# Hygroscopic Dynamics of Solution Phase Aerosol on Generation and Inhalation to the Lungs

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## BACKGROUND

- Soft Mist Inhalers (SMIs) deliver bronchodilators for COPD treatment, overcoming limitations of conventional inhalers such as coordination of actuation and environmental impact.
- Drug deposition profile of SMIs is a function of particle size distribution, with an optimal range of 1-5 μm for effective deep lung delivery.
- Hygroscopic growth of aerosol particles, influenced by the transition from ambient to lung relative humidity (RH) is poorly understood.

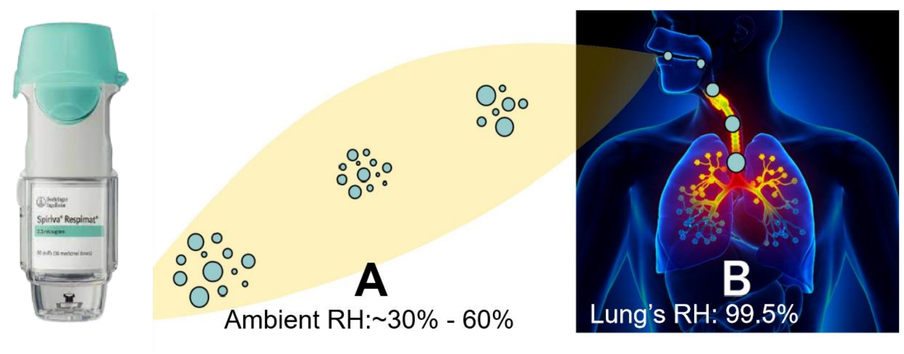



Figure 1: Diagram of droplet dynamics of SMIs on generation and inhalation to the lungs [1]

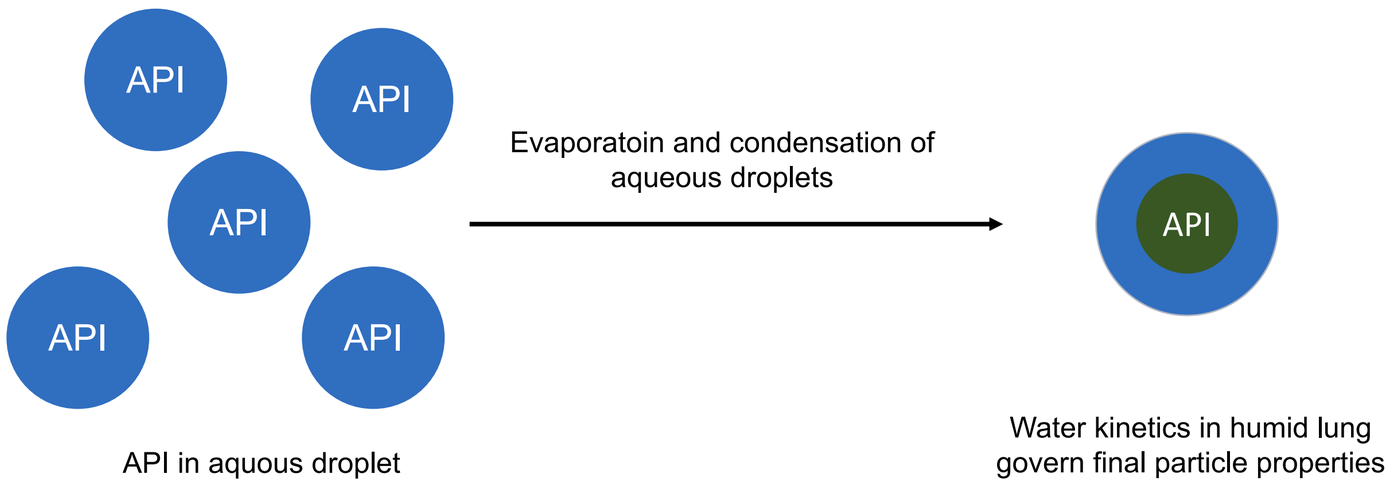



Figure 2: Aqueous aerosol production and dynamic aerosol processes occurring during inhalation of SMIs [2]

## AIM

- To explore the impact of hygroscopic growth on particle size dynamics of aerosols from generation to lung deposition employing TAPS and CK-EDB.
- To revise current drug deposition models to include hygroscopic growth dynamics.
- To develope a Next Generation Impactor (NGI) simulator.

## METHODS

### Tandem Aerodynamic Particle Sizers (TAPS)

- Measuring plume size distribution under varying relative humidity (RH)

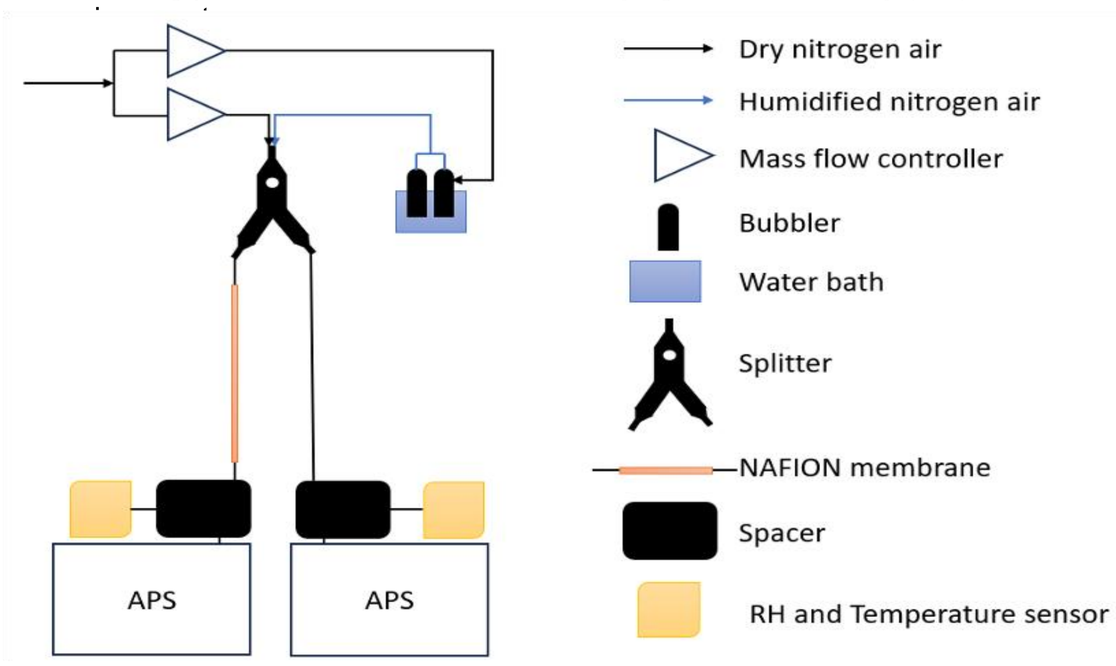



Figure 3: Experimental set up of TAPS [3]

### Comparative Kinetics Electrodynamic Balance (CK-EDB)

- Studying hygroscopicity of single droplets to understand individual particle behavior.

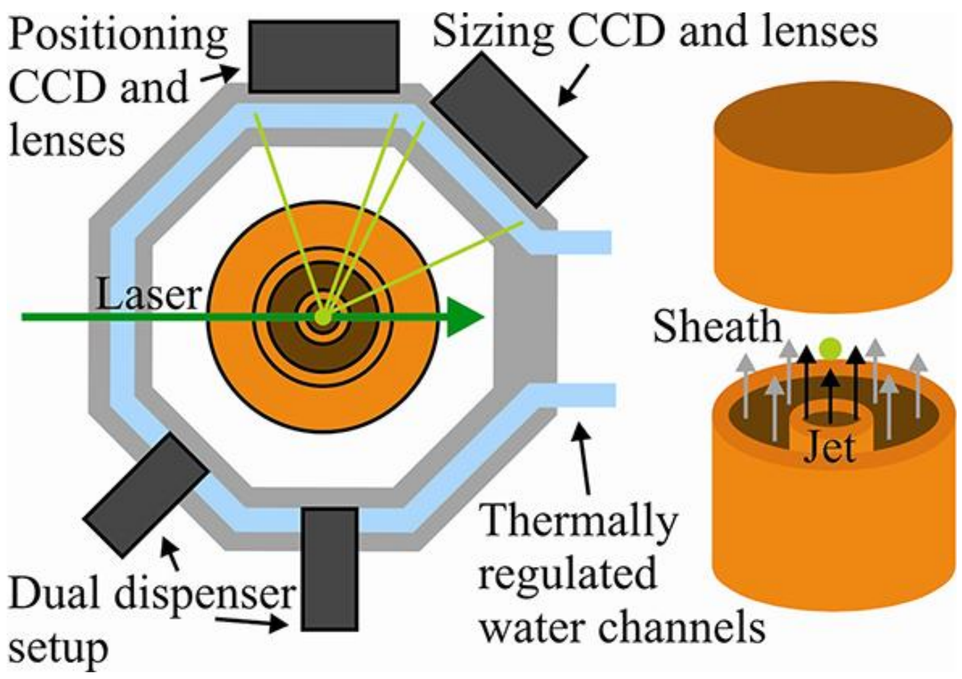



Figure 4: Experimental set up of CK-EDB [4]

## MODELS

### Models (E-AIM and AIOMFAC)

- Comparing experimental results with theoretical predictions to understand the hygroscopic dynamics of SMIs aerosols.

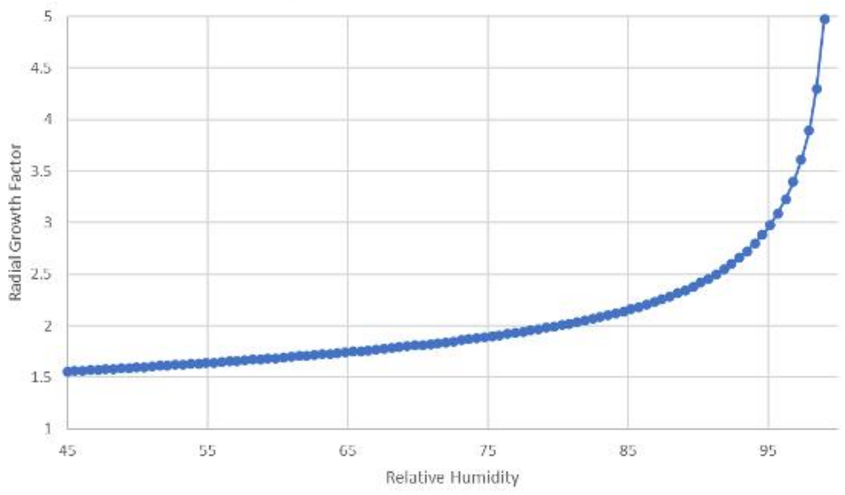
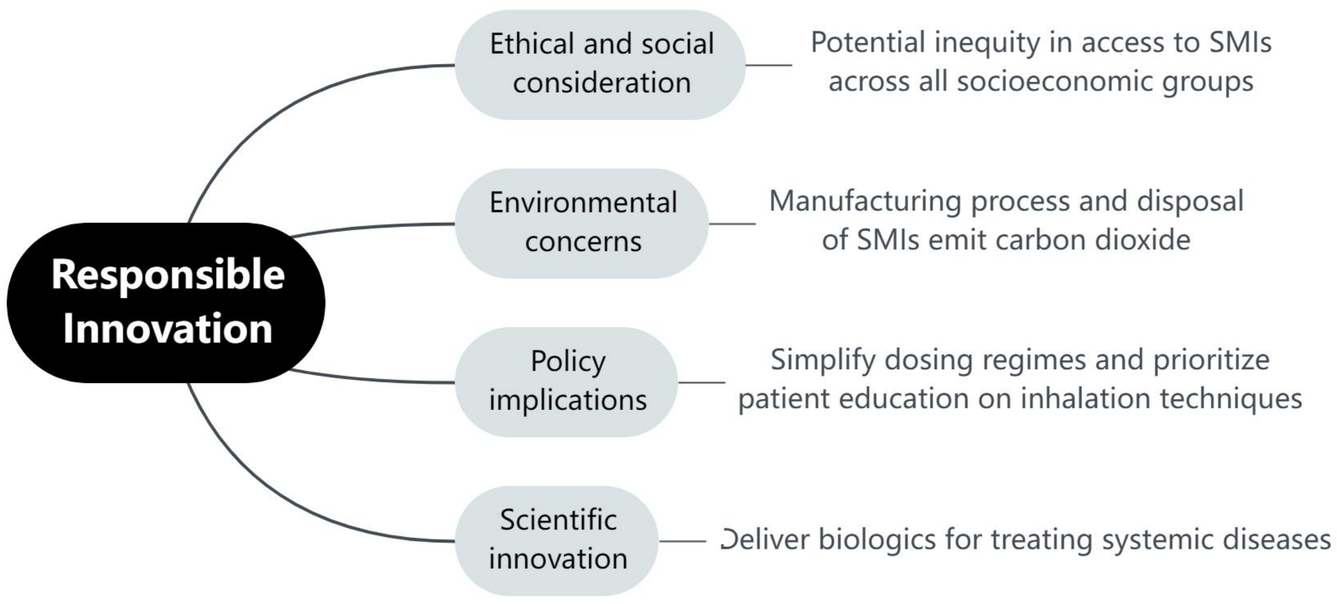



Figure 5: The radial growth factor curve for Sodium Chloride under RH from 45% to 99% determined by E-AIM model [3]

## INNOVATION




## CHALLENGES

- Specific setup of TAPS for SMIs requires a newly designed inlet and tailored splitter to ensure engineering precision and compatibility.
- Testing new APIs for SMIs presents formulation and financial challenges, including selecting appropriate ingredients, rigorous testing, and potential investment. In-house preparation of formulations carries risks, requiring careful implementation planning.

### REFERENCES

1 JP Reid et al (2019). The Microphysics of Aerosol Particle Transformations on Inhalation

2 NC Armstrong Green (2022). Dynamic Response of Hygroscopic Pharmaceutical Aerosol on Inhalation.

3 Jiang et al (2023). Drug Delivery to the Lungs, Volume 34.

4 Davies, J. F et al (2013). Simultaneous analysis of the equilibrium hygroscopicity and water transport kinetics of liquid aerosol. Analytical Chemistry.