

Filtration of aerosol particles in structurally inhomogeneous fibrous filters. II – Experimental results.

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The Partially Segregated Flow Model, *PSFM*, formulated in our previous abstract in order to describe aerosol penetration through polydisperse fibrous filters was verified experimentally for eight polypropylene melt-blown filters. It was found that the fiber size distribution of all tested filters can be satisfactorily described by the log-normal distribution, see an example for the filter #3 in Fig. 1.

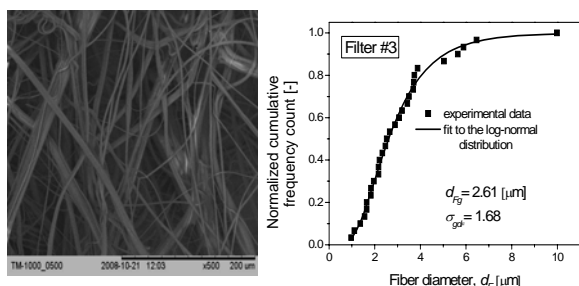


Fig. 1. Fiber diameter distribution for the filter #3.

Structural characteristics of these filters (arithmetic mean fiber diameter, d_{Fa} , filter packing density, α , filter thickness, L , and the geometric mean, d_{Fg} , and the geometric standard deviation, σ_{gdF} , of the fiber diameter distribution) are collected in Table 1.

Table 1. Characteristics of the analyzed filters.

Filter No.	d_{Fa} [μm]	α [-]	L [mm]	d_{Fg} [μm]	σ_{gdF} [-]
1	2.55	0.016	3.5	1.98	1.58
2	2.91	0.024	2.0	1.91	2.04
3	3.15	0.030	1.9	2.61	1.68
4	2.33	0.024	1.3	1.90	1.81
5	2.06	0.019	5.6	1.46	1.80
6	1.53	0.027	5.1	1.22	1.82
7	1.72	0.023	6.4	1.47	1.82
8	3.63	0.039	3.7	2.78	1.87

All filters were examined in terms of the initial penetration, P , of polydisperse solid particles utilizing the modular filter test system (Palas MFP-2000). The measurements were carried out for air velocity $U_0=0.15$ m/s.

The experimental results were compared with theoretical calculations done by applying: *PSFM* for polydisperse filters and with classical theory developed for monodisperse filters used in line with the arithmetic mean fiber diameter, d_{Fa} . For all investigated filters it was possible to obtain

a reasonable agreement with experimental data using the *PSFM*, whilst the penetration computed on the basis of the mean fiber diameter significantly differed from them, see Fig. 2. Determined values of the dimensionless phenomenological parameter, called the segregation intensity, s , were in the broad range 0.08 - 0.55 in the case of the eight investigated filters for superficial gas velocity $U_0=0.15$ m/s. Under those conditions the lowest values of s were observed for filters #6 and #7, which belonged to the thickest ones and were made of the finest fibers. On the other hand, the thinnest filters (#3 and #4) containing larger fibers had much higher values of s .

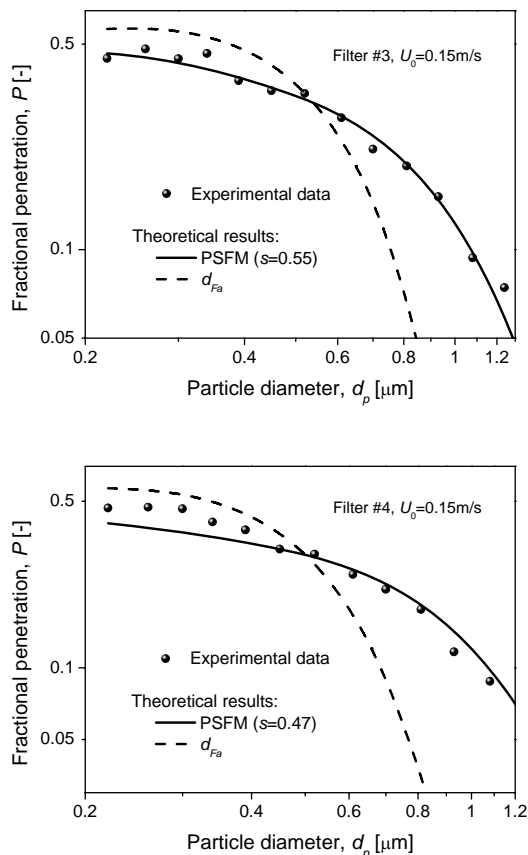


Fig. 2. Comparison of the experimental values of the penetration with theoretical results for filter #3 and #4 (dashed lines – classical theory for arithmetic mean fiber diameter; solid lines – model *PSFM*).

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