Today, we will:

- Finish derivation of grade efficiency for **spray chambers**, and do an example problem
- Briefly discuss **wet scrubbers** (another type of APCS to remove PM)
- Begin a discussion about **air filters**, and how they work

Continuing from previous lecture, for a counter-flow spray chamber we had:
Differential grade removal efficiency across our small control volume of volume *Adz*:

$$\boxed{\frac{dc}{c} = -dE\left(D_p\right)} \qquad (1)$$

Differential grade removal efficiency across our small control volume of volume *Adz*:

$$\boxed{dE\left(D_p\right) = E_d\left(D_p\right)\frac{\pi D_c^{\,2}}{4A}\frac{V_c + U_a}{U_a}c_{\text{number,c}}Adz} \qquad (4)$$

Number concentration of the collector water drops, where Q_s is the water volume flow rate:

$$\boxed{c_{\text{number,c}} = \frac{6Q_s}{V_c \pi D_c^{\,3} A}} \qquad (5)$$

Example: Designing a Spray Chamber

Given: A counter-flow spray chamber is being designed with the following properties:

- D_c = 200 microns (collector water drop diameter)
- A = 0.7854 m^2 (cross –sectional area of the spray chamber)
- Q_s = 0.0000521 m^3/s (volume flow rate of the supply water, at the top)
- $V_{t,c}$ = 0.700464 m/s (falling speed of water drops in still air)
- D_p = 5 microns (diameter of the air pollution particles we are targeting)
- ρ_p = 1000 kg/m^3 (air pollution particles are treated as unit density spheres)
- Q_a = 0.250 m^3/s (volume flow rate of the dirty air, introduced at the bottom)
- Air at STP: ρ = 1.184 kg/m^3, μ = 1.849 × 10^{-5} kg/(m s)

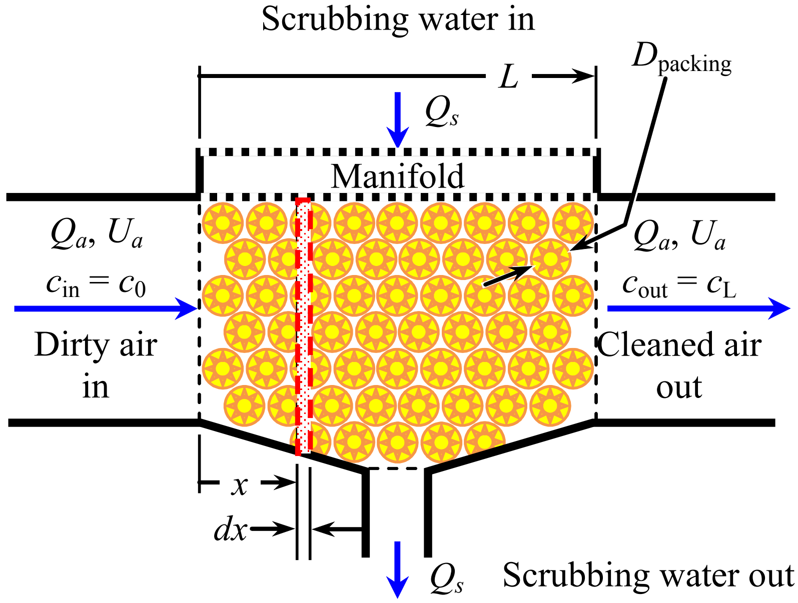
To do: Calculate the required height of the spray chamber to remove 90% of these particles. Give answer in meters to three significant digits.

Solution: From a previous problem, for 5-micron particles and 200-micron raindrops, we had $E_d(D_p)$ = 0.183659.

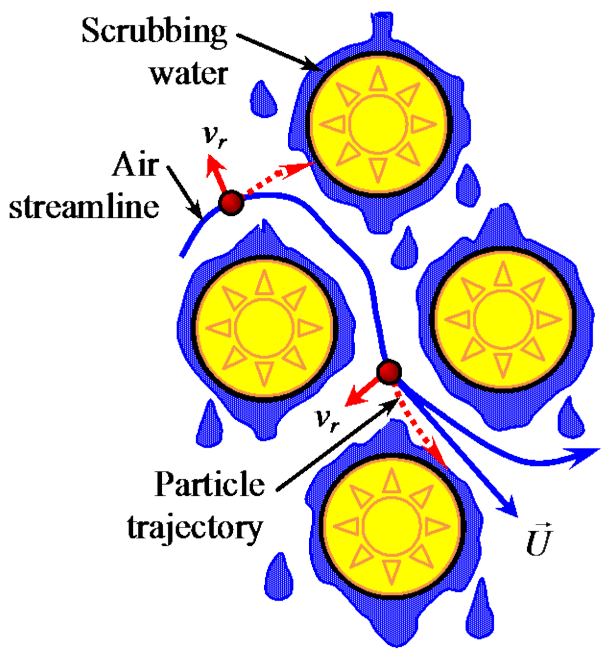
Equations: $\boxed{E\left(D_p\right)=1-\exp\left(-\frac{L}{L_c}\right)}$, where $\boxed{L_c=\frac{2}{3}\frac{Q_a}{Q_s}\frac{V_c}{V_{t,c}}\frac{D_c}{E_d\left(D_p\right)}}$ and $\boxed{V_c=V_{t,c}-U_a}$.

Wet Scrubbers:

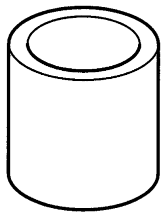
Example: **Transverse Packed-Bed Scrubber**:



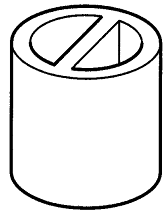
Close-up of packing elements, showing water and inertial separation of small particles:



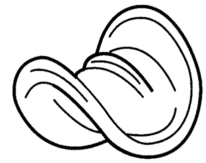
Packing elements come in all kinds of sizes, shapes, and materials:



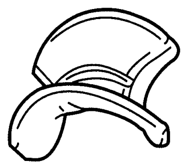
(a) Raschig ring



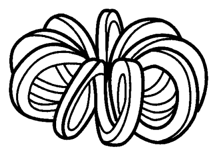
(b) Lessing ring



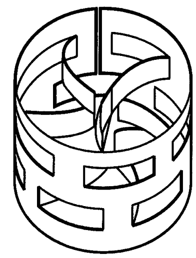
(c) Berl saddle



(d) Intalox saddle



(e) Tellerette ring



(f) Pall ring