

VARIOUS ASPECTS OF NON-STEADY STATE AEROSOL FILTRATION IN FIBROUS FILTERS

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Aerosol filtration in fibrous filters is a non-steady state process. Due to its complexity, it is very difficult to develop any mathematical model that could be used to precisely predict time variation of a filter performance.

In our study, we used two correlations proposed by Podgórski to fit the experimental data of pressure drop and penetration collected during filters' loading. These formulae, containing four empirical constants, can be utilized to extrapolate the experimental results. Our extensive work shows that the equations for the momentary pressure drop and penetration are capable of precisely describing data obtained during measurements for various fibrous filters and their multilayer structures.

In order to predict aerosol particles' penetration through the fibrous filters, the two-stage macroscopic model can be used. First, using the experimental data, the parameters of the model have to be determined. Next, these parameters can be used to calculate penetration at different conditions than the experiments were carried out (different filter thickness or different aerosol concentration). It has been proven that the two-stage macroscopic model of filter loading can be successfully used to correctly predict filter performance.

Many times, at the filter designing stage, engineers have to select which filter structure is optimal for a given application. Quality factor, defined as $QF = -\ln P / \Delta p$ is a commonly used criterion to compare various filters. Definition of the quality factor is based on two the most important parameters examined in filtration, namely penetration, P , and pressure drop across the filter, Δp . However, it does not take into consideration the cost of the filter, which is one of the chief criteria of the filter's selection. To include the total filtration cost, filter utility factor, FUF , can be used choosing the optimal filter. This factor is defined as the inverse of the total cost of the process per unit amount of removed particles. We used the filter utility factor to compare various fibrous filters as well as their multilayer structures and show how to choose an optimal filter for a given process conditions. We show that the quality factor can be used to compare roughly different fibrous filters, whereas the filter utility factor can be a criterion to select the best filter structure from the economic viewpoint as well as to determine the optimal service life of the filtering system.

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