ChE Graduate Seminar Series

Departmental Seminars Presented by Ph.D. Students

Catalytic Oxidative & Non oxidative Steam Reforming of Bio-ethanol for Hydrogen Generation

Tarak Mondal (Advisors: Prof. K.K. Pant and Prof. Ajay K. Dalai)

16th October 2014, Thursday, 0400-0425 pm (15+10 mins), ChE Seminar hall

Hydrogen production from renewable sources such as biomass, has gained attention due stricter environmental norms. Bio-ethanol, produced from biomass fermentation, is a prosperous renewable energy carrier. Reforming of bio-ethanol provides a promising method for hydrogen production from renewable resources and has attracted great attention owing to several advantages, such as negligible CO_2 emission, low toxicity, and high hydrogen content in ethanol.

In the present work, catalytic oxidative and non-oxidative steam reforming of bio-ethanol for hydrogen production was studied over Ni/CeO_2-ZrO_2 and Rh-Ni/CeO_2-ZrO_2 catalysts. The catalysts were prepared by impregnation-co-precipitation method and characterized by BET, XRD, TPR, TPD, Chemisorptions, TGA, SEM-EDX and TEM techniques. Characterization results revealed that addition of ZrO_2 improves the oxygen storage capacity of CeO_2 which improves catalytic activity. The effects of temperature, ethanol/water/oxygen molar ratio, and space time on ethanol conversion and product selectivities were investigated in a tubular fixed bed reactor at atmospheric pressure. It was found that conversion and hydrogen yield increased with temperature and reached maximum at 600°C. The role of Ni is mainly to cleave the C-C and C-H bonds of ethanol to produce H_2 and COx. Rh was added to further reduce CO concentration in product stream by promoting water gas shift reaction. Ethanol conversion and H_2 selectivity were increased with increasing contact time while CO and CH_4 selectivity decreased. Investigation revealed that Rh promoted catalyst has better catalytic activity than that of Ni/CeO_2-ZrO_2 catalyst indicating that addition of noble metal Rh improves the catalytic activity significantly for steam reforming of ethanol.

On the structure of “random” packed beds

Aakarsha Srivastava (Advisors: Prof. Shantanu Roy and Prof. K. D. P. Nigam)

16th October 2014, Thursday, 0425-0450 pm (15+10 mins), ChE Seminar hall

Pellet catalysts are packed in various ways in the packed bed, such as “sock” or “dense” loading, wherein different effective densities are observed in the large scale reactor. Often either of the above packing schemes are characterized by “packing defects”, i.e., surface abnormalities such as a slope, a bump (convex surface), a hollow (concave surface), or even donut shaped rings on the top surface of a packed bed. It is believed that these surface “defects” propagate deep into the bed and in turn cause flow abnormalities and are expected to affect reactor performance.

The working assumption in packed bed design (as taught in reaction engineering) is that the bed is “truly random” and that particles are distributed uniformly leading to a uniform voidage distribution. In many of the classical two and three-phase packed bed reactor applications, the assumption of randomness is adequate in designing and operating the reactor. However, in some of the more applications of great current interest, such as hydrotreating and hydrodesulphurizaton, where “deep conversion” (more than 99.9% conversion) is desired, local non-uniformities in packing structure are thought to have a dramatic impact on performance.

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This project is aimed at understanding and assessing the role of packing defects in packed (trickle) beds. A first major step in this study is to be able to characterize the packed bed structure in a laboratory scale column. Methods like tomography do not provide the fine spatial resolution (and three dimensional structure) required for this study. Thus, in this talk, we will discuss a method based on introducing and solidifying a resin and hence "freezing" the packed bed structure in a laboratory scale packed bed. After solidification of the resin in a sample catalyst bed, different cross sections of bed are cut and photographed followed by image processing of various cross sections. Our aim is to measure the local voidage variation in column and to study the wall effect. It was observed that wall effect can be seen upto 6 times the diameter of cylinder from the wall. Radial void fraction in the core zone is obtained as 50.7% and at the wall zone as 65%.

Hydrodynamic Instability in Polymer Fiber Spinning

Karan Gupta (Advisor: Dr. Paresh Chokshi)

16th October 2014, Thursday, 0450-0515 pm (15+10 mins), ChE Seminar hall

During fiber spinning process, the polymer melt is subjected to a strong extensional flow where the thinning of fiber takes place. The extensional flow is known to undergo a hydrodynamic instability known as Draw Resonance which manifests in the form of sustainable periodic oscillations in fiber cross-section area during the spinning flow. In this presentation, we aim to theoretically estimate the critical parameter, the draw-down ratio, for the onset of draw resonance. The stability theory for the flow transition deals with imposing infinitesimal amplitude disturbances to the steady flow and analyzing the transient growth or decay of disturbance amplitude leading to the critical draw ratio for flow transition. For the polymeric flow, the critical draw ratio, DR_c, is found to depend strongly on the material rheology, in addition to processing conditions. For the high-strength polymer fibers, ultra-high molecular weight entangled polymers are employed. Hence, the classical dumbbell models, suited for the un-entangled polymers, will be inappropriate. We employ the eXtended Pom-Pom (XPP) model, a variant of tube theory, which describes nonlinear rheology of entangled polymer melt. The linear stability analysis is carried out to construct a stability diagram indicating stable and unstable regimes for fiber spinning. In the unstable regime, the nonlinearities in the governing equations saturate the disturbance amplitude to an equilibrium value. Weakly nonlinear analysis is carried out to obtain the equilibrium amplitude. The dynamical equation for the amplitude is the Landau equation with a Landau constant representing the higher order correction to linear growth rate. For polymers with small elasticity, the Landau constant is found to be negative, indicating super-critical Hopf bifurcation at the transition point with a limit cycle behavior. The role of fluid elasticity in the equilibrium amplitude will be discussed.

0515 pm High Tea

CC
All ChE Faculty
Department N. B.
PhD Students (near biometric device)
Mr. Krishna (for audio/video help)
ChE office: refreshment arrangements