

Simulation and the Future of Filter Design:

Geometric Modeling of Filter Media and Filter Pleats from μ CT Images

(Part 2 of 5)

Recent advances in filter design are typified by the use of 3D images obtained by computed tomography (CT) in combination with simulation software. The CT- or μ CT images of filter media and filter pleats are used to develop detailed geometric models of pleats and filter materials, and from these, their behavior can be computed directly through simulation.

CT provides the best impression of a material's geometry, as long as resolution and contrast are adequate. With high enough resolution, 3D images suitable for digital modeling can be obtained from nonwoven fibrous materials, ceramics, woven textiles and woven wire meshes, membranes, and many other porous materials used in filtration.

The models of materials are created from the 3D images after importing and segmenting them. The images may be imported as 3D data (RAW, VOL, ...), or as stacks of 2D images (JPG, PNG, TIF, ...). In the original images, gray values correspond to mass density: filter media appear in lighter gray and pores emerge in darkest gray. During the import process, the gray value images are cropped, aligned, filtered, and finally, segmented. Segmentation is the procedure that converts the μ CT image to the model, i.e. to information such as constituent solid material and pore. In the oil filter medium model shown in the figure (right), solid material is red and pores are transparent.

Once these 3D models have been obtained, the constituent solid materials and the fluid occupying the pore space in the model are associated with their properties. In this way, the behavior of filter media and filter pleats can be digitally tested. This being a non-destructive technique, a single digital model can be subjected to a great diversity of testing conditions. For filter media makers and filter manufacturers, the bottom line is the resulting drop in laboratory testing costs and development time.

Geometric modeling from μ CT images

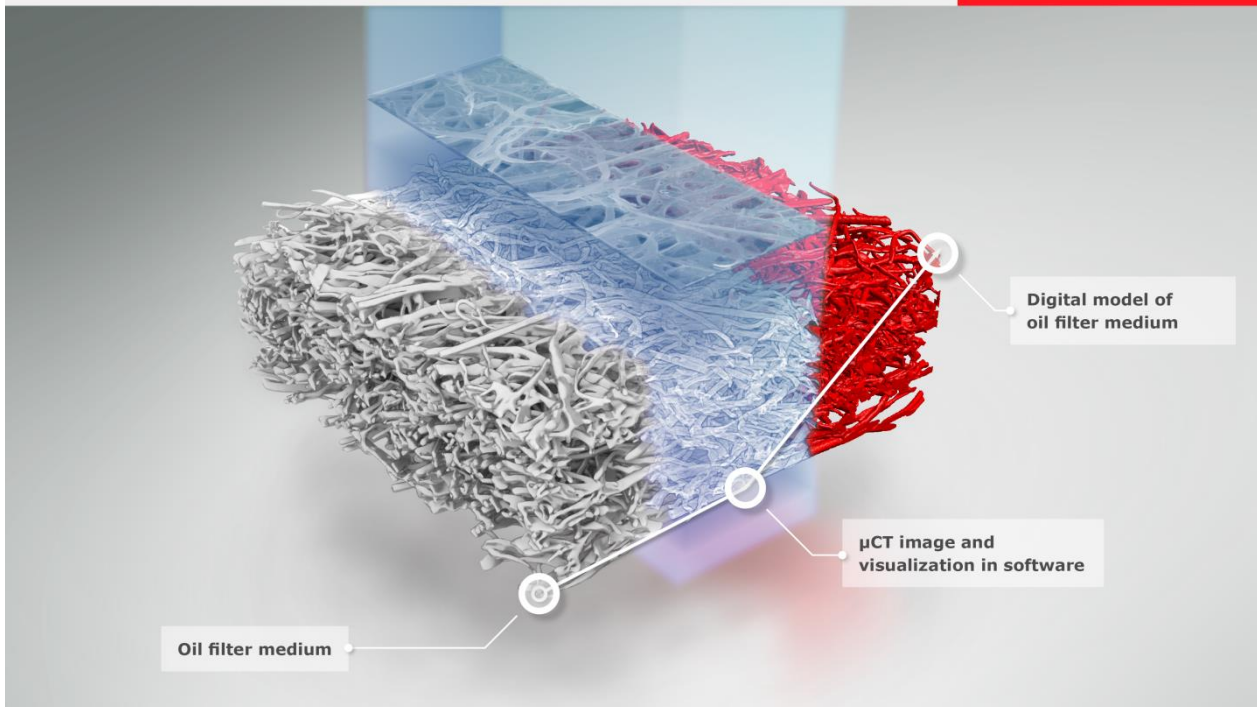


Figure: Digitalization and modeling of an oil filter medium, based on a stack of μ CT images of real filter medium. The figure's left represents the scanned oil filter medium, the middle illustrates the processing and visualization of the μ CT images, and the right displays the 3D digital model of the oil filter medium obtained after segmentation.

Andreas Wiegmann, Ph.D.

Math2Market GmbH

info@math2market.de

www.math2market.com

Keywords

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