Discrete Element Modelling of the Sizing of Particles in Zero Gravity

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Abstract

This report focuses on the discrete element method and experimentation of sizing of particles in zero gravity conditions, with the objective of understanding the difficulties which may arise when attempting to predict the behaviour of particles under these conditions. This research will be beneficial in future asteroid mining operations.

This report first demonstrates how spherical particles behave in a zero gravity environment and how efficiently different types of sieve geometries and configurations perform. Plastic and steel pellets as well as iron ore particles were used as the screening material. The extruded sieve concept produced favourable results, with particles approaching at 60° to 90° to the sieving plane reaching efficiencies of 90%.

Probabilities were calculated for the various sieves, with the following results: rectangular (28.6%), oval (22.4%), square (14.1%) and circular (11.1%). A physical experiment was then performed for the purposes of having a comparative practical screening technique. The results of the physical experiment demonstrated similar efficiencies. In order to calibrate and validate the DEM simulation parameters for the various particles, a simulation of the physical experiment was then performed.

Screening in a zero gravity environment was then simulated. The space case sieve results were compared to the theoretical passing probability of particles, demonstrating similar efficiencies for the plastic and steel pellets. The iron ore particles reached efficiencies which were 1.5 times higher than the theoretical results; however, they were still within the range of probabilities for multibody particles.

The report shows that the main characteristics which govern the behaviour of particles during the screening process in a zero gravity environment are the coefficient of restitution, coefficient of static friction and the shape of the particle.

The overall conclusion of this report is that it is possible to predict the behaviour of material in a zero gravity environment with the use of practical experiments, careful parameter calibration and validation, and LIGGGHTS DEM simulations.