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ATTRITOR MILL- GRINDING MEDIA DYNAMICS

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ABSTRACT

Vertically stirred attritor mills are widely used for comminution in numerous industrial applications ranging from the ceramics, paint, pharmaceutical and mineral industries. These mills can be employed for both dry or wet milling and are often utilized to achieve ultrafine grinding where the particle size is less than 10micron.

The input energy required is transferred by a motor driven impeller to the grinding media to achieve the wanted particle size reduction but not all the power is effectively used in the reduction process. The full understanding for both the media motion and the media ball-media ball, media ball-impeller and media ball-grinding chamber interactions are the key features that need to be analysed in order to improve the performance and/or the product quality.

The design and the scale-up rules are often developed on an empirical base as result of the lack of understanding on how the energy is really transferred from the grinding media to the powder. To overcome some of these limitations a more mechanistic approach can be adopted by using the Discrete Element Method (DEM) to enlighten the exchange of stresses and forces during the milling operation in different conditions.

In this study, the DEM modelling using the LIGGGHTS code (DCS computing, Linz, Austria) has been utilized to provide information on the grinding media dynamics and the state of stress inside an attritor mill. Firstly, a validated comparison between experimental measurements of the grinding media angular velocity and DEM results are presented. The comparison shows a good match between the experimental and the numerical approach, giving additional information such as bed expansion, angular velocity across internal surfaces, that could not be captured by experimental measurements. Then, the impeller design is modified by changing the size of the impeller arms and hence a performance study is conducted analyzing the tangential velocity along the radial distance on surfaces at different heights to characterize the impeller behavior inside the whole attritor volume with the aim to optimize its operation. Finally, by using a novel coarse-graining post-processing tool P4 (Particles Analytics Ltd, Edinburgh, UK) temporal and spatial averaged quantities on velocity field, kinetic pressure, solid fraction and number of contacts were computed to gain an overview of the milling process changing the impeller design.

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