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Abstract

Predicting the Volumetric Mass Transfer Coefficient in a Double Coaxial Mixer: An Artificial Neural Network Approach †

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In recent years, there has been a significant emphasis on predicting the mixing effectiveness of mechanically agitated tanks, particularly those employing coaxial mixers. Coaxial mixers, characterized by central impellers and a close clearance anchor, have shown superiority over conventional systems in achieving homogeneous gas dispersion and enhancing the volumetric mass transfer coefficient (k_La). Evaluating the efficiency of these mixers, especially with high-viscosity non-Newtonian fluids, poses challenges due to their complex design and intricate interactions between operating variables.

Large-scale coaxial mixers, equipped with multiple central impellers, aim to enhance mass transfer at a constant power consumption, but their complex geometry and rheological characteristics further complicate accurate predictions of mixing effectiveness. Traditional correlations for estimating k_La based on experimental data have limitations within specific operating conditions. Enter machine learning methods, specifically Artificial Neural Networks (ANNs), which have gained traction in various industries, including chemical engineering.

ANNs, trained with experimental data, demonstrate remarkable success in predicting k_La within the covered ranges. They excel in examining the impact of design parameters, operating conditions, and fluid properties on multiphase processes. The study at hand focuses on developing an ANN model for predicting k_La in a double coaxial mixing system with yield-pseudoplastic fluids. The system comprises two pitched-blade impellers and an anchor, using different concentrations of xanthan gum solutions. The model considers the central impeller speed, anchor speed, aeration rate, and rheological parameters of the xanthan gum solution. The ANN model, constructed using experimental data obtained through the simplified dynamic pressure method, outperforms empirical correlations proposed in the existing literature, providing more accurate estimations for k_La. Overall, the study showcases the potency of ANNs in predicting mixing effectiveness in gas–liquid mixing tanks, particularly in complex systems with non-Newtonian fluids.

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