Bringing Particle Scale Properties into Descriptions of Industrial Powder Behavior via the Enhanced Centrifuge Method

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Impact

Powder adhesion plays a significant role in many industries. The force of adhesion between particles is dependent on the topography, shape, mechanical properties, and composition of the individual particles. Better design of powder processes and processing equipment will be enabled by a better understanding of particulate adhesion.

Addressing the Challenge: Powder Adhesion

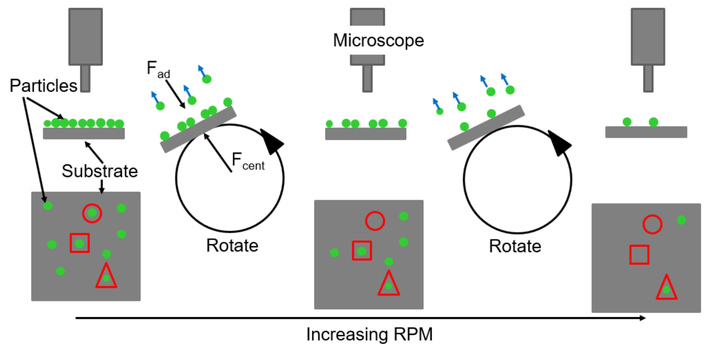
The Challenge: Computational models and simulations that describe powder behavior lack in their ability to describe the adhesion across large numbers of unique particles.

The Desired Solution: A rapid, inexpensive, easily reproduced method to quantify particulate adhesion.

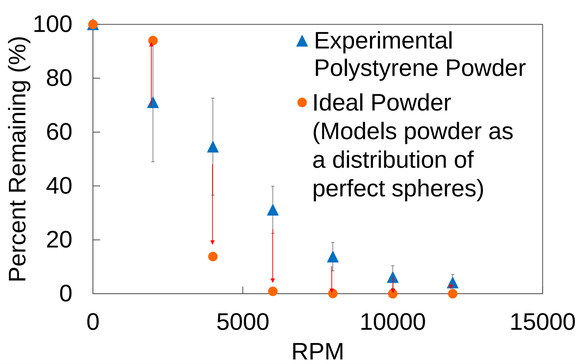
Prior State of the Art: The centrifuge method has been applied in classical adhesion studies to describe powder adhesion. It determines an average adhesion force for powders. The Enhanced Centrifuge Method attempts to quantify the effects of the individual particle properties in a more comprehensive way than this classic approach.

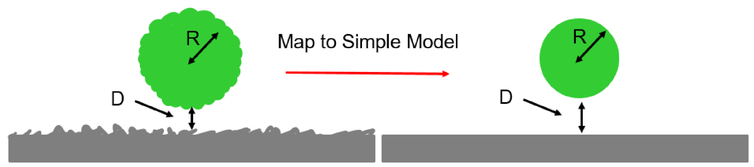
Impact: With reliable estimates of the relative adhesion forces of all particles within a powder, industrial partners can optimize: 1) equipment and process design, and 2) powder composition and morphology to minimize uncontrolled adhesion.

Centrifuge Method



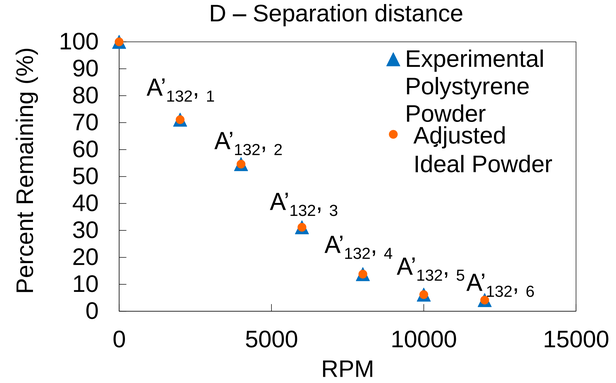
Enhanced Centrifuge Method

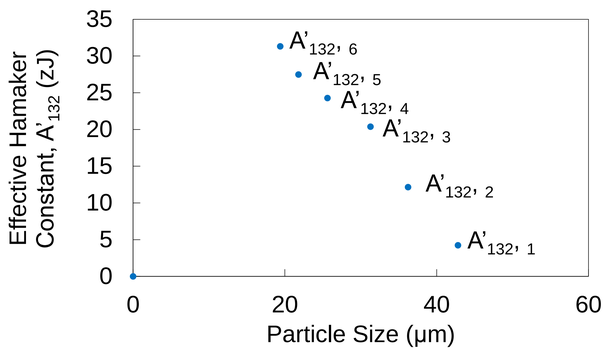




$$F_{vdw} = \frac{A'_{132}\,R}{6\,D^2}$$

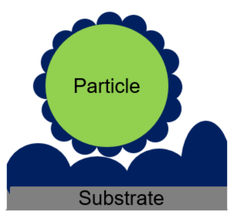
A'_{132} – Effective Hamaker constant
R – Radius of particle
D – Separation distance





Current Work

Decouple particle effects from opposing surface effects:



$$A'_{132} = A_{True} \times \alpha$$

A_{True} – True Hamaker constant
α – Correction factor

$$\alpha = f(particle\ topography, shape, and\ size;\ substrate\ topography)$$

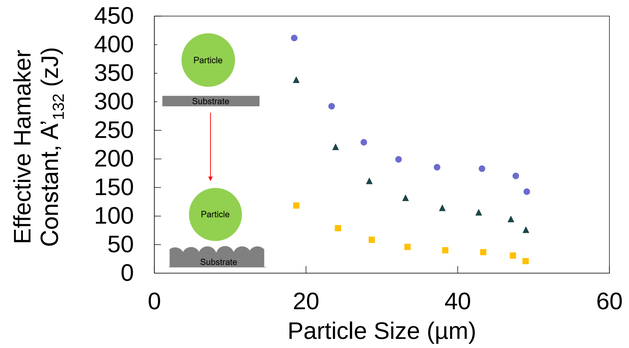
Limit 1

$$\alpha = f(particle\ properties)$$

Limit 2

$$\alpha = f(surface\ properties)$$

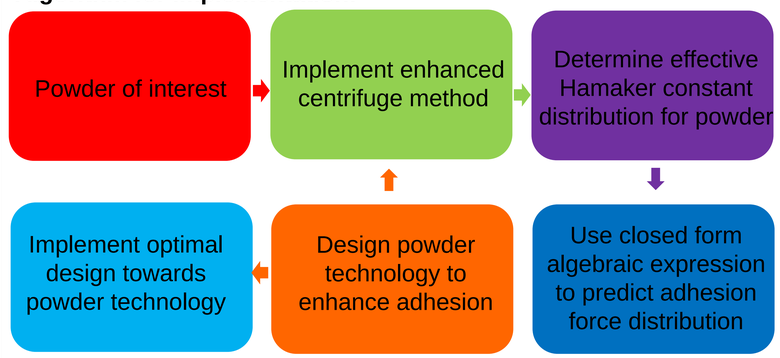
Simulation study via Particle Adhesion Simulator:



Conclusion and Future Work

Preliminary results suggest effective Hamaker constant distributions can be used to describe adhesion in systems of thousands of particles.

Algorithm for implementation:



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