SIMULATION OF FILTER ELEMENTS – PARTICLE CHALLENGE FOR MULTIPLE SCALE POROUS MEDIA

Martin J. Lehmann*, Elisabeth Nißler
MANN+HUMMEL GmbH, Hindenburgstr. 45, D 71638 Ludwigsburg, Germany
martin.lehmann@mann-hummel.com

ABSTRACT

Filter Elements are commonly used for cleaning up fluids from particles. They are often a key enabling technology for lower emissions. For example a high efficient fuel filter is required in order to keep the injection system running and an advanced air filter with low pressure drop increase supports optimal combustion. Other filters not only collect particles but also adsorb odor, such as an enhanced cabin air filter. The performance of all theses filters is described by pressure drop, collection efficiency, dust and gas holding capacity.

Filter Elements are often modeled as porous media. Thereby the description of the porous media depends on the scale. On a macroscopic scale the filter is just a porous block causing pressure drop and removing particles in a complex filter system. However, on a mesoscopic scale the filter element consists of pleated media. The shape of the pleats effects pressure drop and particle collection. Thus simulations at the mesoscopic scale just model the media as porous layer and resolve its shape. The knowledge for modeling pressure drop increase and particle collection of the filter media is derived from microscopic porous media model, consisting of solid fibers and a porous dust cake build-up. Last not least some kind of inhomogeneity due to production process has to be taken into account at all scales.

We are going to briefly illustrate the cascade of porous media models in order to simulate filter elements. Then we are going to point out the current challenges of modeling the filtration process. Finally we will present some examples of successful simulations of filter elements at macroscopic, mesoscopic and macroscopic scale.