

Recent CFD developments for filter element simulations

Oleg Iliev(*), Zahra Lakdawala, Heiko Andrae, Matthias Kabel
Fraunhofer Institut für Techno- und Wirtschaftsmathematik,
Fraunhofer-Platz 1, 67663 Kaiserslautern, Germany.

Michael Dederling,
IBS Filtran, Industriestrasse 19
D-51597 Morsbach-Lichtenberg, Germany.

Vadimas Starikovicius,
Vilnius Gediminas Technical University, Sauletekio av. 11
10223 Vilnius, Lithuania

Abstract:

Nowadays Computational Fluid Dynamics (CFD) simulations are often used in studying various filtration processes and in the design of filter elements. Algorithms and software for CFD simulations of filtration processes earlier were presented by Fraunhofer ITWM, see, e.g., [1,2]. Some algorithmic aspects of our software tool, SuFiS®, are discussed in [3]. The current talk discusses three advanced recent developments. The first one is the subgrid resolution approach, the second one is computer simulation of the efficiency test, and the third one is the interaction of .fluid with deformable filtration media.

The subgrid resolution is a challenging approach, which belongs to the class of variational multiscale methods. More precisely, if some details of the filtration medium or of the filter element geometry are too fine to be resolved by the computational grid, they can be effectively accounted for by solving auxiliary problem on the proper grid cells, and modifying the coefficients of the Navier-Stokes-Brinkman equation there. In this approach, additional care is taken so that the upscaled coefficients for the Navier-Stokes-Brinkman approximate the pressure drop of the unresolved fine scale geometrical details accurately enough.

A challenge in studying filtration processes is the CFD simulation of efficiency tests. We combine parameter identification from measurements carried out on a simplified filter element, with CFD simulation, in order to predict filter efficiency for newly designed filter elements. The parameter identification is based on solving auxiliary problems for one dimensional filtration process. The developed software tool is not only used to evaluate the efficiency of the manufactured filters, but also assists tremendously the engineers in designing new filter elements and selecting the proper filtering medium.

It is known that the filtering medium may be subject to large deformations due to the fluid pressure. To account for such deformations, as well as for the back influence of the changed filter medium geometry on the flow within a filter element, Fraunhofer ITWM is developing software for poroelastic plates and shells, and for their interaction with the fluid to be filtrated.

Recent results on simulation of filtration processes exploiting the subgrid approach, as well as results from computer simulations of efficiency tests will be presented.

[1] O.Iliev, V.Laptev, D.Vasileva, Algorithms and software for flow through oil filters. Filtech Europa, Volume I, pp. I-327 - I-334, October 2003.

[2] M. Dederling, W. Stausberg, O. Iliev, Z. Lakdawala, R. Ciegis, V. Starikovicius, On new Challenges for CFD Simulation in Filtration, Proceedings of World Filtration Congress, Leipzig, 2008.

[3] R.Ciegis, O.Iliev, and Z. Lakdawala, On Parallel Numerical Algorithms for Simulating Industrial Filtration Problems, J. Comp. Meth. Appl. Math, Vol. 7 (2007) No.2

Keywords: Solid-Liquid Separation, Computer Simulation, Subgrid resolution, Efficiency test, Mutipass test, TFEM.

Corresponding Author:

Oleg Iliev.
Fraunhofer Institut für Techno- und Wirtschaftsmathematik,
Fraunhofer-Platz 1,
67663 Kaiserslautern, Germany.

Tel: +49 631 31600 4229

Fax: +49 631 31600 1099

Mail: iliev@itwm.fhg.de

Title: Recent CFD developments for filter element simulations

Desired form of presentation: oral

If accepted, the paper will be presented by the author or one of the co-authors.



Oleg Iliev