Bubble Column Enables Higher Reaction Rate for Deracemization of (R,S)-1-Phenylethanol with Coupled Alcohol Dehydrogenase/NADH Oxidase System

One of the major drawbacks for many biocatalysts is their poor stability under industrial process conditions. A particularly interesting example is the supply of oxygen to biooxidation reactions, catalyzed by oxidases, oxygenases or alcohol dehydrogenases coupled with NAD(P)H (reduced nicotinamide adenine dinucleotide phosphate) oxidases, which all require the continuous supply of molecular oxygen as an oxidant or electron acceptor. Commonly, oxygen is supplied to the bioreactor by air sparging. To ensure sufficient oxygen transfer from the gas to the liquid phase, stirring is essential to disperse the gas bubbles and create high gas-liquid interfacial area. Studies indicate that the presence of gas-liquid interface induces enzyme deactivation by protein unfolding which then readily aggregates and can subsequently precipitate. This contribution has examined the effects of stirring and the presence of gas-liquid interface on the kinetic stability of water-forming NAD(P)H oxidase (NOX) (EC1.6.3.2). These effects were studied separately and a bubble column apparatus was successfully employed to investigate the influence of gas-liquid interfaces on enzyme stability. Results showed that NOX deactivation increases in proportion to the gas-liquid interfacial area. While air enhances the rate of stability loss compared to nitrogen, stirring causes faster loss of activity in comparison to a bubble column. Finally, deracemization of 1-phenylethanol, using a coupled alcohol dehydrogenase /NADH oxidase system (ADH/NOX), proceeded with a higher rate in the bubble column than in quiescent or in a stirred solution, although, inactivation was also accelerated in the bubble column over a quiescent solution.