Comparison of hydrodynamics and oxygen transfer in three different pneumatic bioreactors operating with sugarcane bagasse suspensions

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The enzymatic complex needed for the conversion of lignocellulosic materials into sugars can be obtained by cultivation of microorganisms in stirred tank and pneumatic bioreactors under submerged fermentation. Pneumatic bioreactors (bubble column and airlift) offer several advantages for cultivation of filamentous fungi such as higher oxygen transfer and lower shear stress. In the present work it was evaluated the hydrodynamic behavior and oxygen transfer in three different pneumatic bioreactors operating under different concentrations of sugarcane bagasse. The parameters studied were the overall volumetric oxygen transfer coefficient (k_La) and the gas hold up (ε_G). The solid phase was sugarcane bagasse with the average particle size (d_P) of $0.425 < d_P < 0.710$ mm. Distilled water and air were used as liquid and gas phase, respectively. The experiments were performed at 32°C in 5.0L bubble column, split-cylinder airlift and concentric-tube airlift bioreactors. A central composite design was used to study the influence of solids loading (from 0.013% to 1.0%) and air flow rate (from 10 to 30 L/min) in the response variables. k_La was determined by the dynamic method and ε_G by the expansion volume technique. Empirical polynomial models were fitted to the experimental data and a statistical analysis allowed building the response surface plots. For the highest solids loading studied, split-cylinder presented the highest k_La value, achieving 0.045 s^{-1} for 1.0% solids loading and 30 L/min of air flow rate. The highest ε_G values were obtained for the concentric-tube airlift, 10.73%. The different pneumatic bioreactors were able to maintain high oxygen transfer levels when operating with sugar cane bagasse showing a potential to be used in cellulase production processes.

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