Materials Science & Engineering Thesis Defense

Predicting the Flow Function of Bulk Solids Based on Particle Size and Moisture Content

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Abstract

The way a granular material is transported and handled plays a huge part in the quality of final product and the overall efficiency of the manufacturing process. Currently, there is a gap in the understanding of the basic relationship between the fundamental variables of granular materials such as moisture content, particle shape and size. This can lead to flowability issues like arching and ratholing, which can lead to unexpected downtimes in the whole manufacturing process and considerable wastage of time, energy, and resources. This study specifically focusses on the development of a model based on the surface mean diameter and the moisture content to predict the flow metric 'flow function coefficient' (FFC) to describe the nature of flow of the material. The investigation involved three parts. The first entailed the characterization of the test materials with respect to their physical properties – density, size, and shape distributions. In the second, flowability tests were conducted with the help of the FT4 Powder Rheometer. Shear cell tests were utilized to calculate each test specimen's flow function parameters. Finally, the physical properties were correlated with the results from the flowability tests to develop a reliable model to predict the nature of flow of the test specimens. The model displayed an average error of -6.5%. Predicted values showed great correlation with values obtained from further shear cell tests on the FT4 Rheometer. Additionally, particle shape factors and other flowability descriptors like Carr's Index and Hausner Ratio were also evaluated for the sample materials being investigated. All size ranges displayed a decreasing trend in the values of Carr Index, Hausner Ratio, and FFC with increasing moisture percentages except the 5-11 micron glass beads, which showed an increasing trend in FFC. The results from this investigation could be helpful in designing equipment for powder handling and avoid potential flowability issues.

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