Today, we will:

- Discuss multiple-drop rain drop collection efficiency
- Discuss **spray chambers** (artificial rain chambers to remove particulate matter)

Example: Single-drop collection grade efficiency for one particle diameter

Given: Raindrops of diameter 200 microns are falling through dusty air at STP (ρ = 1.184 kg/m^3, μ = 1.849 × 10^{-5} kg/(m s)). The uniformly distributed aerosol particles are of unit density (ρ_p = 1000 kg/m^3), and of diameter 2 microns. In a previous example problem, we calculated single-drop collection grade efficiency $E_d(D_p)$ = 1.14968% for these particles.

To do: If we model the raindrops as 100 drops lined up in series (above each other), calculate the grade efficiency $E(D_p)$ as a percentage to 3 significant digits for these particles.

Solution:

Cleaners in Parallel:

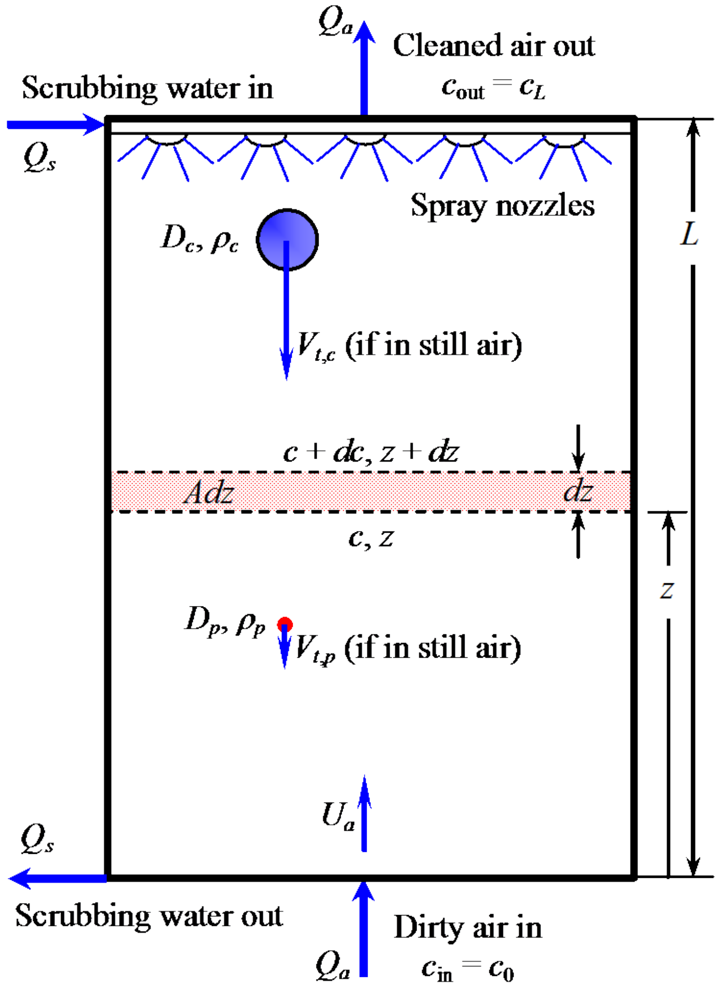
$$E\left(D_p\right)_{\text{overall}} = 1 - \sum_{j=1}^{m} f_j \left[1 - E\left(D_p\right)_j\right], \quad f_j = \frac{Q_j}{Q_{\text{total}}}$$

Cleaners in Series:

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

Counter-Flow Spray Chamber

Schematic diagram:



Example: Number Concentration of Water Drops in a Spray Chamber

Given: A counter-flow spray chamber 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_c = 0.38215 m/s (falling speed of water drops in absolute reference frame)

To do: If the drops are randomly and uniformly distributed throughout the spray chamber, calculate the number concentration $c_{\text{number,c}}$ of collector water drops in units of millions of drops per cubic meter (Mdrops/m^3) to three significant digits.

Solution: