POPULATION BALANCE-BASED OPTIMAL CONTROL OF A CRYSTALLIZATION PROCESS

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Crystallization is a liquid-solid separation process, where solids are formed from a solution. In process engineering crystallization is an important separation technique in the chemical, pharmaceutical, food, material and semiconductor industries. Crystallization is triggered in a supersaturated solution either by cooling, evaporation of solvent, addition of anti-solvent, or by chemical reactions [1, 2].
Mathematical models of crystallization are governed by population, molar and energy balance equations, which describe processes like nucleation (crystal birth), crystal growth, particle breakage and attrition, and possibly agglomeration, along with thermodynamic and molar balances.
In the pharmaceutical and food-processing industry, there has been growing interest in the crystallization of lactose [3]. For a number of reasons, α-lactose monohydrate is the most common form of lactose used in the making of medications. It is affordable, physically and chemically stable, easy to mix, it readily dissolves in but does not absorb water. The term monohydrate refers to the single water molecule being incorporated into the solid crystal. Two forms of lactose (α- and β-lactose) exist simultaneously in aqueous solution, the exchange being governed by mutarotation.
In this talk we present a population balance model-based optimal control of semi-batch solvated crystallization of α-lactose monohydrate, where the container is initially only partially filled. The optimal control problem is: by acting on the feed rate, the crystallizer temperature and on the crystal seed, we wish to steer the process in such a way that the growth of particles within a certain size range is maximized. The moment models are used to check if a desired crystal size distribution is achievable. Numerical simulation experiments were obtained using the solver PSOPT [4].

Références

[1] J.W.Mullin, *Crystallization*, BUTTERWORTH HEINEMANN, 4^{th} EDITION, 2001.

[2] A. D. Randolph, M. A. Larson, *Theory of Particulate Processes*, 2nd ED. ACADEMIC PRESS, SAN DIEGO, 1988.

[3] A. Mimouni, P. Schuck, S. Bouhallab, *Isothermal batch crystallisation of alpha-lactose: A kinetic model combining mutarotation, nucleation and growth steps*, INTERNATIONAL DAIRY JOURNAL, volume 8, 2009.

[4] V. Becerra, *http://www.psopt.org/Home*.