Pacific Northwest
NATIONAL LABORATORY

Frontiers in Catalysis Science and Engineering Lecture Series

Physical Sciences Division

Professor Eric McFarland

Department of Chemical Engineering
University of California, Santa Barbara

Plan B: Taking the Carbon out of Fossil Fuels with Catalytic Reactive Separation

Tuesday, April 23 @ 1:30 pm | EMSL Auditorium

There is no evidence that significant reductions in the carbon dioxide emissions associated with power generation will be cost effectively achieved using current commercial alternatives to abundant and inexpensive fossil fuels. The lowest cost process for producing hydrogen and/or dispatchable electricity without CO_2 emissions in the U.S. utilizes pyrolysis of abundant, low-cost, natural gas. The challenge is to achieve high methane reaction rates and high conversion to molecular hydrogen in a reaction environment where solid carbon can be continuously separated. Reactive separation using high temperature (~1000 ^{o}C) catalytic complex liquids has been investigated in several multi-phase reaction systems and high rates (>1 mole/m^3-s) of methane decomposition and high selectivity for molecular hydrogen observed. When the physical properties of the liquids are selected optimally, conveniently separable solid carbon is produced from methane dehydrogenation in bubble column reactors. Solid catalysts in specific melts may also be continuously reactivated as the high temperature liquid serves as a solvent to remove carbonaceous surface deposits prior to the irreversible formation of deactivating coke. Single pass methane conversion of over 95% to molecular H_2 at over 98% selectivity is demonstrated in complex melt systems. Fundamentals of C-H bond activation on melt surfaces and the interactions with the gas phase chemistry will be discussed and distinctions made as to how different reaction pathways can produce different types of solid carbons. Process designs for solid carbon synthesis with zero carbon hydrogen and/or electricity production together with relative technoeconomics will be presented.

Host: Zdenek Dohnalek | 1-6150
Admin: Diane Stephens | 1-6147

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