Scale-up of Aerated Industrial Multistage Rushton Impeller Bioreactors with Complex Rheology

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Abstract

The power input and gas-liquid mass transfer rank among the most important industrial fermentation process parameters. The present study analyzes the power input and gas hold-up as a function of the flow regime, impeller diameter, and rheological properties in a pilot scale reactor (160 L) equipped with four Rushton impellers. This leads to four dimensionless numbers for predicting measurements in pilot and industrial bioreactors (110 and 170 m3) with a standard deviation of 7 % to 29 %. This is unparalleled for the underlying aerated and non-Newtonian fermentation broths. Several existing correlation equations are discussed to be dissatisfying (up to 130 % deviation), and might be sufficiently valid only within scale or for small scaling factors. The introduced approach predicts adequately accurate over three orders of magnitude. Based on these encouraging results, we identified the Galilei number and the power concept as the central elements in combination with the consequent dimensional analysis for an efficient scaling betweeen pilot and industrial scale.

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