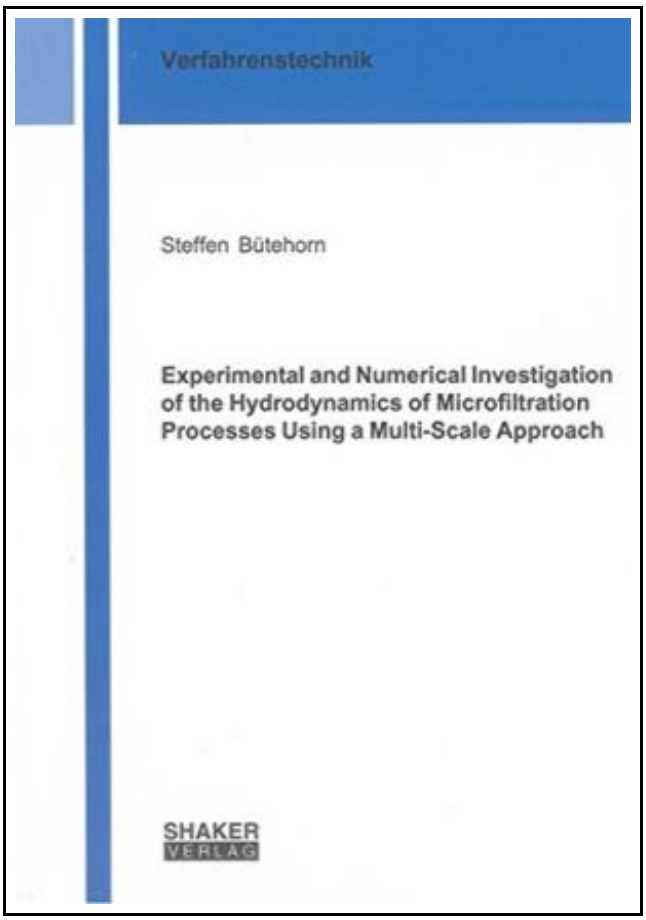
Experimental and Numerical Investigation of the Hydrodynamics of Microfiltration Processes Using a Multi-Scale Approach



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(Joana Ziemann)

EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THE HYDRODYNAMICS OF MICROFILTRATION PROCESSES USING A MULTI-SCALE APPROACH

Shaker Verlag Mai 2011, 2011. Buch. Book Condition: Neu. Neuware - Submerged membrane bioreactor (MBR) processes for treating municipal or industrial wastewater are one of the most promising applications of microfiltration membranes. Previous studies were spread over various fields of research including water science, microbiology, chemical engineering, material science and process control. All of the above research societies contributed comprehensively to a further improvement of the technology. Nevertheless, it is known that higher operational expenses compared to conventional water treatment strategies weaken the competitiveness of MBRs. More precisely, recent energy efficiency analyses identified the coarse bubble aeration of the membrane unit to consume the biggest proportion of the overall energy input. Therefore, hydrodynamic conditions in submerged microfiltration processes were investigated experimentally and numerically on three different scales in the framework of this study. The overall objective was to evaluate the impact of operating parameters, feed characteristics and module design features on the efficiency of air bubbling to control cake layer formation. On a micro-scale, local phenomena such as permeate flow, particle deposition and cake removal were non-invasively visualised with nuclear magnetic resonance (NMR) imaging. Complementary filtration experiments were conducted by applying a number of test facilities equipped with single hollow-fibres (meso-scale) or single hollow-fibre bundles (macro-scale) in different modes of operation. The bubble-induced fibre movement as a key parameter affecting the overall process performance was tracked with a direct observation (DO) technique (meso-scale). A macroscopic computational fluid dynamics (CFD) approach based on X-ray computer tomography (CT) scans and calibrated with numerical pressure loss correlations was established. The investigations have shown the impact of lumen-side pressure losses on the distribution of local permeate flux. Cake formation appeared to be heterogeneous, with thicker cakes close to the point of permeate extraction. The cake growth was in good agreement with the fouling rate...

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