

Case Study: Air Filter Media



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Our Mission

In industry and everyday life, filters serve a variety of purposes. For each of those applications, a specialized solution is needed to fulfill raising demands on filter efficiency, capacity and life time. **GeoDict** supports filter development through modelling and simulation. Use **GeoDict** to:

Understand the behaviour of your filter media from square one by looking at the details of filter media and particle deposition.

Design novel filter media by varying e.g. thickness, fiber types, layering.

Predict the particle filtration properties of novel filter media.

Replace time-consuming building and testing of filter prototypes with accurate simulations.

Workflow

Scan a small piece of the filter media by μ CT to resolve pore-scale features.

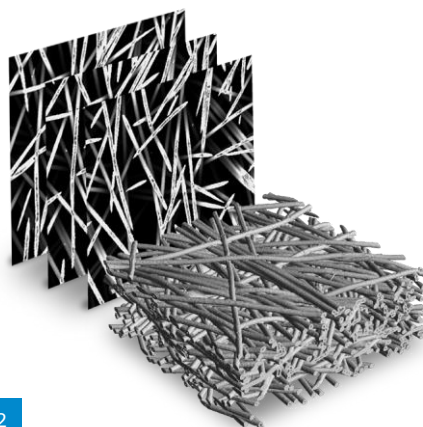
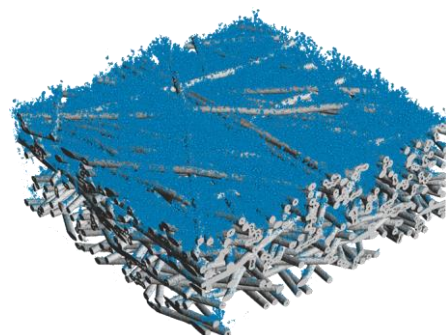
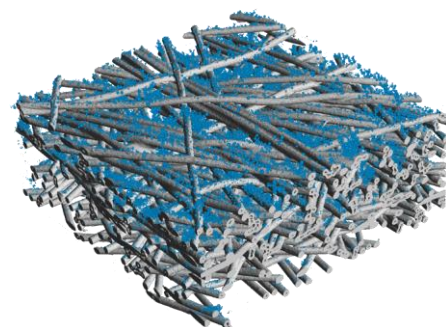
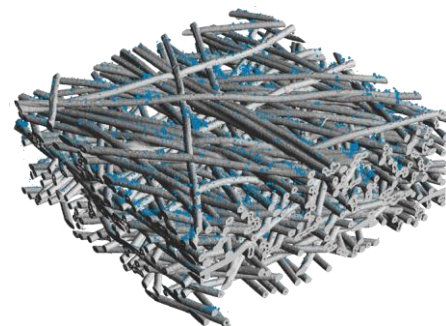
Segment the μ CT-scan into fibers and pores.

Analyze the segmented μ CT-scan to find pore size distribution and largest through pores.

Simulate a single pass experiment to find pressure drop, filter efficiency, filter life time, and filter capacity.

Model the filter media for porosity, fiber diameter, and fiber orientation.

Optimize the filter media by repeating the analysis for different models.



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Air filter properties simulated with GeoDict

Air filter medium analyzed with GeoDict

The μ CT-scan from a cabin air filter is segmented with **ImportGeo-VOL**.

Cut-Out	1.5 x 1.5 mm
Resolution per Voxel	1.5 μ m
Media thickness	600 μ m
Effective porosity	80.85 %

Pore size distribution

of the filter media is determined with **PoroDict**. [Fig 4]

Max through pore size	81 μ m
Mean pore size	65 μ m

Pressure drop of clean media

is determined with **FlowDict** for air at 20°C at a mean velocity of 0.1 m/s.

Permeability constant	1.51 e -10 m ²
Flow resistivity	1.22 e+05 kg/(m ³ s)
Pressure drop	7.35 Pa
Mass flow rate	0.12 kg/(m ² s)

Initial filter efficiency

is computed with **FilterDict** for air at 20°C for two different mean velocities:

0.01 m/s and 0.1 m/s. The simulation assumes that the filter is discharged and considers diffusion, impaction, and interception of particles. [Fig 5]

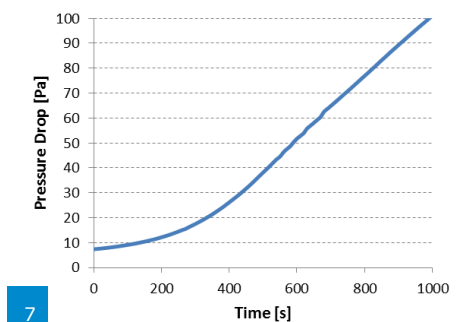
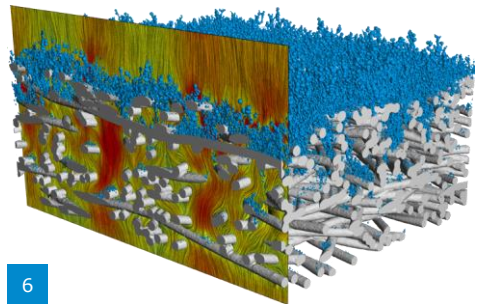
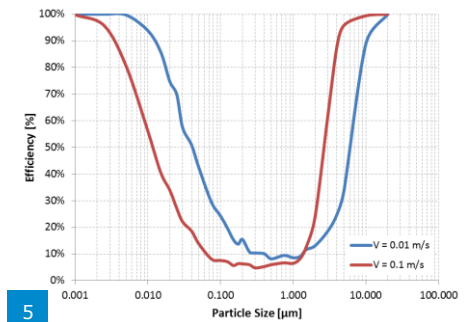
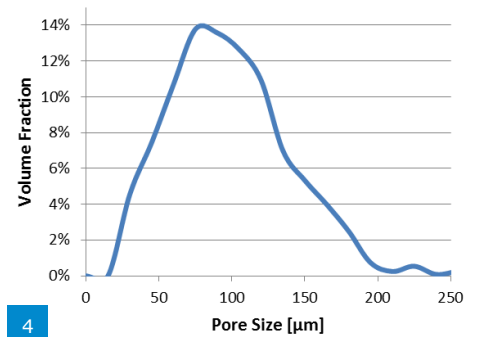
Filter life time and capacity

are determined with **FilterDict** by simulating a Single Pass experiment using SAE-fine test dust, with a concentration of 1 mg/l under a constant flow rate of 60 l/min, and a filter area of 100 cm². [Fig 6,7]

Initial pressure drop	7 Pa
Pressure drop at 1000 s	101 Pa
Total deposited dust after 1000 s	93 g/m ²
Total filter efficiency by weight	93 %

Modelling and optimization

Models of filter media look just like the μ CT-Scans. Depending on porosity, fiber orientation, and fiber diameter, different filtration properties of filter media can be predicted and optimized.



- [1] micronAir cabin air filter
- [2] μ CT slices and 3D structure
- [3] Filter-Media at different stages of particle loading
- [4]: Pore Size Distribution
- [5]: Filter efficiency for test dust SAE-fine
- [6]: Mean velocity through loaded filter media
- [7]: Single pass experiment: Pressure drop over time

Math2Market GmbH
Stiftsplatz 5
67655 Kaiserslautern, German

Dr. Jürgen Becker
+49 631 / 205 605 - 13
juergen.becker@math2market.de

www.math2market.de



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