

Mathematical modelling and Numerical Simulation of Industrial Filter Elements

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Abstract:

The talk summarizes the challenges and recent developments in the area of flow simulation within filter elements and simulation of efficiency tests. New trends such as the local refinement, efficiency test simulation, CFD support for designing filter elements with multiple porous media are discussed. The simulation of filter elements involves huge challenges due to the complex shape of the filter housing and filtering medium, and the resulting impact on the flow field, pressure and deposition of particles. Some aspects of modelling, parameter identification, numeric and results will be touched upon.

The flow, described by Navier-Stokes-Brinkmann system of equations, is coupled with the movement and deposition of particle concentrations which is described by a convection driven transport equation. To address the challenge of simulating filter efficiency tests, we combine parameter identification from measurements carried out on a simplified filter, with CFD simulation, in order to predict filter efficiency for newly designed filter elements. Analytical 1D solutions for filtration regimes with and without clogging, and with and without particle washing, are used to determine filtration parameters from simple measurements on flat filtration media. These parameters are used in creating lookup tables linking local deposition rate and other parameters to the flow velocity, particle particles concentration in the free fluid and the amount of deposited particles. However, the design of such elements is still a real challenge, and we show how CFD simulations efficiently assist such designs.

Local refinement is a challenging approach and allows accounting for finer details in the housing and shape of the filter media using locally refined grids. New results with the recently developed algorithms are presented.

The developed software tools can not only be used to evaluate the performance of the manufactured filter elements, but also assists tremendously the engineers in designing new filter elements and in selecting the optimal filtering medium.