Linking granulation performance with residence time and granulation liquid distributions in twin-screw granulation: An experimental investigation - DTU Orbit (08/11/2017) Linking granulation performance with residence time and granulation liquid distributions in twin-screw granulation: An experimental investigation

Twin-screw granulation is a promising wet granulation technique for the continuous manufacturing of pharmaceutical solid dosage forms. A twin screw granulator displays a short residence time. Thus, the solid-liquid mixing must be achieved quickly by appropriate arrangement of transport and kneading elements in the granulator screw allowing the production of granules with a size distribution appropriate for tableting. The distribution of residence time and granulation liquid is governed by the field conditions (such as location and length of mixing zones) in the twin-screw granulator, thus contain interesting information on granulation time, mixing and resulting sub-processes such as wetting, aggregation and breakage. In this study, the impact of process (feed rate, screw speed and liquid-to-solid ratio) and equipment parameters (number of kneading discs and stagger angle) on the residence time (distribution), the granulation liquid-powder mixing and the resulting granule size distributions during twin-screw granulation were investigated. Residence time and axial mixing data was extracted from tracer maps and the solid-liquid mixing was quantified from moisture maps, obtained by monitoring the granules at the granulator outlet using near infra-red chemical imaging (NIR-CI). The granule size distribution was measured using the sieving method. An increasing screw speed dominantly reduced the mean residence time. Interaction of material throughput with the screw speed and with the number of kneading discs led to most variation in the studied responses including residence time and mixing capacity. At a high screw speed, granulation yield improved due to high axial mixing. However, increasing material throughput quickly lowers the yield due to insufficient mixing of liquid and powder. Moreover, increasing liquid-to-solid ratio resulted in more oversized granules, and the fraction of oversized granules further increased at higher throughput. Although an increasing number of kneading discs was found to be critical for achieving a uniform distribution of the granulation liquid, the granulation performance was hampered due to insufficient solid-liquid mixing capacity of the current kneading discs which is essential for wet granulation. Thus, a balance between material throughput and screw speed should be strived for in order to achieve a specific granulation time and solid-liquid mixing for high granulation yield. Additionally, more efforts are needed both in modification of the screw configuration as well as the geometry of the mixing elements to improve the mixing capacity of the twin-screw granulator. The results from the current experimental study improved the understanding regarding the interplay between granulation time and the axial and solid-liquid mixing responsible for the granulation performance in twin-screw wet granulation.

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