Optimal cooling curve of batch seeded crystallization, determined from the nonlinear first-order dynamic metastable limit model

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Crystallization is an indispensable separation and purification process in chemical and related industries. Nevertheless, many aspects of crystallization are not still understood well and, hence the industrial crystallization is sometimes regarded as an art.
In this research, a new dynamic model that describes the time-varying behavior of the metastable limit is proposed for cooling crystallization. For this, experimental results in a literature obtained for (NH4)2SO4 crystallization from the (NH4)2SO4-H2O system have been reinterpreted and a nonlinear first-order dynamic model has been derived to describe the relation between the cooling rate and the metastable limit. On the basis of this result, an optimum cooling curve that provides the maximum productivity without homogeneous nucleation is determined. Experiments have been performed in a batch crystallizer to verify the theoretical prediction. Through this study, a dynamic model for the metastable limit in cooling crystallization has been proposed and an optimum cooling curve has been calculated incorporating the model.