Evaluation of particle shape and size evolution during high-shear wet granulation using twin-screw granulator ☆

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Abstract

In a twin-screw granulator (TSG) the arrangement of transport and kneading element modules causes a mixing which leads to a certain granule shape and size distribution. In pharmaceutical solid dosage manufacturing, many of the physical and chemical properties related to the product quality (such as tablet final finish, strength, solvability and drug content uniformity etc.) depend on this shape and size distribution of this multi-particulate systems. However, there is very less understanding regarding the primary shaping mechanisms behind this distribution in the TSG during wet-granulation due to the opacity of the multi-phase system. The purpose of this study was to experimentally characterise the change in size and shape distribution along the TSG length in order to understand the function of individual screw modules and their interaction in the TSG. The granulation experiments were performed using a continuous twin-screw C1 granulator (25 mm diameter) and samples were taken by opening the barrel after stopping the process running at steady-state. The change in size and morphology of particles was evaluated using digital image processing (DIP) of granule samples hereby characterising different properties such as diameter, perimeters, areas, eccentricity, circularity and other shape related parameters. The study suggests that there is large heterogeneity in granule size and shapes in the samples taken from different locations. The results also demonstrate that most of the granules have an elongated shape (circularity < 0.25), possibly due to the high shear environment and lack of layering mechanism during granule formation in the TSG barrel. Besides, the study also demonstrated that DIP is a fast, convenient, and accurate technique in TSG sample analysis, however, not without limitations such as off-line analysis which need to be addressed further. Such experimental data are important for better understanding of the key mechanisms in the wet-granulation using TSG and are a prerequisite for mechanistic process modelling which can further improve the knowledge and control of the granulation process.

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