DYNAMICS AND ENERGETICS OF A VERTICALLY STIRRED MILL: A VALIDATED DISCRETE ELEMENT METHOD (DEM) MODEL VIA POSITRON EMISSION PARTICLE TRACKING (PEPT).

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Vertically stirred attritor mills are widely used for comminution in numerous industrial applications ranging from the ceramics, paint, pharmaceutical and mineral industries, to achieve ultrafine grinding both in dry and wet conditions. The comminution energy is transferred by a motor driven impeller to the grinding media to be used for the particle size reduction, but not all the energy is effectively utilised for this process. A high proportion of it is dissipated by the collisions among the grinding media as in heat and noise dissipations. Therefore, the full understanding for both the media motion and the media-media and media-walls interactions are the key features to improve the equipment efficiency and/or the product quality. Additionally, the design and the scale-up are often developed on an empirical basis due to the lack of direct understanding on how the energy is transferred and how the material flows inside the equipment [1]. The current work aims to address these limitations by utilising the Discrete Element Method (DEM LIGGGHTS code, DCS Computing, Linz, Austria), to generate information on the grinding media dynamics inside an attritor mill operating in different conditions (impeller speed, media filling, shaft design, clearance of the impeller) and the basic knowledge to develop a future scale-up methodology. Positron Emission Particle Tracking (PEPT, Birmingham University, UK) measurements [2], have been utilised for DEM model validation by investigating the grinding beads dynamics inside a 1.4lt lab attritor mill. In agreement with other literature work, it was found that the distribution of velocity obtained from the PEPT experiments (tracking for long time a single particle) is not equivalent to the DEM-velocity distribution (based on all the particles). However, the DEM model captured the main features of the grinding media motion such as: torque on the impeller and velocity magnitude. The DEM model well predicted the local grinding media velocity at different radial positions along the attritor mill height. The observation on the grinding media velocity at different radial positions also allowed the identification of distinct area inside the attritor mill controlled by different mechanisms such as: static friction, rolling friction and Coefficient of restitution of the particles.

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