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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

[1] M.C. van Benten, J.T. Padding, and D.L. Schott. “Towards Hydrogen-Fuelled Marine Vessels using Solid Hydrogen Carriers”. In: The 14th International Conference on Bulk Materials Storage, Handling and Transportation. Wollongong, Australia, July 2023.
[2] A. Grima. “Quantifying and modelling mechanisms of flow in cohesionless and cohesive granular materials”. In: University of Wollongong Thesis Collection 1954- 2016 (Jan. 2011).