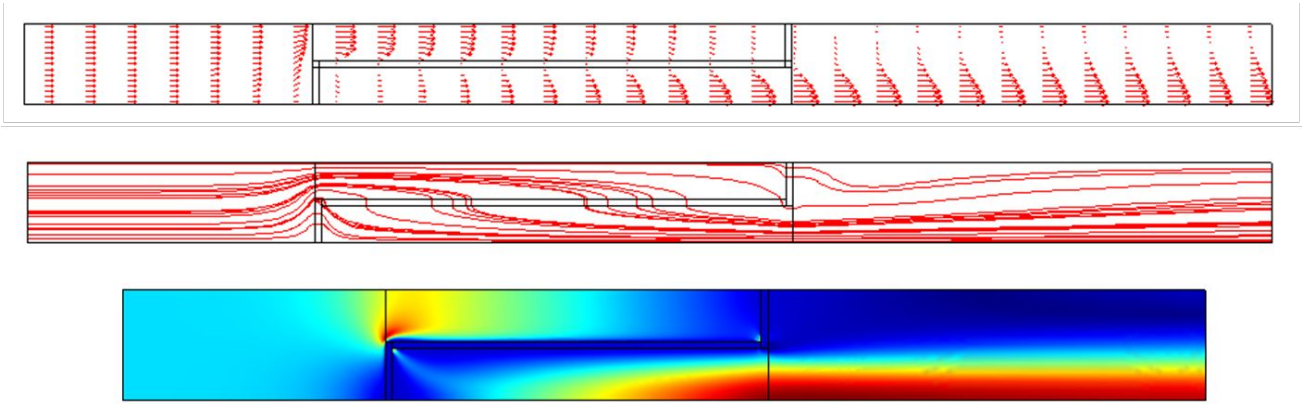
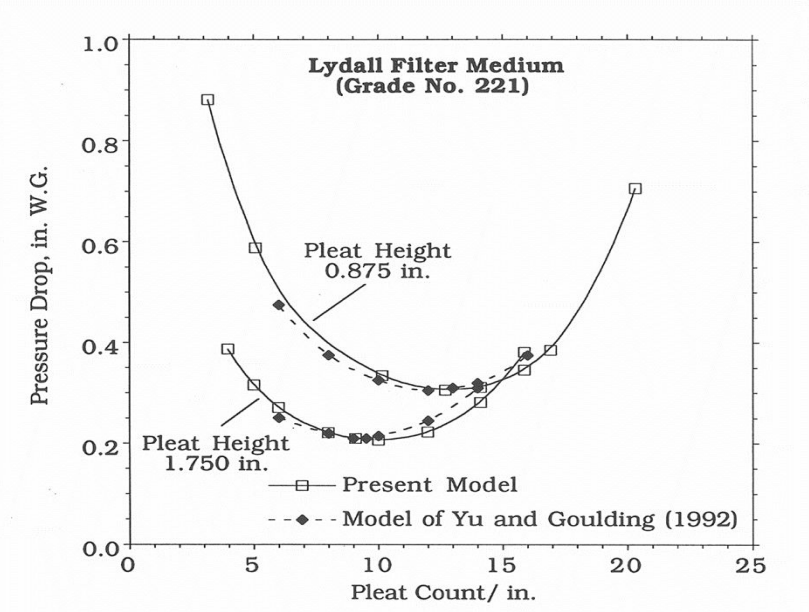
Research Thrust #3:
Filtration and Separation

This thrust researches and develops the scientific knowledge and technologies in a wide applications requiring the filtration and separation of particles/fiber and gases. The major research directions include (but not limited to) air/liquid quality control, pollution source control, design and optimization of filtration/separation units/systems, as well as filtration media design, production, and testing.

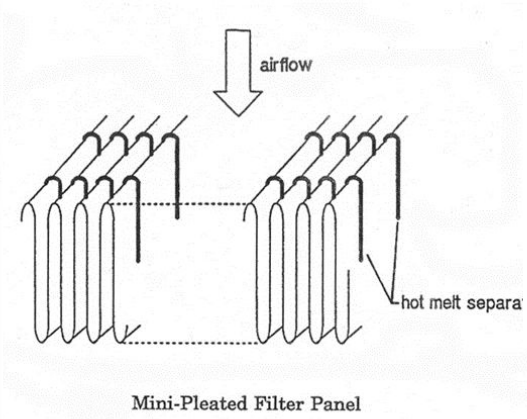
Filter Pleating Design



Flow field for a pleated filter panel

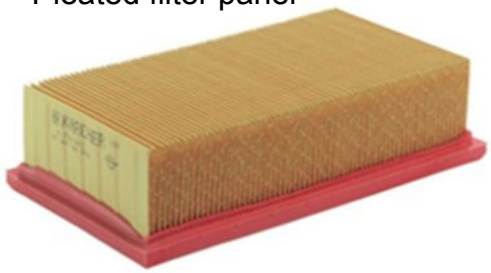


Pressure drop across a pleat filter as a function of pleat density



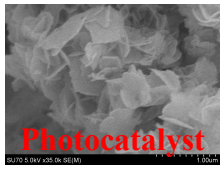
Mini-Pleated Filter Panel

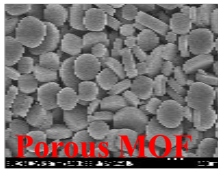
Pleated filter panel

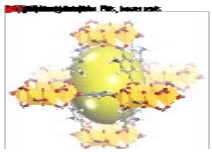


Pleated filter cartridges

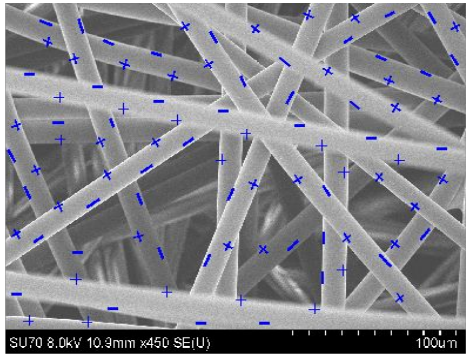
Adsorbent Coated Electret Filter Media for Mitigating PMs and Gaseous Pollutions Simultaneously



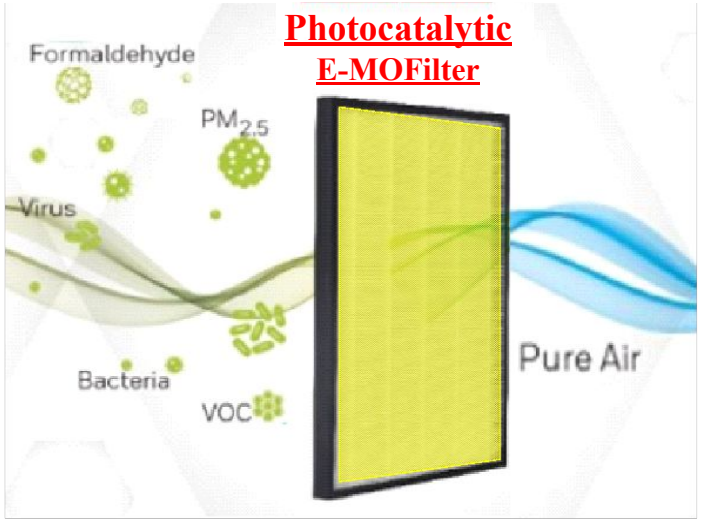




+



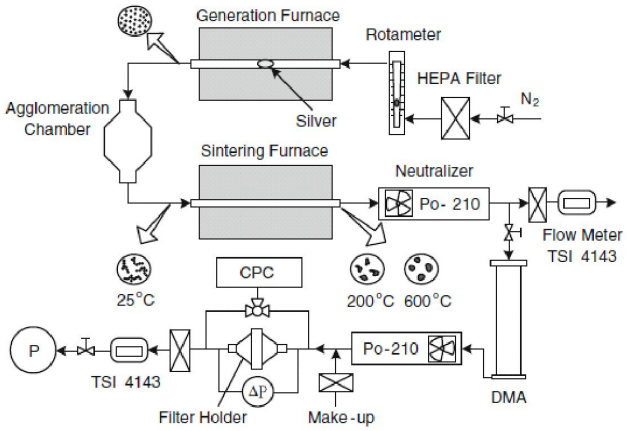
=



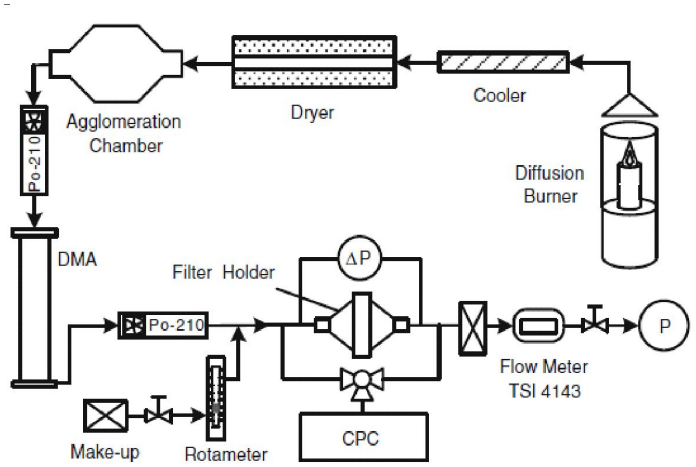
Publication: Zhang et al. (2021), Journal of Membrane Science, 618, 118629.

Filtration Test Rig-Nanoparticles Generations (polydisperse and monodisperse) and Filter Penetration Measurements

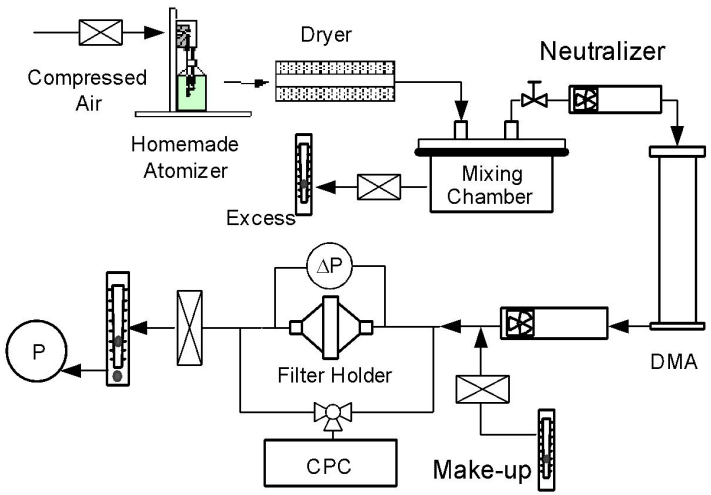
Silver particle generation system



Soot particle generation system



NaCl / CNT particle generation system



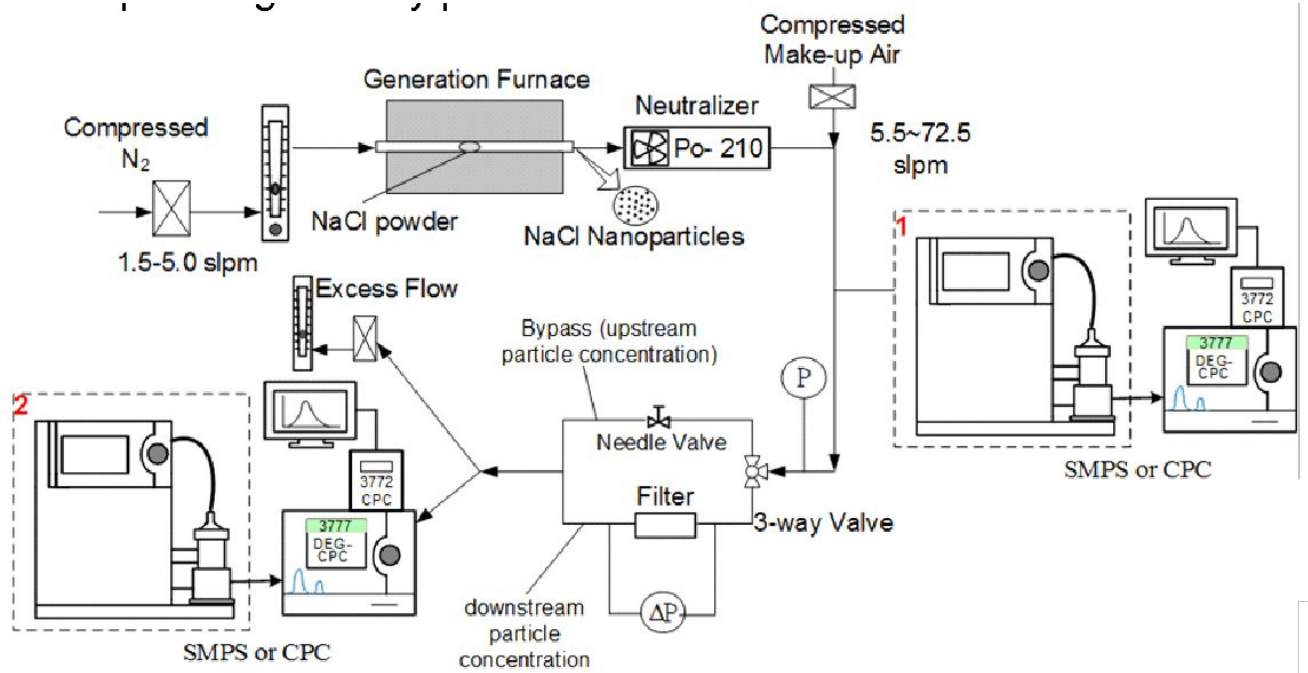
Publication:

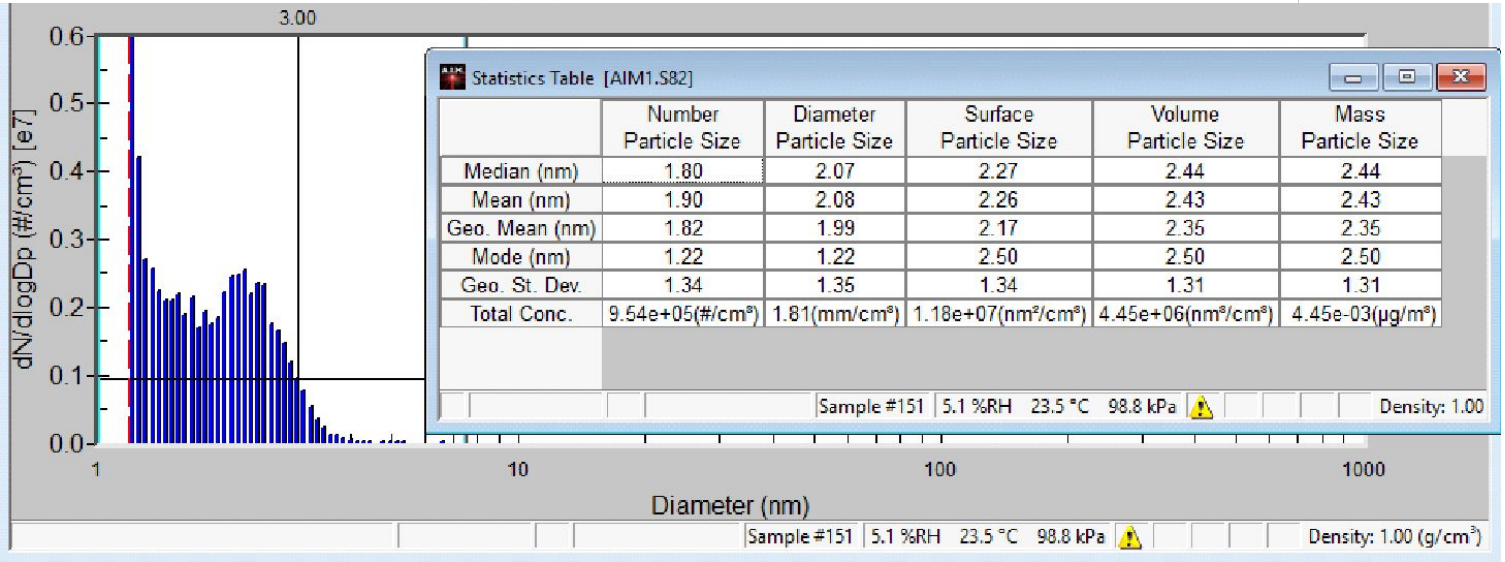
Chen et al. (2014). Aerosol Science and Technology, 48:997-1008.

Tang et al. (2018). Separation and Purification Technology, 198: 137-145.

Tien et al. (2020). Separation and Purification Technology, 233, 116002.

Sub-3 nm Nanoparticle Generation and Filtration Test: Extremely High Efficiency Filters with 99.999999%



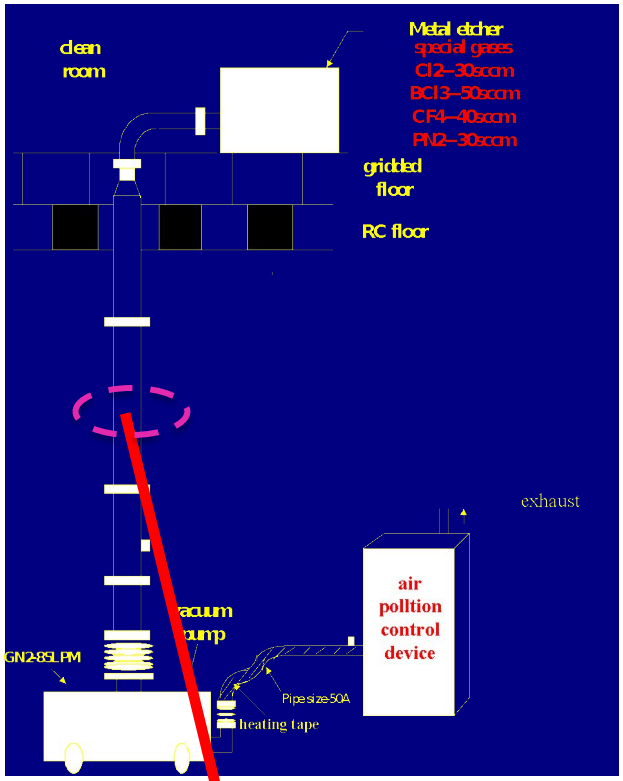


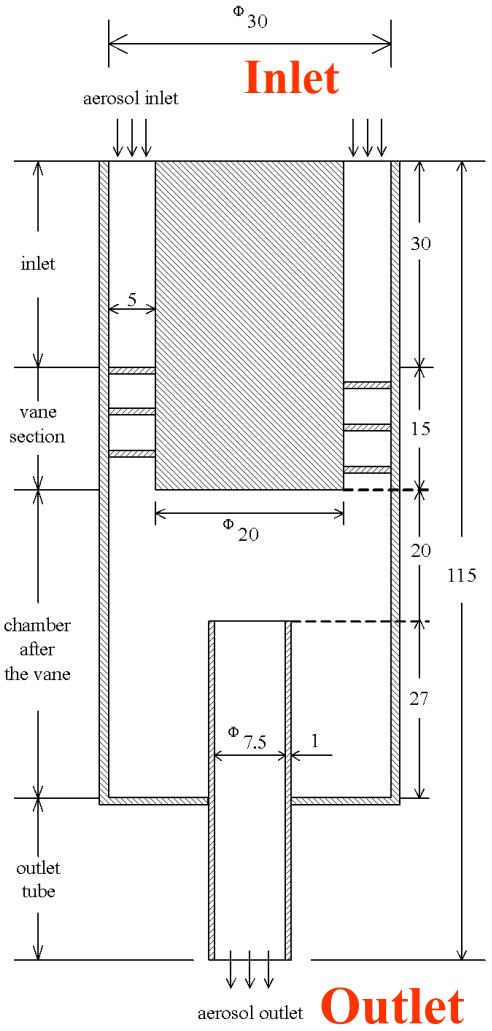
	Number Particle Size	Diameter Particle Size	Surface Particle Size	Volume Particle Size	Mass Particle Size
Median (nm)	1.80	2.07	2.27	2.44	2.44
Mean (nm)	1.90	2.08	2.26	2.43	2.43
Geo. Mean (nm)	1.82	1.99	2.17	2.35	2.35
Mode (nm)	1.22	1.22	2.50	2.50	2.50
Geo. St. Dev.	1.34	1.35	1.34	1.31	1.31
Total Conc.	9.54e+05(#/cm³)	1.81(mm/cm³)	1.18e+07(nm²/cm³)	4.45e+06(nm³/cm³)	4.45e-03(μg/m³)

Publication:

Chen et al. (2015). Technical Report of Mott Corp.

Cyclone for Nanoparticle Removal

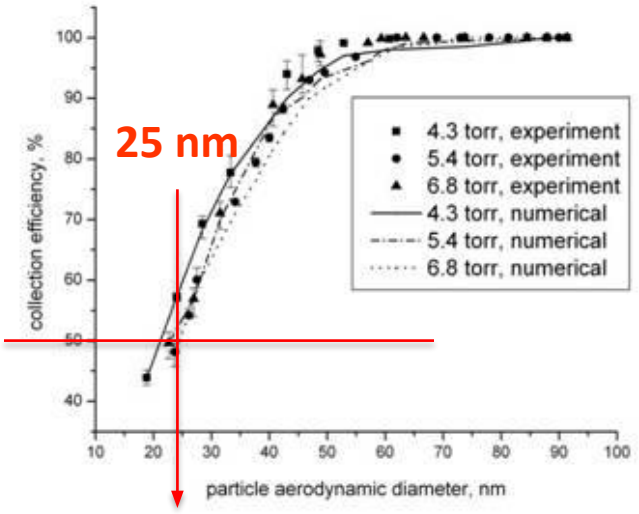




Simulation domain

Aerosol inlet

Aerosol outlet

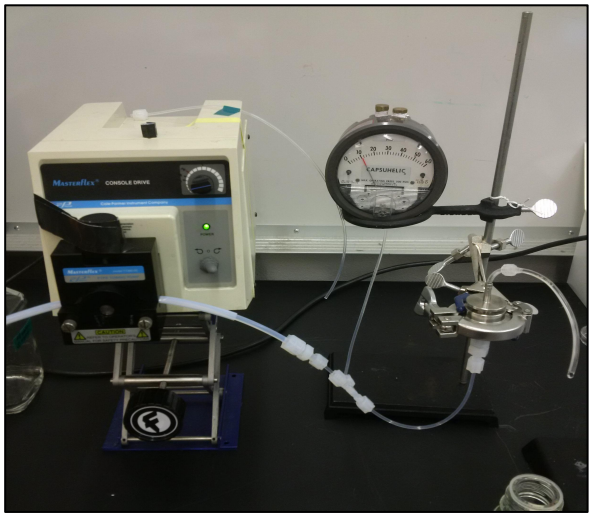


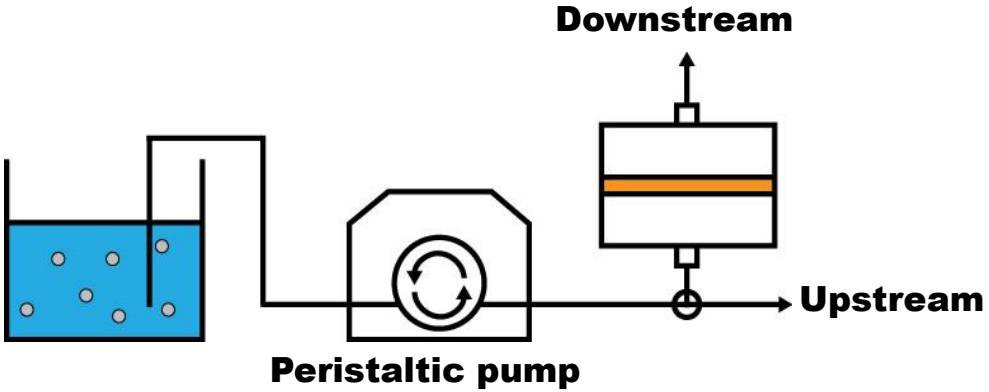
Publication:

Chen et al. (2007). Journal of Nanoparticle Research, 9:71-83.
Tsai et al. (2008) Environmental Science & Technology, 46: 4546-4552.

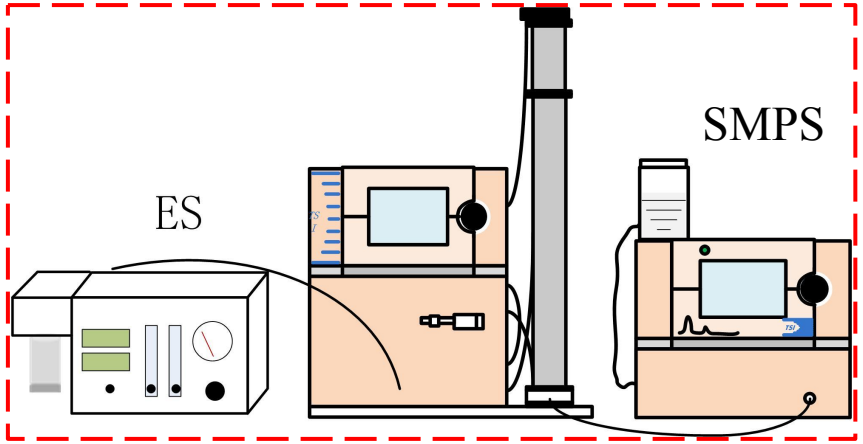
Liquid Filtration

Electrospray SMPS Aerosol Measurement for Efficiency Evaluation





Membrane ultrafiltration system



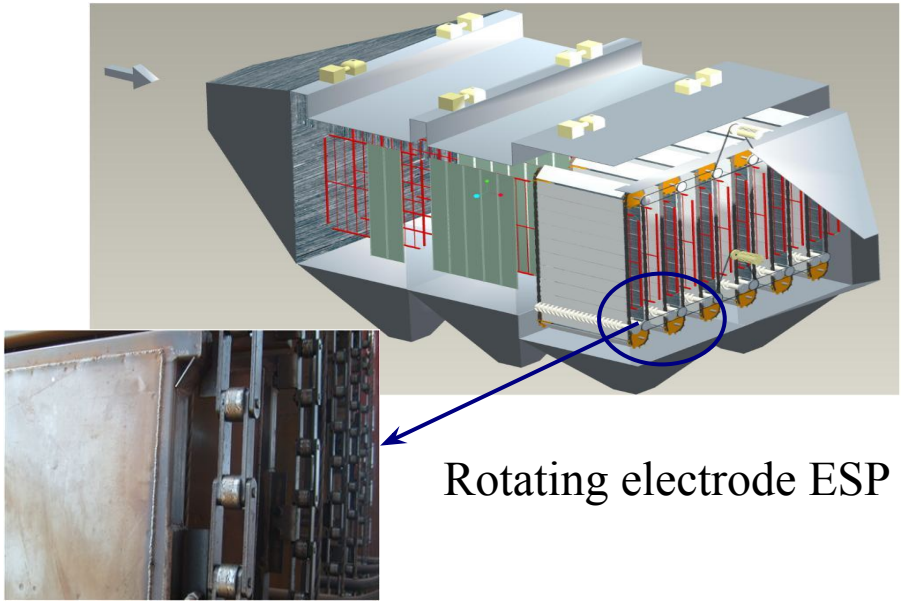
Electrospray-Scanning Mobility Particle Sizer

Publication:

Chen et al. (2016). Journal of Membrane Science, 497:153-161.
Lee et al. (2017) Journal of Membrane Science, 524: 682-690.

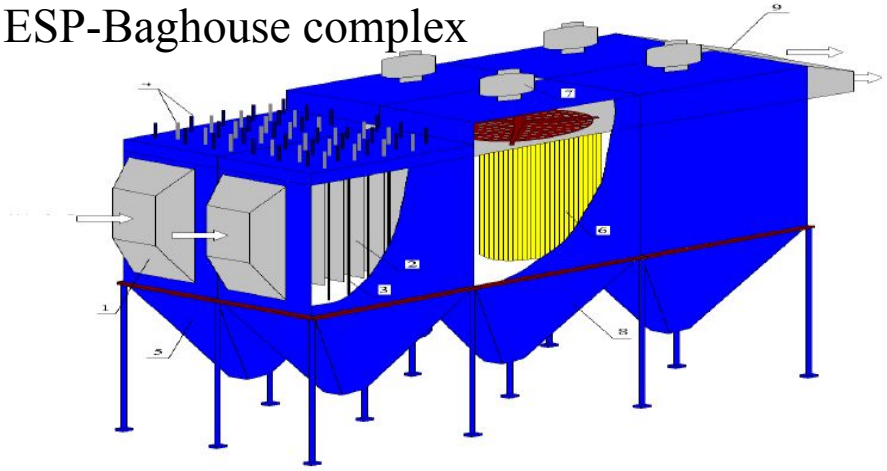
Electrostatic Precipitator (ESP) for $PM_{2.5}$ control

- Design of ESP
  - Rotating electrode plate tech.
  - Wet ESP tech.
  - Small particle coagulation
  - Low and very low temperature flue gas ESP tech.
  - ESP-Baghouse complex: remain the first electric field of ESP, and replace the other electric fields with baghouse



Rotating electrode ESP

ESP-Baghouse complex



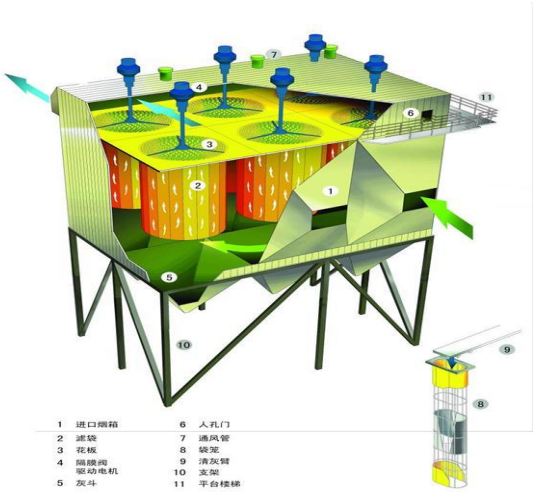
Publication:

Lin et al. (2010). Aerosol Science and Technology. 44:38-45.

Baghouse for fine particle control

- Baghouse Type: pulse jet dust clean baghouse; rotate blow dust clean baghouse
- Large industrial application:
  - Power station
  - Steel
  - Cement
  - Rubbish incinerator

pulse jet dust clean baghouse



rotate blow dust clean baghouse

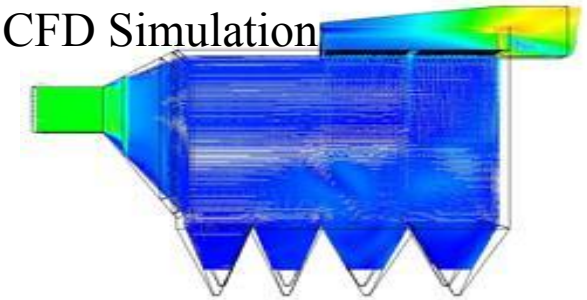
Publication:

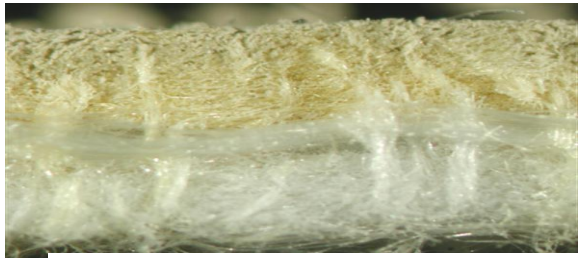
Lo et al. (2010). Powder Technology, 198, 75-81.
Li et al. (2020). Separation and Purification Technology, 234, 116086.

Baghouse Technology

- Equipment: CFD modeling and design, low pressure pulse jet and energy saving
- Fiber: high performance fiber such as Aramind, Polyimide, PPS, PTFE fiber
- Filtration media: Needle felt filters, Membrane filters, high density surface filters, spunlace felt filters, spun-bonded filters

CFD Simulation



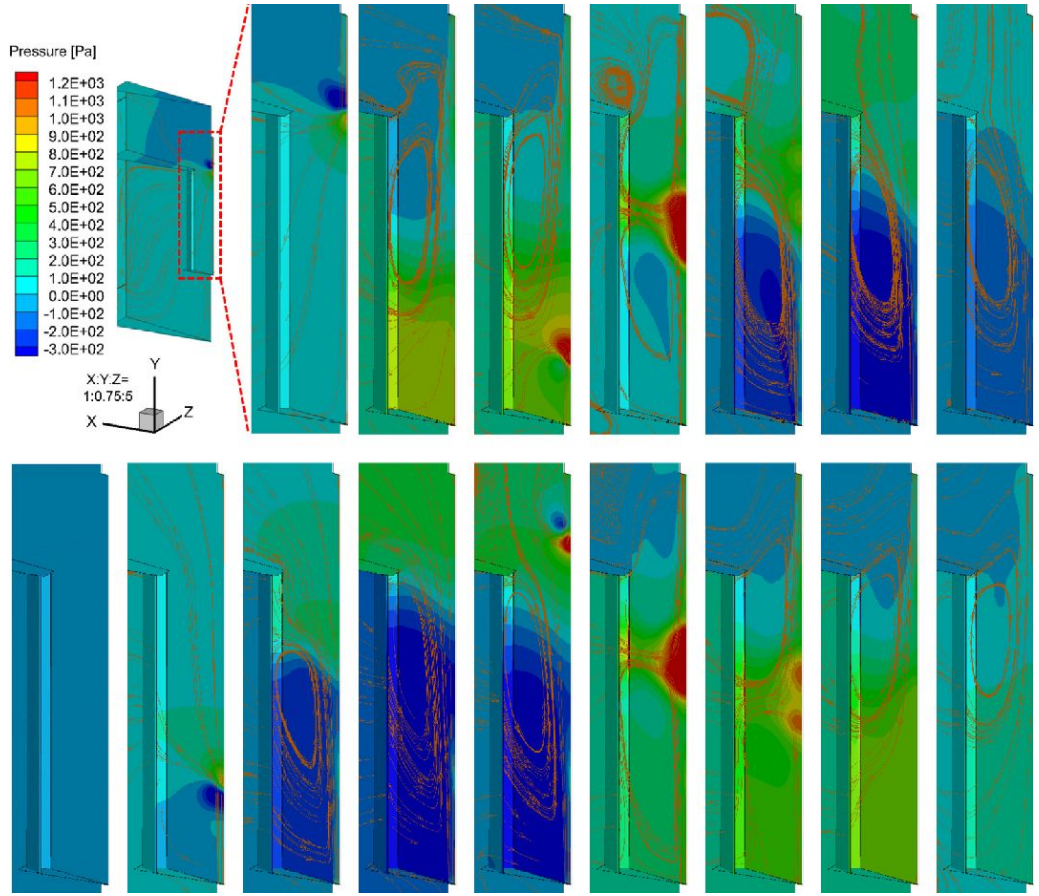


high density surface filter

n of Reverse Flow Cleaning for Pleated Filter Cartridges

odeling of
cs during a
ed-flow
lter

- Optimization of the cleaning performance through the design of pleat and cartridge shapes, pulsed flow timing and frequency, flow accessary, cartridge installation orientation, and housing configurations

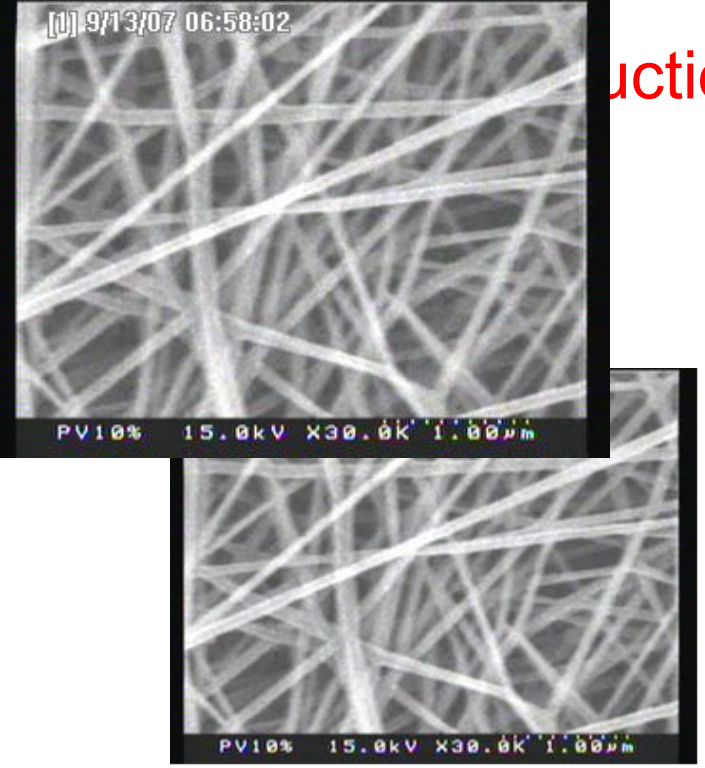


Evolution of static pressure contours and flow streamlines when the opposing puled-jet cleaning was operated with the delay time of 0.075 s (a) and −0.075s (b) while keeping PR=1.0

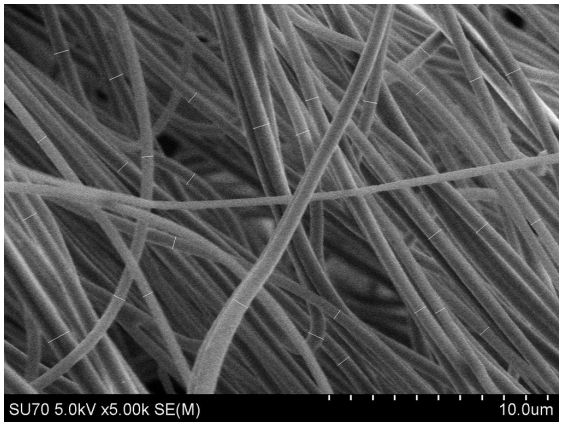
Li et al (2020) Separation and Purification Technology 234, 116086

uction of Filtration Media

- Centrifugal spinning
- Electro-centrifugal spinning

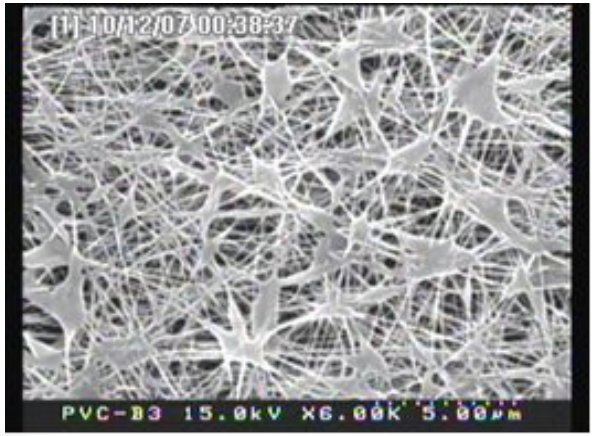


PVA fibers (10% wt)

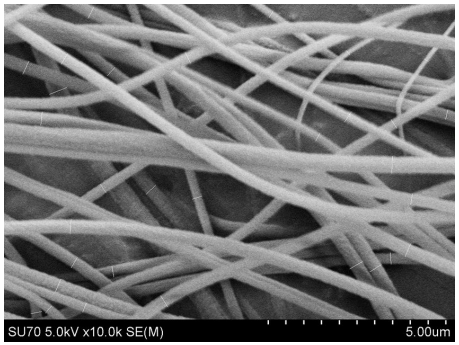


0.65 μm PAN fibers (10% wt)

- Ultrasonic electrospinning



Beaded PVA fibers (3% wt)



0.326 μm PAN fibers (8% wt)

VCU