Size Segregation of Particulate Mixtures with Lognormal Size Distributions

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Size segregation is often observed in industrial granular flows, and can be either beneficial or detrimental depending on the desired properties of the granular product. Hence, considerable interest exists in understanding the segregation phenomenon. Most theoretical and experimental investigations of size segregation have focused on the behavior of binary systems (i.e., flows with two particle sizes). Nonetheless, many industrial flows have particle size distributions that more closely resemble continuous distributions (e.g., Gaussian or lognormal distributions). Therefore, an understanding of size segregation in granular flows with continuous size distributions is desirable. The current study represents a continuation of a previously reported study, which focused on size segregation in particulate mixtures with Gaussian particle size distributions. In the current study, the size segregation of particles with lognormal particle size distributions was investigated. Time-stepped, discrete-particle ("molecular-dynamics") simulations were employed to elucidate information about the steady-state spatial distribution of the particles when a non-uniform granular temperature gradient was applied to the simulated domain. A wide parameter space was investigated, including a range of distribution widths, coefficients of restitution and solids concentrations. The results demonstrate that while particles of all sizes concentrate in regions of low granular temperature, large particles have a more pronounced affinity for low temperature regions. Thus, the mean diameter of the local size distribution increases as the granular temperature decreases. Additionally, the local size distribution appears to maintain a lognormal shape throughout the simulation domain. These observations suggest that a moment-method representation of the particle size distribution may aid in the development of a granular kinetic theory for continuous size distributions. Additionally, clear similarities between the behaviors of comparable Gaussian and lognormal systems suggest that a kinetic theory developed solely for lognormal particle size distributions could adequately capture the behaviors of Gaussian mixtures as well.