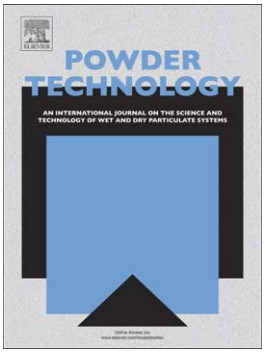

An approach to and validation of maize-seed-assembly modelling based on the discrete element method

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An approach to and validation of maize-seed-assembly modelling based on the discrete element method

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Abstract: To build an analysis model of maize seed particles using the discrete element method, the shape, size, density and moisture content of maize seed particles are measured and analysed. It can be seen that within the same variety of maize seed particles, the shape can be classified into horse-tooth, spherical-cone, spheroid, prism, and irregular shape. The percentage of horse-tooth, spherical-cone, and spheroid particles accounts for approximately 90% of the total. The characteristic size of the horse-tooth, spherical-cone, and spheroid particles approximately obey a normal distribution, and there is a certain functional relationship between the sizes. For the same variety of maize seed assemblies, the horse-tooth, spherical-cone, and spheroid particles are selected to build the analysis model. The upper size of the horse-tooth particle and the thickness of the spheroid particle are chosen as the primary sizes and are randomly generated according to their normal distribution. The other characteristic sizes are calculated via their corresponding functional relationships. An analysis model of individual maize seed particles is built using the multi-sphere (MS) method. Taking three varieties of maize seeds as examples in this paper, the results show that the simulated results are close to those obtained experimentally in terms of - when the horse-tooth, spherical-cone, and spheroid particles are filled with 10 to 14, 18, and 6 sub-spheres, respectively. A preliminary verification is performed of the feasibility and validity of the modelling method of maize seed particle assemblies and individual maize seed particles.

Keywords: Maize seed, DEM, Particle modelling, Multi-sphere, Simulation analysis, Optimization design

1. Introduction

The discrete element method (DEM) initially proposed by Cundall in 1971 can analyse the mechanical behaviour of particulate materials [1] by tracking the movements of individual particles in an assembly [2]. The discrete element m
equation [3-4] and its application extends from the mining industry to food processing and agriculture [5-10].

Maize, as a bulk crop, has a total yield in China which has leapt to the top in agricultural crops [11]. The quality of maize seeds is a key factor affecting its yield. Through the DEM analysis models of maize seeds and related mechanical components, the DEM can be used to analyse the contacts between seeds and between seeds and mechanical components in the processes of harvesting, threshing, separation, coating, packaging, and so on. The structural parameters and working parameters of the related mechanical components can be optimized further, and the processing quality of maize seeds can be improved. Among them, it is essential to build a more precise particle model of maize seed assemblies.

To build the particle model of maize seed assemblies, it is necessary to study the geometrical

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