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Abstract

Forecasting Trona Product Quality in Spray Drying Using Reactive Engineering Approach (REA) †

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Abstract: This study presents the formulation and development of a Reactive Engineering Approach (REA) kinetic model to characterize the drying kinetics of Trona across diverse experimental scenarios. By integrating fundamental reaction principles with experimental data, the REA model aimed at offering predictive capabilities to forecast trona drying behaviours. The model formulation involved solving both heat and mass transfer models to predict the drying behaviour and product quality such as temperature distribution and moisture content and along the spray dryer. The model equations were solved using finite difference method to develop a one-dimensional model. The validity of the developed REA kinetic model was assessed by comparing its predictions against the experimental data from diverse drying conditions. Experimentation involved drying Trona slurry under varying experimental condition such as slurry flowrate (12–28 mL/min), solid concentration (5–15%), inlet gas flowrate (40–80 m^3/h) and inlet gas temperature (120–200 °C). This was carried out using a laboratory scale spray dryer while observing the spray characteristics including exit temperature and moisture content. The model simulation results presented close alignment with the experimental data indicating effective representation of the moisture loss behaviour under different operating conditions. Specifically, the model predicted higher rates of moisture loss at higher inlet gas temperatures (200 °C), consistent with experimental observations. Additionally, it indicated a decreasing rate of moisture loss along the chamber height (0–0.5 m) due to decreasing temperatures. Moreover, the model predicted a decreasing rate of moisture loss with increasing slurry concentration, consistent with final moisture content measurements.

Keywords: spray drying; Reactive Engineering Approach; kinetics; Trona; product quality

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