Facing a Multiphasic World

Reactions in multiphasic systems—such as gas–liquid–liquid—are gaining importance due to the increased number of applications using these systems in the bioprocess industry. However, the operation and control of such systems is challenging because the addition of dispersed liquid phases alters the dynamics of the system. In particular, the transfer rate of the solute gas across the boundary layer and the gas–liquid contact characteristics can be changed due to the interfacial properties of the dispersed liquid. Amaral and co-workers have contributed to a better understanding of this multiphasic world by studying the mechanisms involved in the oxygen transfer in a submerged aerated bioreactor in the presence of a second liquid phase: a perfluorocarbon used as an oxygen carrier. The authors show how the mass transfer in multiphasic systems is influenced by the bioreactor working volume, the type, and content of the organic phase and the composition of the aqueous phase. Page 588

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Flux Analysis Gets Faster, Less Expensive, and More Relevant

Metabolic flux analysis (MFA) using stable isotope tracers and mass spectrometry is a powerful platform for metabolic engineering and systems biology. Fluxes describe the rates at which material is flowing through specific metabolic routes and thus provide key indicators of pathway kinetic bottlenecks and cellular phenotype. To date, flux determination has relied on metabolic and isotopic steady state measurements requiring long and expensive labeling experiments. Young and co-workers of the Bioinformatics & Metabolic Engineering Laboratory at the Massachusetts Institute of Technology have extended the recently developed elementary metabolite unit (EMU) method of pathway decomposition to reconstruct cell-wide fluxes from isotopically nonstationary labeling data. Besides achieving accurate flux determination from transient data, their approach gives a 5,000-fold computational speedup in comparison to previous approaches and opens the door to nonstationary MFA of biologically relevant networks. Page 686

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CFD Simulation of Non-Newtonian Fluid Flow in Anaerobic Digesters

Mixing in an anaerobic digester (AD) not only affects mass transfer but also bacterial retention and degree of methane supersaturation. Mixing as a key design and operational parameter for ADs has not been adequately studied. Many questions remain such as optimal mixing as a function of solids concentration and biological activities within the digester. Wu and Chen’s work provides an example of the need for further fundamental understanding of mixing-related properties of the liquid in a digester and the utility of mixing modeling for application to ADs. For example, the velocity field for the same mixing regime can be completely different, depending on the solids concentration of a given fluid. An optimal mixing power input can be determined via computational fluid dynamics (CFD) modeling and this work provides a base for further AD mass transfer modeling which is currently being undertaken by the authors’ research group at Washington State University. Page 700

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Protein Engineering For Bioprocess Development

The vast diversity of enzymatic activities found in nature provides fertile ground for the development of biological processes for the production of a wide range of specialty chemicals. However, obtaining sufficient biocatalyst productivity has proved challenging and often limiting for many commercial applications. Previous work described the use of protein engineering to overcome this limitation in several applications that utilize the enzymatic conversion of hydroxynitriles to hydroxycarboxylic acids (Wu et al. 2007 Biotechnol Bioeng 97:689–693). The current work expands on this theme in the context of a recently developed chemoenzymatic process for the manufacture of high purity glycolic acid. A key step in this process is the enzymatic conversion of glycolonitrile to ammonium glycolate using nitrilase. In order to achieve the required biocatalyst productivity, protein engineering and fermentation optimization were used to increase the enzyme-specific activity up to 15-fold and the biocatalyst-specific activity up to 125-fold. Page 717

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