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Impact of Mixing Parameters on Homogenization of Borax Solution and Nucleation Rate in Dual Radial Impeller Crystallizer

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Abstract : Interaction between mixing and crystallization is often ignored despite the fact that it affects almost every aspect of the operation including nucleation, growth, and maintenance of the crystal slurry. This is especially pronounced in multiple impeller systems where flow complexity is increased. By choosing proper mixing parameters, what closely depends on the knowledge of the hydrodynamics in a mixing vessel, the process of batch cooling crystallization may considerably be improved. The values that render useful information when making this choice are mixing time and power consumption. The predominant motivation for this work was to investigate the extent to which radial dual impeller configuration influences mixing time, power consumption and consequently the values of metastable zone width and nucleation rate. In this research, crystallization of borax was conducted in a 15 dm3 baffled batch cooling crystallizer with an aspect ratio (H/T) of 1.3. Mixing was performed using two straight blade turbines (4-SBT) mounted on the same shaft that generated radial fluid flow. Experiments were conducted at different values of N/NJS ratio (impeller speed/ minimum impeller speed for complete suspension), D/T ratio (impeller diameter/crystallizer diameter), c/D ratio (lower impeller off-bottom clearance/impeller diameter), and s/D ratio (spacing between impellers/impeller diameter). Mother liquor was saturated at 30°C and was cooled at the rate of 6°C/h. Its concentration was monitored in line by Na-ion selective electrode. From the values of supersaturation that was monitored continuously over process time, it was possible to determine the metastable zone width and subsequently the nucleation rate using the Mersmann’s nucleation criterion. For all applied dual impeller configurations, the mixing time was determined by potentiometric method using a pulse technique, while the power consumption was determined using a torque meter produced by Himmelstein & Co. Results obtained in this investigation show that dual impeller configuration significantly influences the values of mixing time, power consumption as well as the metastable zone width and nucleation rate. A special attention should be addressed to the impeller spacing considering the flow interaction that could be more or less pronounced depending on the spacing value.

Keywords : dual impeller crystallizer, mixing time, power consumption, metastable zone width, nucleation rate
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