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Pore-scale hydrodynamics influence the spatial evolution of preferential flow paths in porous media bioclogging system

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Biofilm is a universal form of microbial existence, which is formed by microbial cells and their extracellular polymers bonded to each other. It's ubiquitous in rivers, human organs and drinking water distribution systems, where microorganisms attach to the surface of particles and cause bioclogging, which often results in negative impacts. In this paper, we developed a visualization experimental system, to realize the real-time dynamic and multi-scale observation of microbial growth under different pore structure, flow rate and nutrient concentration conditions. Visualization experimental results show that microbial growth was spatially obviously non-homogeneous due to the randomness of microbial attachment sites and preferential seepage of nutrients. In the early stage of the experiment, microorganisms mainly existed in the form of suspended cells, clusters and streams, and with the growth of microorganisms, clusters gradually coalesced to form individual biofilm clusters connecting the inlet to the outlet. In the late stage of the experiment, the biofilm formed a relatively fixed structure, and the nutrient solution mainly flowed along the preferential flow paths. Under constant flow conditions, the microbial growth led to the narrowing of the preferential flow paths, and the shear stress of the fluid would cause the preferential flow paths to become wider, the competition between microbial growth and fluid shear leads to the intermittent opening and closing of the preferential flow paths.

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