Characterization of a continuous agitated cell reactor for oxygen dependent biocatalysis

Biocatalytic oxidation reactions employing molecular oxygen as the electron acceptor are difficult to conduct in a continuous flow reactor because of the requirement for high oxygen transfer rates. In this paper, the oxidation of glucose to glucono-1,5-lactone by glucose oxidase was used as a model reaction to study a novel continuous agitated cell reactor (ACR). The ACR consists of ten cells interconnected by small channels. An agitator is placed in each cell, which mixes the content of the cell when the reactor body is shaken by lateral movement. Based on tracer experiments, a hydrodynamic model for the ACR was developed. The model consisted of ten tanks-in-series with back-mixing occurring within and between each cell. The back-mixing was a necessary addition to the model in order to explain the observed phenomenon that the ACR behaved as two continuous stirred tank reactors (CSTRs) at low flow rates, while at high flow rates behaved as the expected ten CSTRs in series. The performance of the ACR was evaluated by comparing the steady state conversion at varying residence times with the conversion observed in a stirred batch reactor of comparable size. It was found that the ACR could more than double the overall reaction rate, which was solely due to an increased oxygen transfer rate in the ACR caused by the intense mixing as a result of the spring agitators. The volumetric oxygen transfer coefficient, kL a, was estimated to be 344 h⁻¹ in the 100 mL ACR, opposed to only 104 h⁻¹ in a batch reactor of comparable working volume. Interestingly, the large deviation from plug flow behavior seen in the tracer experiments was found to have little influence on the conversion in the ACR, since both a plug flow reactor (PFR) model and the backflow cell model described the data sufficiently well. Biotechnol. Bioeng. 2017;9999: 1-9. © 2017 Wiley Periodicals, Inc.