284g Case Study: Optimization of an Industrial Fluidized Bed Drying Process for Large Geldart Type D Nylon Particles

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In polymer production, fluidized bed drying is often the last but a vital operation to assure low moisture content, which is crucial for subsequent polymer processing. However, it remains difficult to predict the dryer performance accurately as no general application models for the design of fluidized bed dryers have been published. In industrial-scale production, gas bubbles can grow to significant sizes and reduce the mass transfer between the solids and the fluidizing gas predicted using single-phase models. Therefore, recent work has been focused on coupling two-phase fluidization theory with the relevant drying models to predict drying rates. Coupled heat and mass balance equations arising from the integrated models need to be solved numerically and results verified at laboratory scale experiments [1,2].

To adopt this approach to model a multi-stage industrial-scale fluidized bed dryer for large Geldart Type D nylon particles, a descriptive flow-chart is designed to identify the operating fluidization regime. A theoretical criterion using cross-flow factor is developed to identify the conditions under which the single-phase models are no longer valid during bubbling fluidization [3]. Using two-phase fluidization theory to describe the gas-solids contact pattern, the drying rates are determined by modeling the transport of moisture between the dense and bubble phases. An iterative numerical solution strategy is used to avoid the need to solve coupled heat and mass balance equations simultaneously, which renders the model more practical for industrial application. Changes in bubble size and wall effects along the bed height, which were normally neglected in previous work, have been taken into account to improve accuracy. The model developed is used to optimize the operating conditions of the industrial-scale dryer to achieve better performance. After evaluating the sensitivity of operating conditions (temperature, weir height, fluidization velocity, residence time) using the two-phase drying model, recommendations are made to optimize the plant operations.

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