Hydrodynamic study of spherical and non-spherical particles in a batch rotary drum

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Rotary drums are common devices used in several industrial activities due to their capacity of providing a good material mixing performance. For instance, in food products processing, the rotary drums are employed in drying, heating, mixing or coating of granular materials. Rotary drums can be operated in order to achieve the rolling regime for the product under consideration. This regime is preferred because it provides better heat transfer conditions ensuring a high product quality. So, correctly understanding the coupled phenomena involving the product in a rotary drum is essential for make use of its maximum potential. As a previous step of a physics-based computational modelling of these phenomena, here we assess the influence of operating conditions and the shape of granular materials on their hydrodynamic behavior in a rotary drum. For this, we choose three particles types, with similar size (few millimeters): quinoa grains, pearl pasta, and crozet pasta. The two first ones are spherical or almost; the two latter ones are expected to exhibit the same physico-chemical properties, and the third exhibits platy shape. It can be noted that both the operating conditions of the pilot unit and the particles shape can influence the hydrodynamic behavior of the particles inside the rotary drum. Usually, the granular systems found in food applications have no spherical shape and to study their flow properties can thus be more complicated than for spherical particles. The experimental protocol involved firstly the observation of the rolling regime inside a rotary drum with diameter of 84 mm, for the three particles types using image analysis, and later on the estimation of the dynamic and static angle of repose, the active layer thickness and the mixing time. The results are allowing us to study the flow behavior of materials with different shapes, contributing to the experimental validation of the rolling regime as seen by a physics-based computational modelling of these same materials using Discrete Element Method (DEM) in a rotary drum. Once validated its hydrodynamic component, our efforts will be focused on the modelling the coupled heat transfer phenomena.