Numerical and experimental investigation of transport and separation of complex shaped particles in an optical belt sorter using a DEM-CFD approach

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ABSTRACT

With globally growing material streams, sensor–based optical sorters are becoming increasingly important for the effective sorting and handling of bulk solids [1]. Optical sorters are employed in a variety of industrial applications such as recycling, handling of mineral products, and the processing of food and pharmaceutical substances. The systems usually comprise a transportation unit, where the particles are introduced and defined movement conditions are imposed on the material stream, a sensor for particle detection and a separation mechanism. For the latter, compressed-air-nozzles are commonly used. Correct and efficient sorter design and calibration is still subject to empirical approaches and is highly dependent on the respective bulk solid.

Discrete Element Method (DEM) simulations can help to optimize both design and operation of optical sorters by calculating particle–particle as well as particle–wall interactions [2]. In this study the DEM is employed to model an existing lab scale optical belt sorter consisting of a vibrating feeder, conveyor belt, line scan camera for particle detection, and compressed-air-nozzles for particle separation. The fluid properties and dimensions of the jets of compressed air are modeled with Computational Fluid Dynamics (CFD) and the results are used to calculate the fluid-particle interaction within the DEM. Complex shaped particles like maize grains and coffee beans are approximated with the help of a multi-sphere method [3]. The quality of both particle and air jet approximation is ensured by comparison with conducted experiments.

The influence of different system parameters like particle shape, mass flow or valve bar positioning on separation quality is investigated both numerically and experimentally. Obtained results are compared and the quality and capabilities of the DEM simulations are discussed. Qualitative information regarding system and particle behavior is derived and possible improvements for optical sorters are provided.

REFERENCES

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