

E-cigarette Aerosol Dynamics in a Physical Model of the Adult Human Oral/Pharyngeal/Tracheal Cavity

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Objective

- ❑ To generate experimental data to validate a computational fluid dynamic (CFD) model for e-cigarette aerosol deposition in respiratory tract



Physical Model

- Physical Prototypes created from digital geometry using 3D printer

- Wall covered with a layer of cotton cloth that can be saturated with water to reflect high relative humidity in respiratory tract

Oral/Larynx/Pharynx/Tracheal section

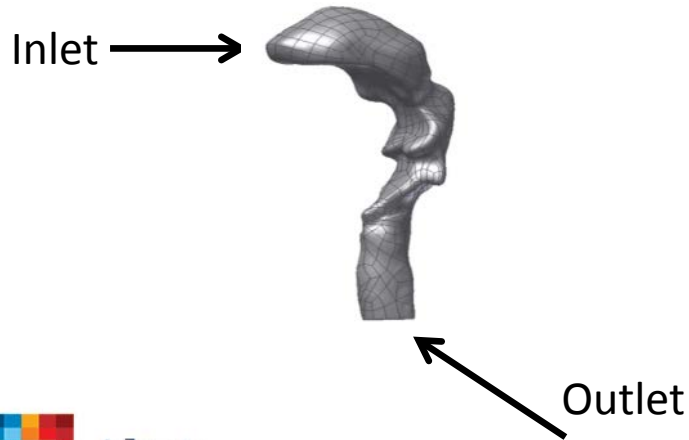
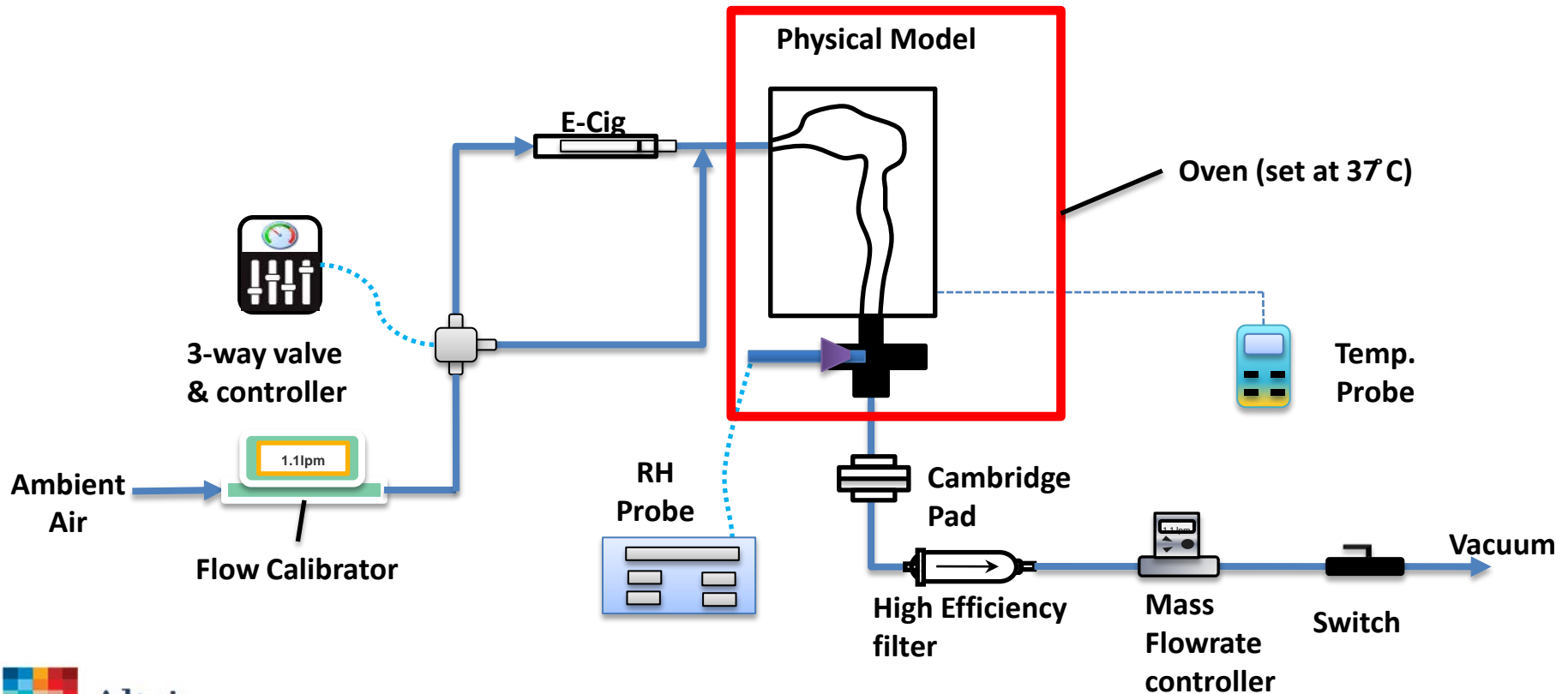


Diagram of the Experimental Setup



Experimental Conditions

Case	E-liquid composition	puff duration (sec.)	puff volume (cc)	Temperature (C)	Wall conditions
N-1	2.5% Nicotine by weight (NBW), 15% water, 49.5% PG/Gly 33%	3	55	37	wet
N-2	2.5% NBW, 15% water, 49.5% PG/Gly 33%	3	55	37	dry
N-3	2.5% NBW, 10% water, 87.5% PG	3	55	37	wet
N-4	2.5% NBW, 10% water, 85.5% Gly	3	55	37	wet

Procedures

- 3 puffs E-cig warm up
- 1.1 L/min constant flow rate
- 11 sec air wash between puffs
- 3 replicates /cartridge and 3 cartridges/case
- 5 continuous puffs for gravimetric analysis, single puff for chemical analysis using GC/MS

Limitations

- Doesn't represent real inhalation
- Single fixed geometry
- Simple formulations without flavors

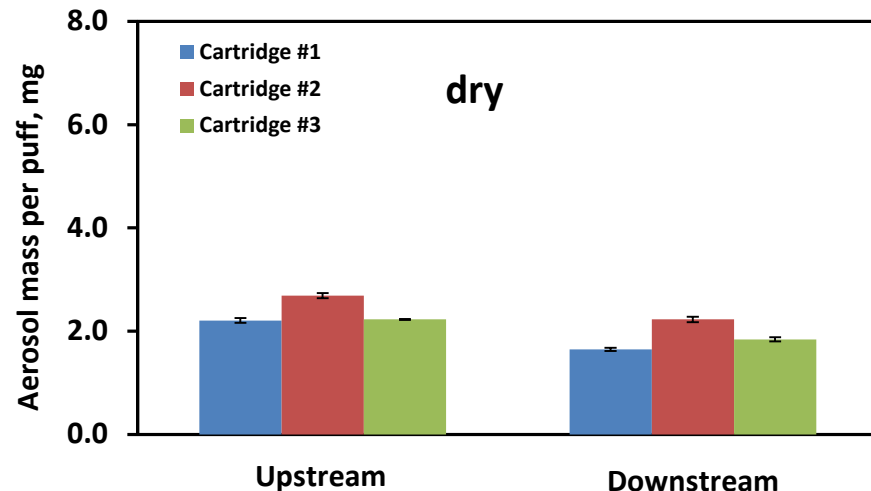
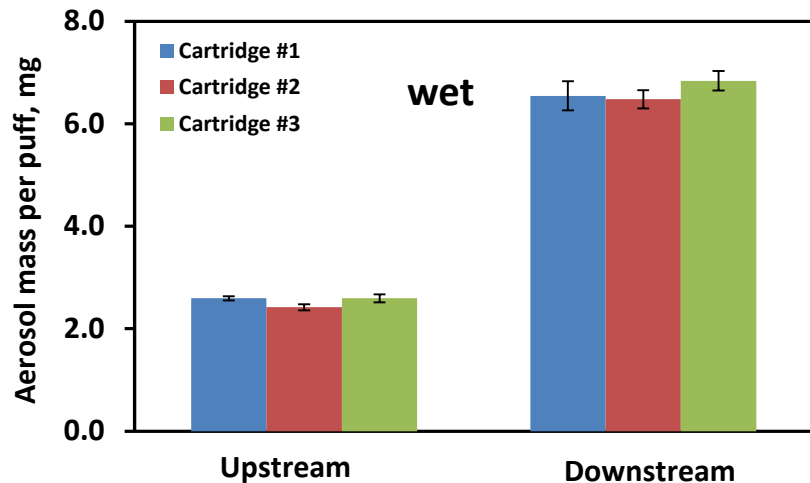


Gravimetric Analysis



Results – Gravimetric Analysis

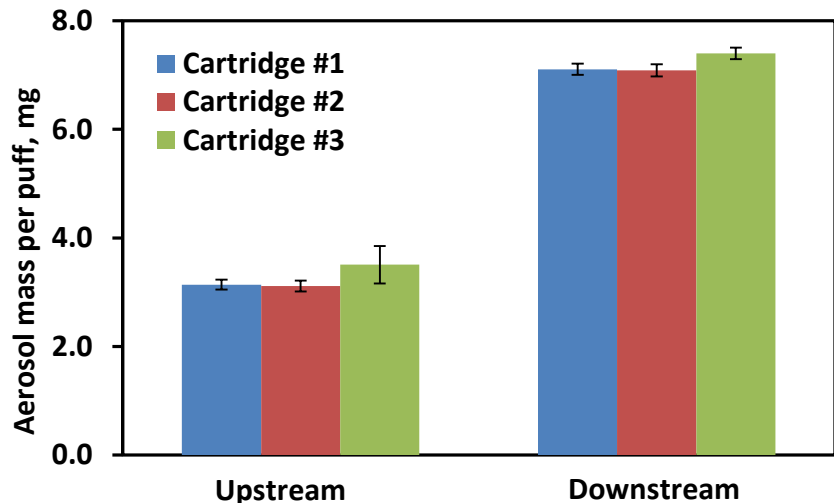
2.5% NBW, 15% water, 49.5% PG/Gly 33%



Physical model	Particle growth (wet), times
Oral/Pharyngeal	2.1
Oral/Pharyngeal/ Tracheal	2.6

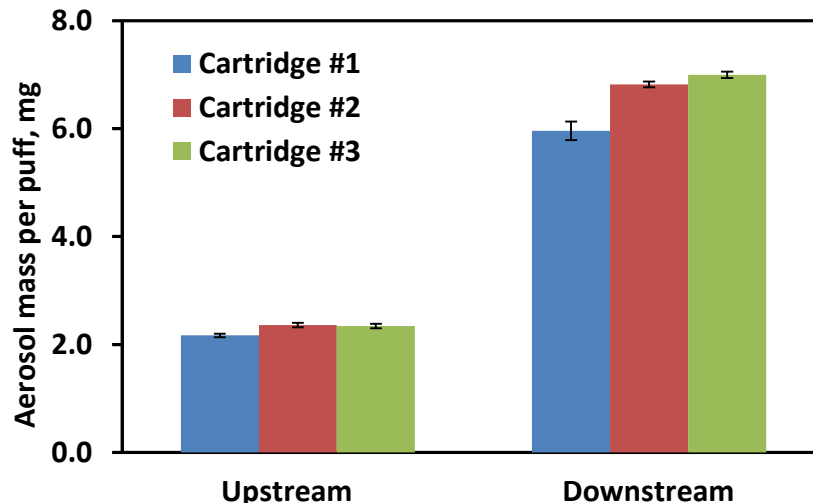
Results – Gravimetric Analysis

wet, 2.2 times increase



2.5% NBW, 10% water, 87.5% **PG**

wet, 2.9 times increase



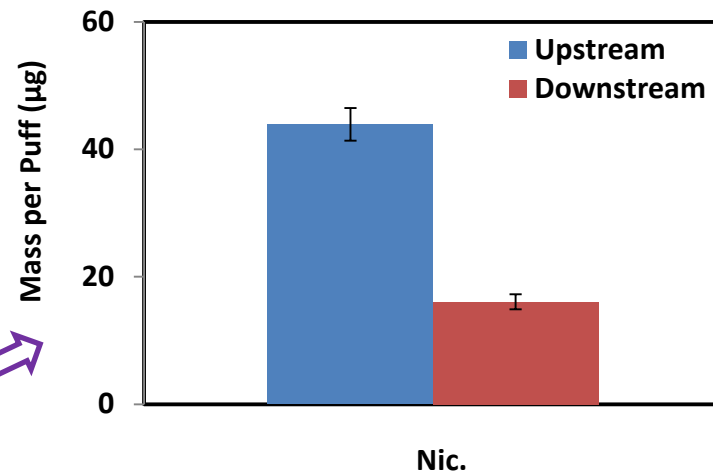
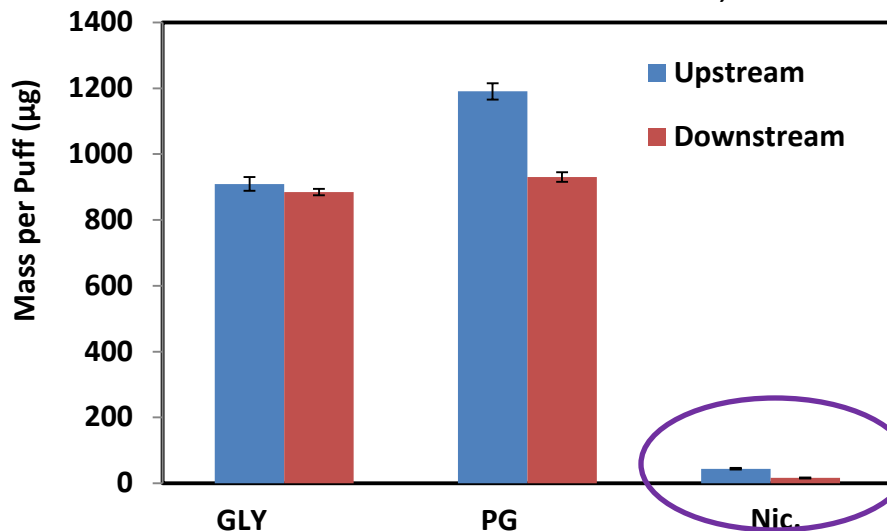
2.5% NBW, 10% water, 87.5% **Gly**

Chemical Analysis



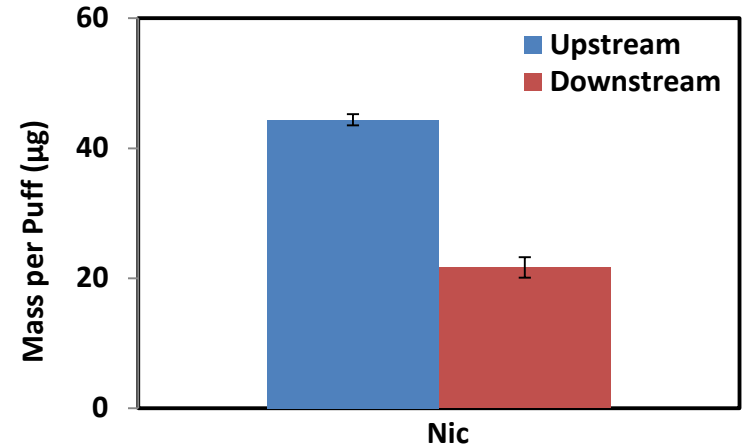
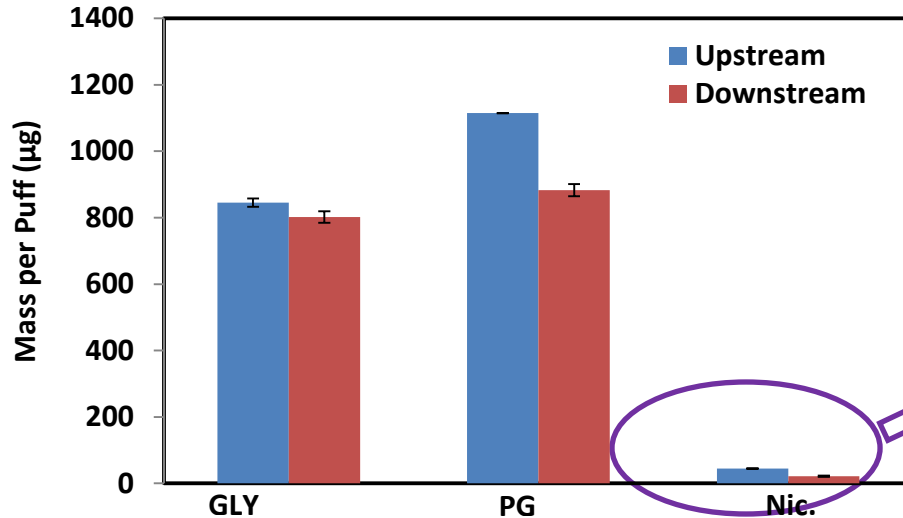
Results – Chemical Analysis (wet)

2.5% NBW, 15% water, 49.5% PG/Gly 33%



Physical model	Nicotine deposition, %
Oral/Pharyngeal	48
Oral/Pharyngeal/ Tracheal	63

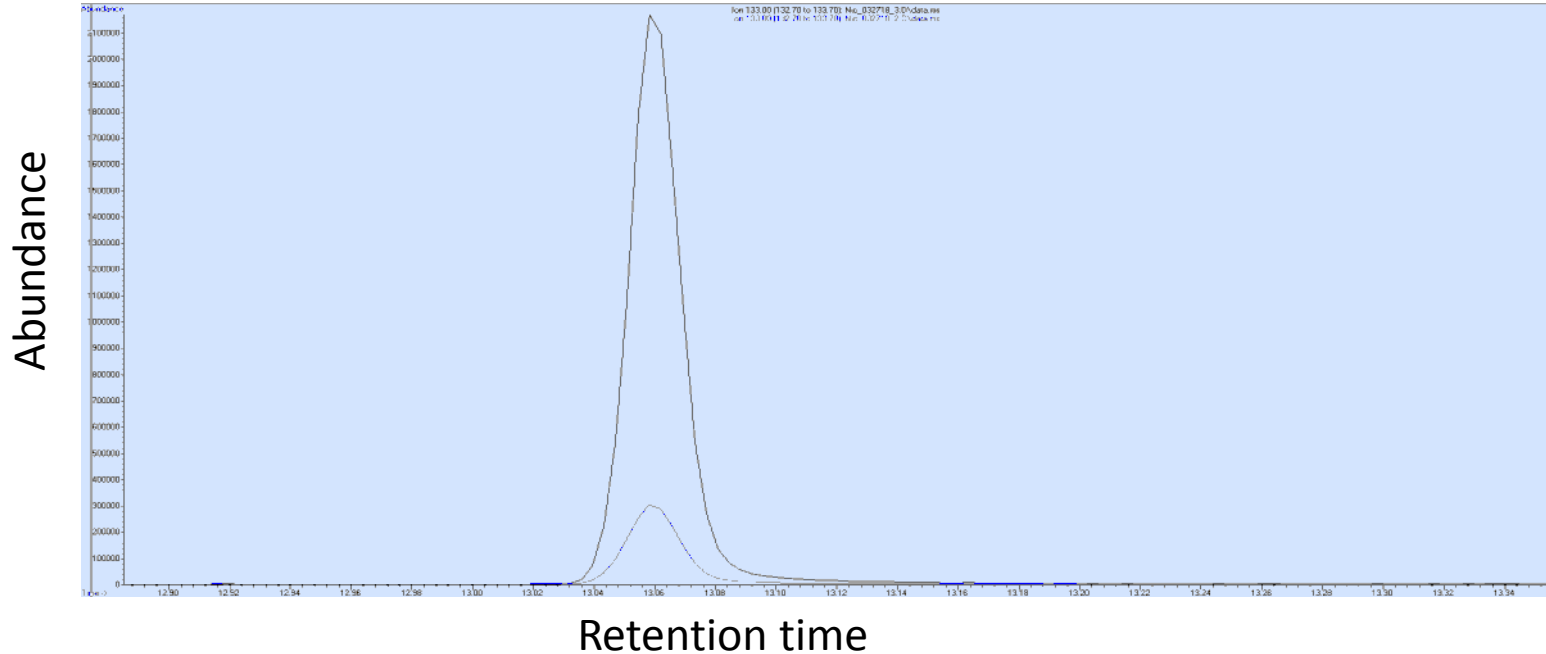
Results – Chemical Analysis (dry)



2.5% NBW, 15% water, 49.5% PG/Gly 33%

Nicotine Is Hydrophobic

10 ml water solution (contained 2.5% nicotine) mixed with 10 ml octanol

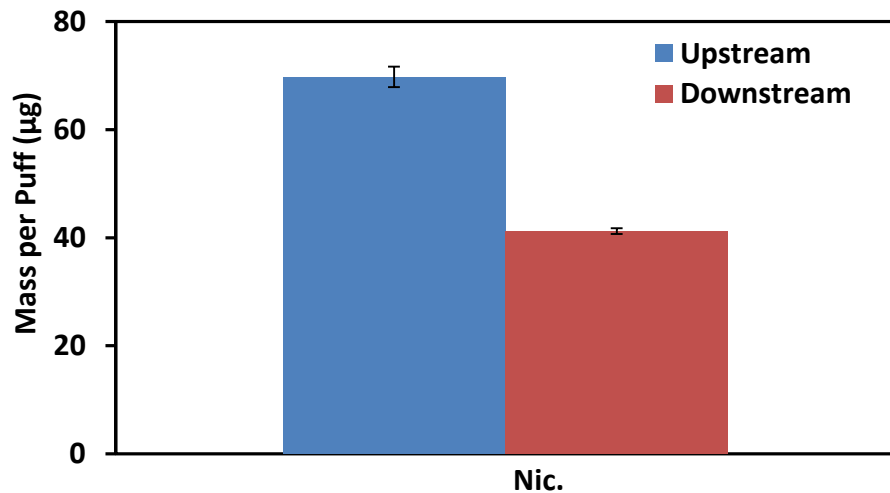


--- nicotine in octanol

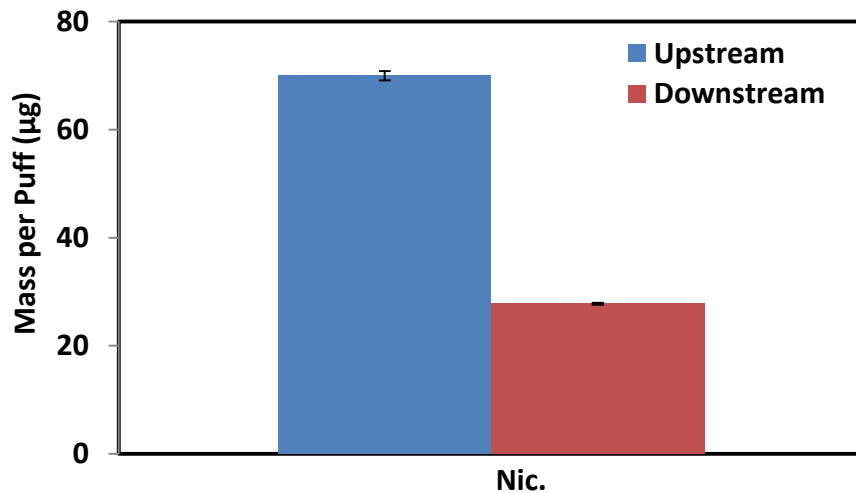
--- nicotine in water



Results – Chemical Analysis (wet)



2.5% NBW, 10% water, 87.5% **PG**



4.5% NBW, 10% water, 85.5% **Gly**



Summary

- Particle size and Nicotine deposition increases as the length of the physical model increases
- Nicotine deposition increases as a result of hygroscopic growth due to hydrophobicity of Nicotine
- The deposition of Nicotine is higher in Glycerin & water than in PG & water



Thank You!



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