Method of Lines Analysis for a Moving Bed, Counter-Current Flow, Polymer Devolatilization Unit (K. J. ANSELMO, J. M. Zielinski, B. T. Carvill, H. S. Caram, W. E. Schiesser)

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After the formation of a polymer in a polymerization reactor, volatile residues, such as monomers, solvents, and impurities must be removed before further processing may occur. An accurate analysis of a devolatilization process can lead to optimization of the drying conditions for that unit and the conception of novel drying methods.

The drying of a polymer is a complex problem involving simultaneous heat, mass, and momentum transport and is traditionally mathematically analyzed as an unsteady-state transport problem. Commercially, however, process engineers are generally more interested in the steady-state behavior of the drying operation, so the current model is also typically integrated forward in time to steady state.

In this work, an unsteady-state mathematical model was developed to simulate a typical polymer drying unit operation based on the conservation of mass and energy. The resulting PDE model is 1-D for the gas stream, which flows countercurrently to the polymer particles through the dryer, but is 2-D for the polymer particles so that the movement of particles along the dryer is taken into account as is the molecular transport into and out of the particles.

The system of PDEs was solved numerically using the numerical method of lines (MOL), and included the complex, nonlinear diffusion of solvent within the particles. The resulting numerical solutions compared well with special-case solutions, and support the experi- mental observation that the addition of solvents can facilitate the removal of small amounts of volatile impurities from a polymer product.

Thus, the model serves as a basis for the understanding of commercial drying operations and for the optimization of the operating conditions.