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COUPLED CALIBRATION FOR COHESIVE AND FREE-FLOWING GRANULAR MATERIALS USING DEM

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ABSTRACT

Sodium borohydride (NaBH₄) is considered as an alternative fuel for the maritime industry [1]. In contrast to conventional fuels, NaBH₄ is a granular material. To use a simulation-supported design for assessing the feasibility of equipment designs for storing and handling this material, its mechanical characteristics are required. These are then used to calibrate and verify simulations using the Discrete Element Method (DEM). However, as this is a novel application for this material, virtually no bulk characteristics are known yet. Therefore extensive testing has been done to extract required mechanical characteristics, such as cohesion, adhesion, internal friction, wall friction, and the Angle of Repose (AoR). These experiments showed that NaBH₄ is initially free-flowing, but an increase in the moisture content because of an increase in relative humidity leads to an increase in cohesion, effectively reducing the flowability of the bulk material. Furthermore, our experimental results showed plastic deformation of individual NaBH₄ particles.

This work focuses on capturing both the free-flowing and cohesive behaviour of NaBH₄ in DEM. To this end, the two-step calibration approach introduced by Grima [2] is adopted and adjusted. First, the free-flowing behaviour is calibrated using a non-cohesive contact model, Hertz-Mindlin (HM). Second, the cohesive material is calibrated using the appropriate cohesive parameters of the Edinburgh Elasto-Plastic Adhesion contact model (EEPA), while the (calibrated) non-cohesive parameters are kept constant. The novelty of this work is the use of EEPA for the second calibration step, which allows the modelling of both the cohesive behaviour and the plastic deformation of the individual particles in the bulk material.

References

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