Effect of a High Shear Homogenizer on Mixing Time in a Fully Baffled Stirred Tank

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Abstract

Mixing effectiveness in fully baffled stirred tanks and reactors is often improved by introducing a high shear homogenizer in the system. This practice is especially common in the pharmaceutical and related industry since shear sensitive processes such as emulsification and dispersion are typically enhanced by this arrangement. In this work, experiments were conducted to determine the mixing time in stirred tanks equipped a high shear homogenizer and a centrally located primary impeller (i.e., a disk turbine or a pitched-blade turbine). Two experimental techniques were used to determine mixing time, i.e., a colorimetric method coupled with image analysis and a conductivity measurement method. Experiments showed that the mixing time generated by the primary impeller alone was significantly reduced by the use of the high shear homogenizer. The same phenomenon was observed at different primary impeller speeds and homogenizer speeds, and at different total tank volumes. A compartmental model was developed here to predict the mixing time in the systems under investigation. The effects of both devices were taken into account in the model by assuming that their combined pumping effects contribute to reducing the mixing time. The model predictions were compared with the experimental data and good agreement was observed. Finally, numerical simulations were conducted using a computational fluid dynamic (CFD) code (Fluent) to predict the velocity distribution in the tank and how it is affected by the presence of the homogenizer. In addition, these simulations were used to predict the mixing times, which were then compared to the experimental results. The numerical results were also found to be in good agreement was the experiments.