Hopper Flow and Particle Characterization

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Abstract

The design of this project is to understand the effects that particle properties, such as size and surface roughness, have on their discharge rate through a hopper. Discharge tests, using glass beads of sizes 0.6mm, 2mm and 4mm, were performed using small scale glass and 3D printed hoppers. The surface of the particles were characterized by AFM, which found the surface roughness.

Goal of Research

The goal of this project is to answer the question, "what effect does the size and surface characteristic of a particle have on it's ability to flow though a hopper".

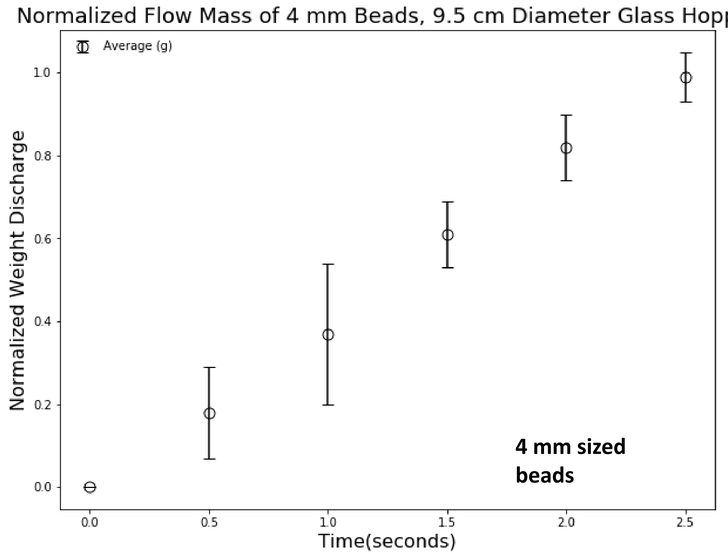
Background

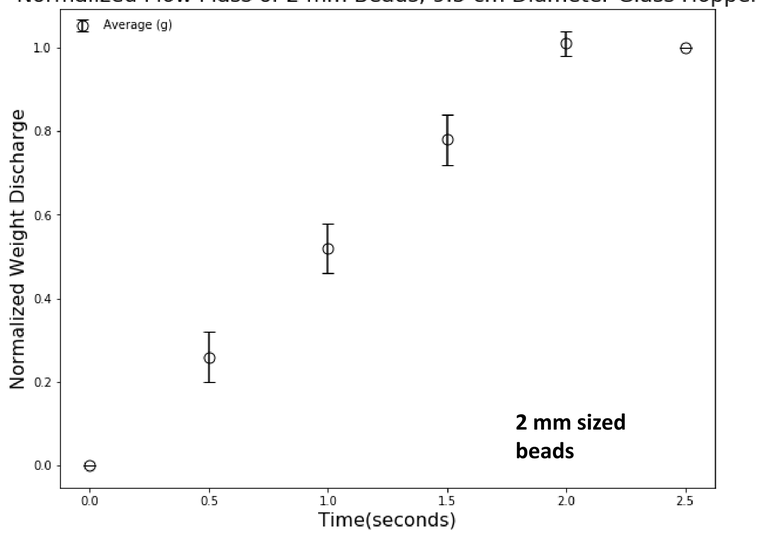
Hoppers are used in a variety of industries for the storage and handling of particles. Surface roughness and particle size are important factors in determining a particles discharge characteristics through a hopper system. The roughness of a particle is commonly determined with a technique called Atomic Force Microscopy (AFM). Using different sizes of glass beads allows a range of data to be obtained, which can be used to gain an idea of the behavior of particles that were not studied.

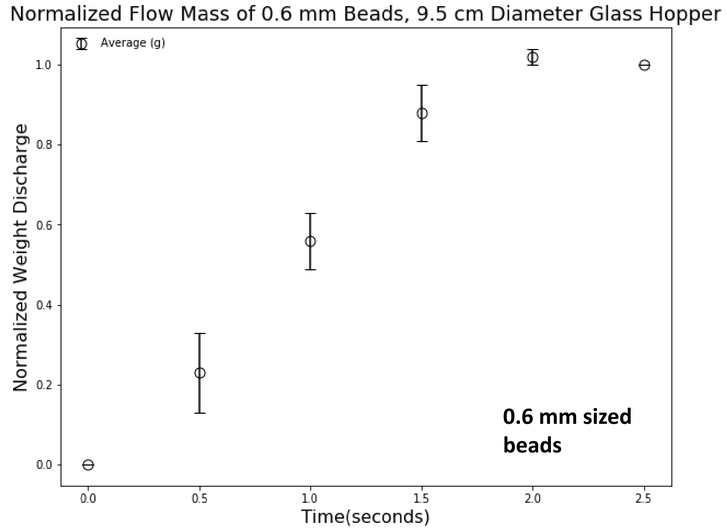
Material and Methods

The particles used in this experiment are glass silica beads of the size of 0.6 mm, 2mm and 4mm. Three different sized hoppers were used, two that are 3D printed and one that is made out of glass.

Results and Conclusion







The graphs are examples of the preliminary results of the data gathered. They are the normalized weight of the particles as a function of time. These plots will be used in this project as a basis of comparison when parameter such as the particle roughness and hopper roughness are changed.

Obstacles and Solutions

The first problem that was encountered was that as the particles flowed out of the hopper they would gain a charge and adhere to the walls of the hopper. This was solved by grounding the hopper.[1] The next challenge was creating a slide plate that allows the hopper to be filled with out having to hold the slide plate by hand. This was done by using rubber bands to fasten the slide plat in place.

Future Research

Future avenues of research include varying the particles and hoppers surface roughness through etching with sodium hydroxide and performing flow test with multiple sizes of particles. The current research aims on setting the foundation for this future research by gathering information on the unadulterated glass beads and hoppers. This data will be used as a standard to compare the treated glass beads and hopper.

Works Cited

(1) *Guidelines for the CONTROL OF STATIC ELECTRICITY IN INDUSTRY ARCHIVE*; Wellington.
(2) Ketterhagen, W. R.; Curtis, J. S.; Wassgren, C. R.; Kong, A.; Narayan, P. J.; Hancock, B. C. Granular Segregation in Discharging Cylindrical Hoppers: A Discrete Element and Experimental Study. *Chem. Eng. Sci.* **2007**, *62*, 6423–6439. https://doi.org/10.1016/j.ces.2007.07.052.

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