

Simulation and the Future of Filter Design

(Part 1)

The vision of many filter media makers and filter manufacturers is to remain competitive by fulfilling their client's requirements of low pressure drop, high filter efficiency, and long filter lifetime, while incorporating innovative filter materials quickly and at low cost. Nothing would be better than to hone in on a few promising designs and restrict costly lab tests to these few designs.

A sophisticated step towards this goal is to use computer simulations. Filtration processes can be simulated on digital three-dimensional models of filter media, single pleats, or complete filter elements in a variety of conditions. The origin of these models can be digital images of scanned existing materials, CAD models, or digital materials modelled in the computer to fit specifications given by the designer. No matter what the source of the model is, filtration simulations can be run on models of nonwoven fabrics (including nanofiber webs), fabricated metals such as woven wire cloth and sintered wire meshes, woven fabrics, ceramics, open cell foams, cellulose media, micro-membranes, porous plastics, wet-laid fibers, etc., etc. The potential for variations of media constructions through generation and combination of models in simulations is unprecedented.

Many filtration simulations can run concurrently to test different material designs under the same conditions. Or a single digital material prototype can be subjected to a diversity of conditions: sand particles in oil at high temperatures, oil at sub-freezing temperatures, a particular kind of particles or a specific particle distribution, a certain flowing fluid (air, oil, water, fuel, blood...), etc. The possibilities of digital testing are virtually boundless.

New and improved products, shorter R&D times, and all-around lower costs are benefits that make the inclusion of simulation in current workflows a worthwhile new technological strategy to boost the competitive edge of manufacturers in the filtration sector.

Experiment vs. Simulation

ISO 4548-12 multipass test for oil filters

—•— Simulation result
- - - Experimental mean curve
/// Experimental result range

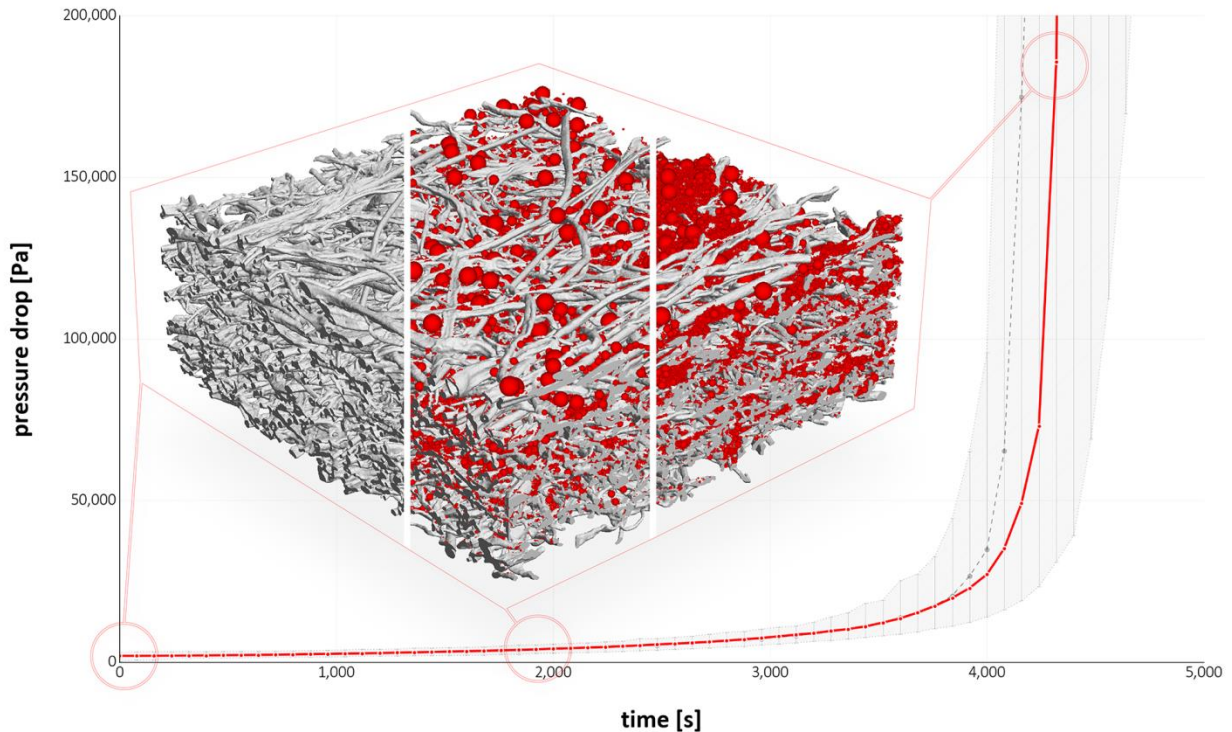


Figure: Validation of digital testing by comparing experimental results and simulation results for the ISO 4548-12 multipass test in an oil filter. The 3D structure model used in the simulation was obtained from scanned 3D images of filter media from the oil filter that was experimentally tested. The structure is shown divided into three sections: the left corresponds to the clean filter, while the middle and the right show the progression of the particle filtration process.

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