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Using a methodical method called Hybrid Mixture Theory for porous materials, we derive a nonlinear Volterra partial integrodifferential equation (VPIDE) that models swelling polymers which can be used, for example, to model drug-delivery polymers (used for example in Aleve), expansive soils, soybeans, and biotissues. After solving the equation numerically using pseudospectral differentiation matrices in polar geometry in space and a method-of-lines approach in time, we show and interpret results for a variety of diffusion coefficients, permeability models, and parameters in order to study the model's behavior. (Received February 27, 2017)