

Part A: Proposal # (#Assigned by NCRC)

Simulating Multi-component Aerosol Filters via Geometrical Modeling and Volumetric Imaging

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Proposal Summary:

While there are numerous analytical expressions available for predicting the pressure drop and collection efficiency of the single-component filters (filters with a single fiber diameter) made up of circular fibers, there are practically no such relations for multi-component filters (filters with different fiber diameters). In this proposal, pressure drop per unit thickness and collection efficiency of multi-component filters and made up of circular and non-circular fibers will be calculated via numerical simulation. Digital Volumetric Imaging (DVI) technique will be used to reconstruct the real 3-D geometries of air filters. Real and modeled 3-D geometries will be used in the simulation for comparison and benchmarking, and therefore, drawing solid conclusions.

GeoDict a Computational Fluid Dynamics (CFD) developed by ITWM, Germany will be used in this study along with the CFD code from Fluent Inc to simulate aerosol flow through 3-D filter structures. This study completes our on-going NCRC project # 04-70 entitled "Filtration by Micro and Nanofiber Filters: Simulation and Experiment" which ends in August 2007. Specific targets of the current proposal are the followings:

- Obtain expressions for predicting pressure drop and collection efficiency of multi-component filters
- Study the influence of the fiber cross-section on the filter's pressure drop and collection efficiency
- Compare the simulations of modeled filters with those performed on real structures obtained via Digital Volumetric Imaging (DVI)

Specific Objective:

Obtain pressure drop and collection efficiency expressions for multi-component filters, establish influence of fiber cross section, and compare simulations of modeled filters with those performed on structures obtained via DVI.

Millstones:

1st year: Benchmarking modeled geometries

Using DVI system, we will obtain 3-D structures of real filters (after measuring their filtration efficiency by TSI 3160) and simulate aerosol flow through them. The results of this study will be compared with that of flow through modeled geometries. We assess the accuracy of our modeling.

2nd year: Multi-component filters having fibers with circular cross-sections

We will generate series of fibrous structures with different fiber components to establish a relation for between the blend ratios and filtration efficiency for each diameter ratios.

3rd year: Multi-component filters having fibers with noncircular cross-sections

We will extend the above study to filters with noncircular fibers and draw overall conclusions to be used in product development.