Contribution ID: **13** Type: **Poster Presentation**

Complete Grain Segregation Under Submerged Conditions in a Rotating Drum

Wednesday, 21 May 2025 10:05 (1h 30m)

Density-driven segregations in rotating drums, well-studied under dry conditions, reveal diverse symmetrical patterns due to variations in heavy and light grain densities (rho;_h, rho;_l,) and rotating speeds (omega;). Experimentally, we observe a complete segregation state in submerged systems, absent under dry conditions for the same rho;_h, rho;_l and omega;. Simulations validated by experiments, using coupled computational fluid dynamics and discrete element methods, show that the mixing index can be accurately predicted across a wide range of effective density ratios, *D*=(rho;_h-rho;_f)/(rho;_l-rho;_f) is the fluid density. As *D* increases, systems transition from well-mixed to fully segregated states, accompanied by an increasing number of vortices and more pronounced asymmetry. At higher Reynolds numbers (*Re*), the vortex area for heavy grains shrinks at lower *D*, while for light grains, it saturates; at higher *D*, an additional vortex appears in the light particle zone, expanding continuously. These findings provide new insights into segregation transitions in submerged granular systems and have implications for science and engineering applications.

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References

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Session Classification: Poster

Track Classification: (MS06-A) Physics of multiphase flow in diverse porous media