**Influence of Fiber Diameter Distribution on the Filtration Performance of Depth Filter.**

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**Highlights**

* Modeling of filtration performance of depth filter
* Investigation of fiber diameter distribution of depth filter media
* Influence of fiber diameter distribution on pressure drop and filtration efficiency
* Improved prediction of filtration performance

**1. Introduction**

The separation of particles from gas streams having low to medium loadings is an essential task in various civil (e.g. cabin air filters) or industrial (e.g. particulate air filter for clean rooms in aseptic production areas) applications. A high efficiency combined with a low pressure drop is desired to realize cost- and energy efficient separations. For the task of optimization the filter media, knowledge about the connection of macroscopic parameters of fibrous depth filter (e.g., pressure drop and filtration efficiency) to their microscopic properties (e.g., fiber diameter distribution or porosity) is evident [1]. In recent simulations, the fiber diameter distribution (FDD) within the filter media is often neglected and replaced by a medium or averaged value [2]. In this work, the impact of this parameter is in focus.

**2. Methods**

The FDD of a fine filter (F7, Trox GmbH, Neunkirchen-Vluyn, Germany) based on glass fibers (Filter A) and a coarse dust filter (TH 300-T2, Afprofilter GmbH, Bönen, Germany) based on polyester fibers (Filter B)were investigated using scanning electron microscopy (SEM), (H-S4500 FEG, Hitachi High Technologies Europe, Krefeld, Germany). The FDD was analyzed by digital image analysis. For that purpose, the open source software diameterJ [3] was used. 24 SEM-images of each material at clean- and raw-gas side were considered and the fiber diameter at around 20.000 positions in each image was evaluated. Those data were implemented in an in-house developed model for calculation filtration performance which is computed using Matlab (Matlab 2016a, The Mathworks, Nivack, USA). Filtration performances were measured according to the VDI 3926 using aluminum oxide as test dust (Pural NF, Sasol, Brunsbüttel, Germany).

**3. Results and discussion**

The FDD of both considered filter media was obtained by digital image analysis. The spans of the distributions, as well as the medium fiber diameter (MFD), were derived from these data. Since no significant deviations between the raw- and clean-gas sides were found, a constant FDD inside the filter was assumed for calculations. Calculations of the filtration efficiency were carried out and results are compared for using the MFD and the FDD (figure 1). A high influence of the FDD on the calculation of the filtration efficiency can be figured out. It is shown that implementing the FDD increases the calculated filtration efficiency (up to more than 50%) in comparison to using the MFD. Furthermore, it was found that this parameter becomes more significant in the region were inertial deposition of the dust can be assumed than in the diffusional dominate region at smaller particle diameter. Also, an influence on the pressure drop was figured leading to higher values for both filter media by considering the fiber diameter distribution. A comparison to experimental data results in an improved prediction of filtration efficiency. This emphasizes the importance of this parameter regarding investigating the filtration of particles in fibrous depth filter.



**Figure 1.** Calculation of filtration efficiency with and without considering the fiber diameter distribution

**4. Conclusions**

The FDD of two fibrous depth filter media were successfully determined combining SEM and digital image analysis. The influence of that parameter was theoretical investigated, implemented into an in-house developed model and compared with experimentally determined filtration efficiencies and pressure drops. From those results the importance of considering these data in modeling the filtration efficiency was emphasized.

**References**

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