

Simulation of Vibration-Induced Segregation of Equal-Sized Bronze and Glass Spheres

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The influence of the surrounding air on the dynamics of fine granular material is becoming an increasingly topical area of research interest. While for large granular particles (diameter > 1 mm) the effect of the gas phase can usually be ignored, for smaller particles the ambient air can have a pronounced influence. One of the most striking examples of the effect of air was demonstrated in the experiments by Burtally et al. A bed of fine (110 micron) equal-sized bronze and glass spheres was found to segregate under vertical vibrations at atmospheric pressure. No significant segregation was observed under vacuum conditions.

We report on extensive simulations of this system, using a hybrid model, where a molecular dynamics type method is used to account for the motion of the spheres (30 000 in total), and a computational fluid dynamics model is used to account for the flow of air in the system. There is a full two-way coupling between the solid and the gas phase. In general, we observe the same phenomena as in the experiments. Furthermore we find that the particle interaction parameters, such as the level of dissipation and surface friction in particle-particle collisions, have a clear influence on the segregation phenomena. In particular, for some shaking parameters (frequency and amplitude) we found that without friction, the bronze phase would move to the bottom, whereas with friction present a sandwich formation is formed with a bronze phase layer in the middle.

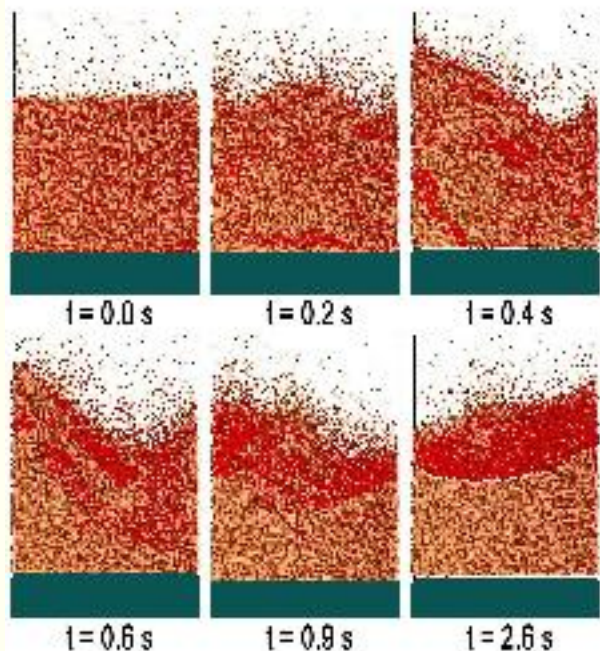


Figure 1: System with bronze moving to the top. Initial situation consists of a mixture of bronze (red) and glass (orange) particles. Sinusoidal vibration at 55 Hz, amplitude 0.9 mm.

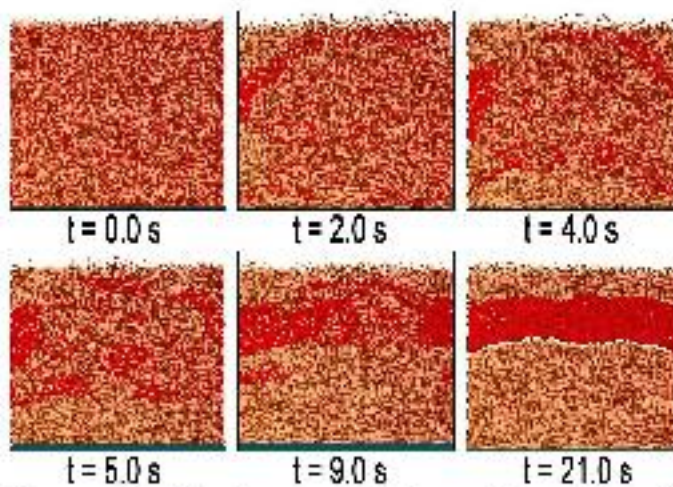


Figure 2: System with formation of a glass-bronze-glass sandwich. Sinusoidal vibration at 130 Hz, amplitude 0.147 mm.

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