Cleaning of simple cohesive soil layers in a radial flow cell and slit flow cleaning cell

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Periodic cleaning is essential for preventing cross-contamination and restoring operational efficiency in food and beverage manufacturing. Optimising a Cleaning-in-Place system requires a good understanding of the cleaning fluid behaviour in a particular flow configuration and reliable knowledge of how the soil is removed. Computational fluid dynamics (CFD) can provide high-quality information about industrially relevant flows which arise in complex geometries that would be inaccessible through experimentation alone. Current efforts are directed at identifying and quantifying the combinations of parameters that determine cleaning via studies using model soils.

This work compares experimental cleaning studies conducted using two simple geometries, namely a radial flow cell (RFC) and a slit flow cleaning cell (SFCC) featuring flow along a rectangular channel with a 10:1 aspect ratio Both geometries can be reliably simulated using CFD and results compared favourably with published studies. The rigs were fabricated from polymethyl methacrylate (PMMA), allowing optical access for visual monitoring and quantification of soil removal. Despite its simple geometry, flow in an RFC is characterised by several recirculation zones at larger Reynolds numbers with larger gaps: these are absent in an SFCC, while the latter allows soil removal to be studied under turbulent conditions. These cells were used to study the kinetics of removal of two different, thin (up to 250 ?m), dried soil layers of (a) instant coffee (governed by diffusive mass transfer) and (b) an abrasive domestic cleaning product (governed by the dissolution of the matrix and particulate removal).

The local soil removal rates and cleaning behaviour were quantified. The presence and size of particles influenced the removal kinetics, as did the surface roughness, chemistry, and flow structures. High-fidelity 2D axisymmetric (RFC) and asymmetric (SFCC) coupled CFD-species transport models were developed using ANSYS Fluent™. When compared with the experimental data, results from the CFD were found to give reasonably good estimates of the local mass transfer rates.