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## Pressure drop and non-intrusive velocity measurements in packed beds

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Flows in packed beds are encountered in many engineering applications, such as solar thermal energy storages, chemical catalytic reactors, petroleum and civil engineering, magnetic refrigerators, biological tissues, and pebble-bed nuclear reactors.

Critical challenge of designing packed beds involves understanding the total pressure loss, complex flow fields, heat and mass transfer phenomena occurring within the interstitial regions. Unfortunately, complex geometries and randomly connected void spaces within packed beds have hindered efforts to characterize the underlying transport phenomena.

Geometrical complexity inside of a randomly packed bed represents a challenge to experimental and computational efforts in order to construct transport models that have been previously built upon volume averages of micro-scale parameters, however, should accurately capture the flow behaviors.

Fully leveraging the advantages of this type of packed beds requires a fundamental understanding of flow topology within the randomly packed sphere beds. Multiple points or full-field measurements of flow characteristics at a high level of spatial and temporal resolutions are needed to fully map the complex flow patterns and to provide data at high spatial density to permit accurate volume averaging in the pebble bed.

Texas A&M University is conducting isothermal measurements of pressure drops, flow measurements in a randomly packed spheres experimental facility to support the research on advanced nuclear reactors sponsored by Department of Energy (DOE). The main purpose of these tests is to perform high spatial and temporal resolution measurements, and use the obtained results for code validation and model development.

In this poster, we present our experimental results from pressure drop and non-intrusive velocity measurements in different facilities of randomly packed spheres at various porosities and Reynolds numbers.

Pressure drops across the axial length of a versatile facility were measured by high accuracy pressure transducers at various modified Reynolds numbers, and friction factors were accordingly computed. The obtained experimental results were compared and in a good agreement with previous studies available in literature.

High-fidelity velocity measurements at the pore scales and near the wall boundary in a facility of packed spheres were performed by featuring a combined approach of matching-refractive-index (MRI) and laser-diagnostics, such as Time-resolved Particle Image Velocimetry (TR-PIV) and Time-resolved Stereoscopic PIV (TR-SPIV). This approach allows us to non-invasively probe the flow within packed spheres at the microscopic scales with high temporal and spatial resolutions. Statistical results including mean velocity, root-mean-square velocity and Reynolds stress, computed from the TR-PIV and TR-SPIV measurements are illustrated. Effects of wall enclosures and Reynolds numbers to the flow patterns are investigated. Finally, we applied Proper Orthogonal Decomposition analysis to extract coherent flow structures in the near-wall and far-wall regions of the packed beds.

## References

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