How Does the Fluid Motion Affect the Crystallization?

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Abstract:
The crystallization is frequently used for purification and crystalline materials processing in areas of pharmacuetical, food, and fine chemical industires. In the crystallization, the fluid motion gives an great influence not only on uniformity of concentration and temeprature but also on the nucleation and growth of crystal in the crystallizer. Particularly, fluid motions of Taylor vortex (TVF) and Batchelor vortex flows (BVF) induce the new phenomena in crystal nucleation, growth and agglomeration, which are not attainable by tranditional random fluid motion. TVF and BVF are periodic pair-wise toroidal circular fluid motions generated in the gap between two boundaries, of which one is rotated and the other is stationary. In polymorphic crystallization of SMZ, TVF induces a strong molecular alignment effect and so directly nucleates the stable form-I. In contrast, the randon turbulent eddy flow (TEF) first nucleates the metastable form-II of SMZ and then tranforms it to the stable form-I, as following Ostwald's Rule of Stage. In the cocrystallization of CAF and MA, similarly, the stable (1:1) cocrystal is directly nucleated in BVF, whereas the metastable (2:1) cocrystal is first generated and then shifted to the stable (1:1) cocrystal in TEF. In addition, the homo-chiral nucleation of $NaClO_3$ is induced in TVF, resulting in 100% chiral symmetry breaking at the induction point. Meanwhile, the chiral-mixture nucleation occurs in TEF, resulting in the no chiral symmetry breaking. The manss transfer in TVF is high, resulting in the fast phase transformation. So, the crystallization of GMP in TVF is 10~20 times higher productive than that in TEF. Also, the toroidal fluid motions of TVF and BVF are highly effective for the crystal agglomeration. So, they produced the spherical agglomerates of $(Ni/Mn/Co)(OH)_2$ with high tap density in the reaction crystallization. In this presentation, the new impact of the periodic fluid motion on the crystallization is addressed.

Keywords: Periodic fluid motion; Taylor vortex; Batchelor flow; Polymorphic crystallization, Agglomeration; Chiral symmetry breaking