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S1.4.2 - *Experimental Investigation and Numerical Simulation of Flow-induced Deformations of Filter Media*

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Fluid flowing through filter materials causes deformations which can lead to well-known (and undesired) effects like pleat collapse, pleat crowding, etc. Therefore, simulation models assuming “rigid” filter media are not capable of predicting such phenomena. Modeling and simulation of the interaction between fluid flow and solid structures (FSI) have been subject to extensive research for decades. A direct transfer of these methods to the case of porous materials is not suitable, because the fluid flow enters the material and therefore, the transmission of forces is not limited to the media surface (alone). Compared to FSI, Fluid-Porous-Structure Interaction (FPSI) is a quite new and challenging area of research (see e.g. [1] - [4]). The talk presents the joint research conducted at Technische Universität Kaiserslautern and Fraunhofer ITWM to increase the understanding and improve simulation methods for the deformation of filter media caused by stationary liquid flow (e.g. fuel and oil filters). As a starting point, flow resistivity and structural mechanical properties (tensile, compression and bending tests) were measured in a dry condition for a range of filter media. In order to clarify, to which extent these material data can be applied under flow conditions, a specialized test bench is developed which allows for recording flow rate, differential pressure, and the deformation of the filter medium by optical measurements. The testing fluid in this experimental case is water. The experimental findings are used both to identify the material models for the media and to validate the simulations. Here, Computational Fluid Dynamics (CFD) is coupled with structural mechanics simulations. The coupling from CFD to structural mechanics uses the fact that the gradient of the fluid pressure is a volumetric force density acting on the interior of the filter material. The corresponding deformation is used to update the shape of the filter material and the flow is recomputed. This procedure is repeated until a steady-state for the media shape is reached. If the simulations of flow and structural mechanics use a common grid, the displacement field provides the update of the media shape. However, if the two simulation codes operate on different grids, suitable methods to transfer the required data (pressure gradient, shape) back and forth are required. The results of this work are presented and discussed as well as the ongoing and future developments.

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Vanessa Puderbach is a scientific assistant and Ph.D. student at the Institute of Particle Process Engineering, Technische Universitität Kaiserslautern. Her research field is the solid-liquid separation of particles from fluid using a filter medium. She is experimentally investigating the deformation of the filter medium for the optimization of numerical filtration models.

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