | Department of Mechanical and Aerospace Engineering

Seminar Series

Carbon-Negative Hydrogen Production from Biomass and Waste: Two Gasification-Based Approaches

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McDonnell Douglas Engineering Auditorium (MDEA)

Abstract: Global interest and investment in hydrogen as a carbon-free energy carrier for power generation, transportation and industrial use has seen a recent upsurgence. Electrolysis based on renewable power from wind and solar is the standard approach for fossil-free production of hydrogen. However, biomass and waste can also be used to produce hydrogen, with the potential to incorporate capture and sequestration of atmospheric CO_2 (via vegetation), thus achieving carbon-negative hydrogen production. The University of Utah is exploring this through two approaches. The first technology, sorption-enhanced gasification (SEG), involves the use of two interconnected fluidized beds that circulate a mixture of olivine and limestone/lime particles. Biomass is 80-85% converted in the steam-fluidized gasifier reactor. High-hydrogen synthesis gas is produced via a combination of steam reforming, water-gas shift, and in-situ sorption of resultant CO_2 by CaO particles. Unconverted char travels with the bed particles to the combustor reactor, where fluidizing air burns the char, thus heating up the bed particles and calcining the $CaCO_3$ to release CO_2 and regenerate CaO. Operating the combustor as an oxy-fuel reactor generates flue gas that is nearly pure CO_2. The other technology involves pressurized oxygen-blown, entrained-flow gasification of biomass or sorted MSW that has been pre-liquefied by flash pyrolysis. Carbon conversion greater than 99% is achieved is just a few seconds to produce a very clean syngas. Deep water-gas shift to convert the gas to H_2 and CO_2 followed by pressure swing absorption results in product streams of pure H_2 and CO_2. This presentation discusses the principles and chemistry of the two technologies, describes the designs of Utah's pilot-scale reactors, and shares experimental results of lab- and pilot-scale investigations.

Bio: Kevin Whitty is a professor of chemical engineering at the University of Utah and also Associate Dean for Research for the John and Marcia Price College of Engineering. He received his B.S. in chemical engineering from Oregon State University and his M.Sc. and Ph.D. degrees from Åbo Akademi University in Finland. He has over 30 years' experience researching advanced energy technologies including gasification, high pressure oxy-fuel combustion, and chemical looping combustion of fossil and renewable fuels. Prior to joining the University of Utah in 2001, Dr. Whitty spent several years in industry managing research and directing pilot operations for companies developing energy technologies. This experience helped shape his research approach, which focuses on bridging the gap in understanding between fundamental lab-scale studies and operation of industrial-scale systems. He has designed several research rigs ranging from 200 kW to 4 MW, including three pilot-scale gasifiers at the University of Utah. Dr. Whitty is a Fellow of the American Institute of Chemical Engineers, led the IEA Bioenergy gasification task committee for six years, and has been principal investigator of more than sixty government and industry sponsored programs.