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Filtration by porous media: the role of flow disorder

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Considerable ongoing efforts aimed at understanding transport and deposition behavior (filtration) of colloids and microbial particles in porous media, have been carried forward. The reason lies on the common intent to prevent waterborne disease and enhance bio-remediation, riverbank filtration and protection of drinking water. Complex behaviors has been observed in many colloid transport experiment in porous media: long tailing phenomena and spatial distribution of deposited particles are two crucial aspects affecting the macroscopic transport, mixing and mixing mediated processes that are not captured by classical approach, named classical filtration theory (CFT). Cardinal point of CFT is the estimation of the attachment rate, η, assumed constant and empirically estimated by an a posteriori data fitting. Stochastic approaches are also invoked to recover consistency with experimental data, but often without a direct link with the pore-scale processes, where filtration takes place. Our work focuses on geometries well defined by specific pore-grains size distribution, to investigate the role of the pore-scale flow heterogeneity in filtration process. At micro-scale level, both simulations of 2D particle tracking and microfluidics experiment allow us to measure local properties of transport and filtration (attachment/detachment). To provide an upscaled view of the macroscopic filtration process we develop a Continuous Time Random Walk (CTRW) numerical method based on the parameters directly measured via pore scale numerical simulations and microfluidics experiments.