Today, we will:

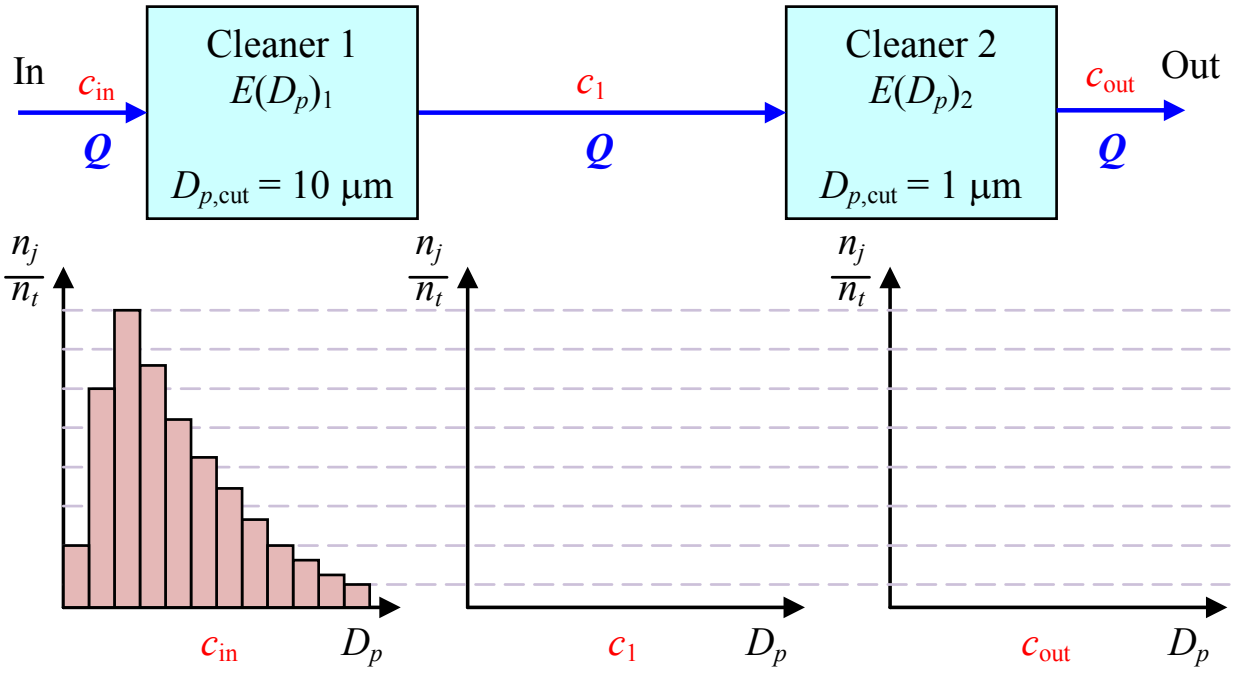
- Do more examples of air cleaners in series and parallel; particle histograms
- Discuss cascade impactors
- News article presentation by Hannah Seeger

Example: Histograms of particle number fraction through air cleaners in series

Given: Two particle cleaners in series as sketched below, with different values of $D_{p,\text{cut}}$.

To do: Sketch the particle number fraction histograms at each of the three locations.

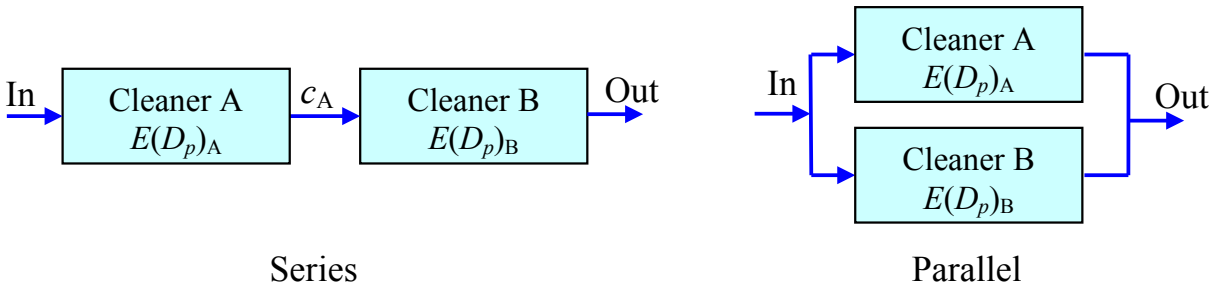
Solution:



Example: Air Cleaners in Series or Parallel

Given: Two identical air cleaners are available to clean a polluted air stream. We want to know which is better – to connect them in series or in parallel. At a particular D_p,

- $E(D_p)_A = 90\%$
- $E(D_p)_B = 85\%$



Series Parallel

To do: Compare the overall removal efficiency in series and for the *best case* in parallel. What is the *best* overall removal efficiency you can get from these two cleaners? Give your answer as a percentage to 3 significant digits. Equations:

Series:

$$E\left(D_p\right)_{\text{overall}} = 1 - \prod_{j=1}^{m}\left[1 - E\left(D_p\right)_j\right]$$

Parallel:

$$E\left(D_p\right)_{\text{overall}} = 1 - \sum_{j=1}^{m} f_j\left[1 - E\left(D_p\right)_j\right], \quad f_j = \frac{Q_j}{Q_{\text{total}}}$$

Solution:

Cascade Impactor:

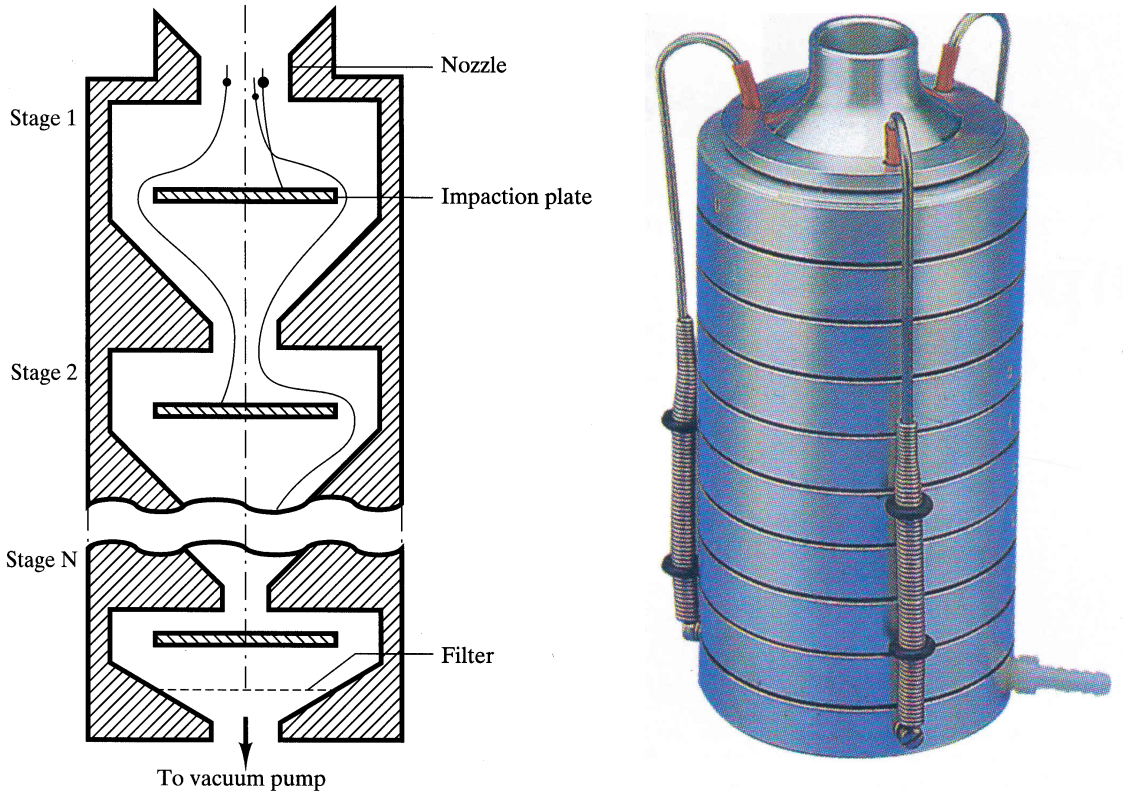


Figure 9.7 of Heinsohn & Cimbala. Cascade impactor: (a) schematic diagram, showing trajectories of particles of three different diameters (adapted from Willeke and Baron, 1993); (b) Andersen eight-stage, non-viable, 1 ACFM ambient air sampler (from Andersen Instruments Inc.).

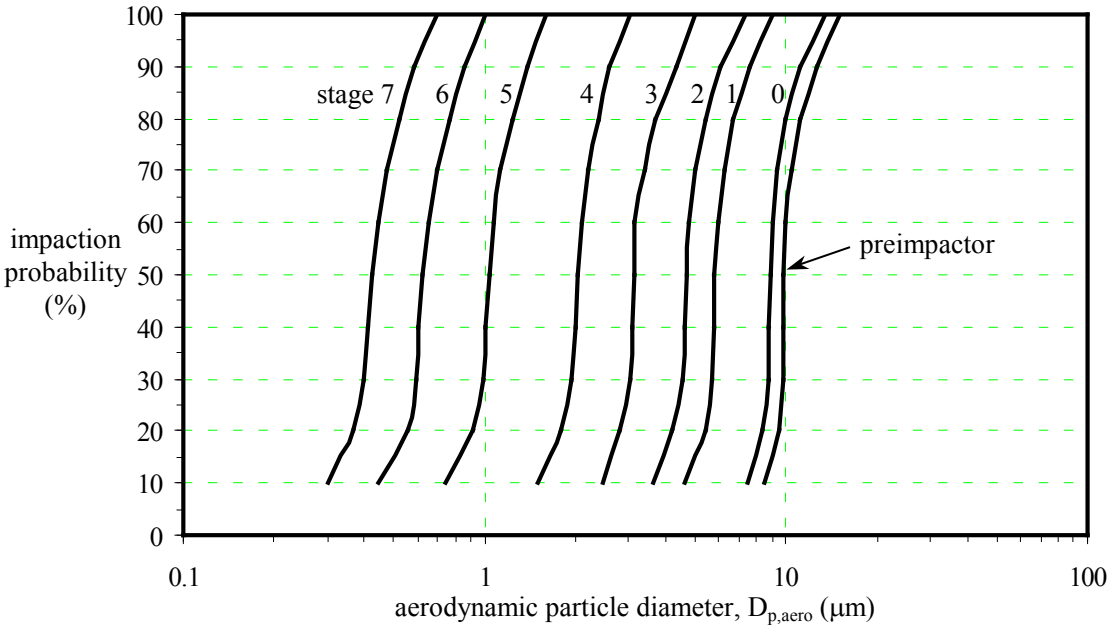
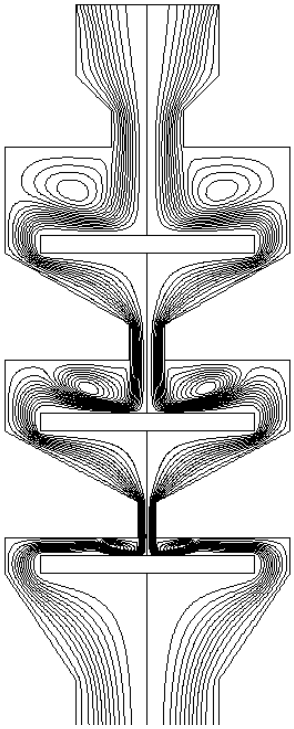
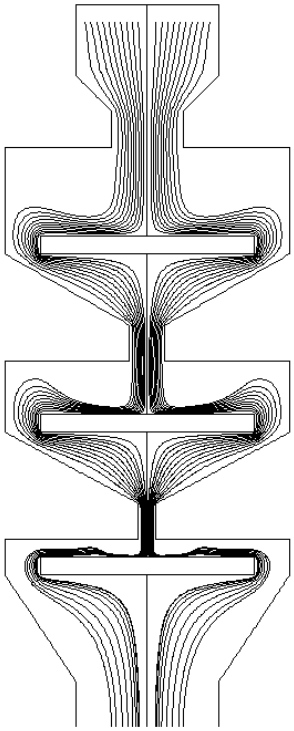


Figure 9.8 of Heinsohn & Cimbala. Particle collection efficiency for each stage of an Andersen eight-stage, 1 ACFM ambient air sampler with preimpactor (redrawn from Andersen Instruments, Inc.).

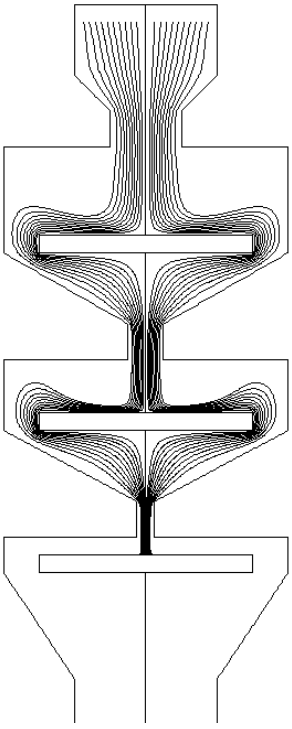
Computational fluid dynamics (CFD) simulations of a cascade impactor (by J. Cimbala):



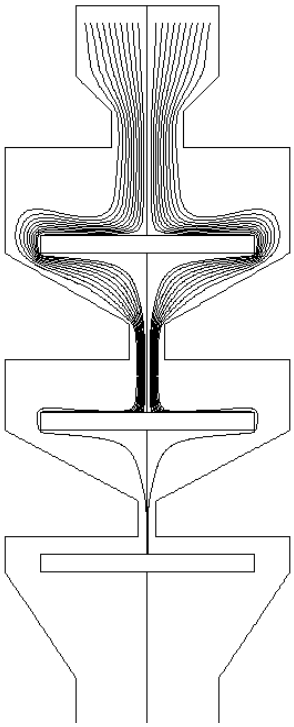
(a) air streamlines



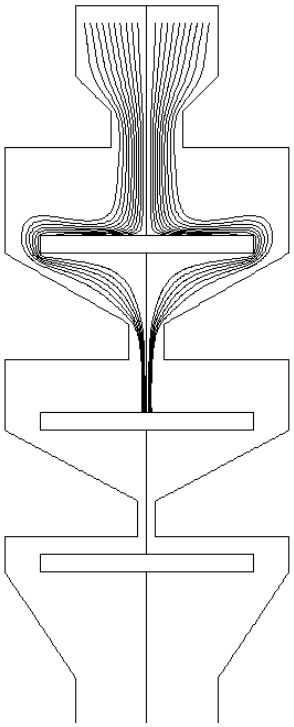
(b) 1-micron particles



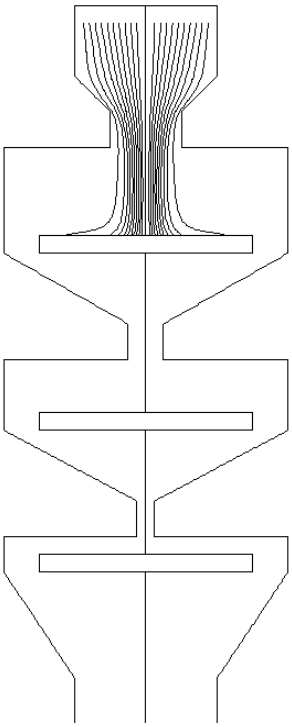
(c) 2-micron particles



(d) 5-micron particles



(e) 10-micron particles



(f) 15-micron particles

Figure 10.17 of Heinsohn & Cimbala. CFD simulation of flow in a 3-stage cascade impactor; (a) streamlines, (b)-(f): trajectories of unit density particles of diameter D_p = (b) 1, (c) 2, (d) 5, (e) 10, and (f) 15 μm.