ChE SEMINAR

Sustainable Catalysis with Gas-Expanded Liquids

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Seminar Room
Dept. of Chemical Engineering
Monday October 27, 2014: 12:00 noon

ABSTRACT

A gas-expanded liquid (GXL) is formed when near-critical gases (such as either CO2 or a light olefin at ambient temperature) are dissolved in a conventional liquid phase at moderate pressures [1]. When near–critical CO2 is dissolved in a conventional organic solvent, the so-called CO2-expanded liquid (CXL) is formed. This talk will address the unique ways in which the pressure-tunable physical and transport properties of GXL media have been exploited to develop greener catalytic process concepts for O_2 and H_2O_2-based oxidations, hydroformylations and ozonolysis. The demonstrated advantages include process intensification at mild conditions by increasing dissolution of the limiting reagent (gaseous reactants such as O2 or syngas or light olefins) in the GXL reaction phase [2]; enhancing inherent safety by suppression of flammable vapors [2]; and waste mitigation by reduced usage of organic solvents and by suppression of side reactions that generate undesired byproducts such as CO_2 [3].

Specific examples of novel process concepts that will be discussed include continuous olefin hydroformylation in CXL media with exceptional TONs and selectivity, employing soluble polymerbound Rh catalysts that are effectively retained in the stirred reactor by nanofiltration membranes [4]; and a novel homogeneous ethylene oxide process concept that uses methyltrioxorhenium as catalyst and

hydrogen peroxide as oxidant, virtually eliminating CO2 formation as a byproduct [5]. Quantitative economic and environmental impact analyses have been employed to benchmark CEBC's novel technology concepts against conventional processes [6]. Such comparative analyses not only guide research and development but have also assisted CEBC's industry partners in making licensing decisions on some of these GXL-based technologies.

References:

1. P.G. Jessop and B. Subramaniam, Chem. Rev., 107, 2666 (2007); B. Subramaniam and G. R. Akien, Current Opinion in Chemical Engg. 1(3), 336 (2012); B. Subramaniam, R. V. Chaudhari, et al., Chem. Eng Sci. 115, 3 (2014).
2. (a) M. Wei et al., J. Am. Chem. Soc., 124, 2513 (2002); (b) Y. Houndonougbo et al., J. Phys. Chem. B., 110, 13195 (2006); (c) Z. Xie et al., J Chem. Eng. Data, 54, 1633 (2009).
3. X. Zuo, F. Niu, W. K. Snavely, B. Subramaniam and D. H. Busch, Green Chem. 12, 260 (2010).
4. Z. Xie, J. Fang, S. K. Maiti, W. K. Snavely, J. A. Tunge and B. Subramaniam, AIChE J, 59, 4287 (2013).
5. M. Ghanta, H-J Lee, D. H. Busch , B. Subramaniam, AIChE J. 59, 180 (2013).
6. J. Fang et al. Ind. Eng. Chem. Res., 46, 8687 (2007); M. Ghanta et al., Ind. Eng. Chem. Res. 52, 18 (2013).