The Degradation Products and Particle Aggregation Properties of Electronic Cigarette Vapor

Wesley Honeycutt June 17th, 2014



Origin and Background



- Electronic cigarettes are experiencing a surge in popularity
- Little is known about health effects

• Laws being passed without understanding of the Ayers, J. W.; Ribisi, K. M.; Brownstein, J. S. Tracking the Rise in Popularity of Electronic Nicotine Delivery Systems (Electronic Cigarettes) Using Search Query Surveillance. *American Journal of Preventive Medicine* **2011**, 40, 448–453. Williams, C. Winates of the Board of Regents for the Oklahoma Agricultural and Mechanical Colleges for the December 6, 2013 Meeting; Scholar's Inn Clubhouse, Langston Oklahoma, 2013; p. 75. Board of Regents for the Oklahoma Agricultural and Mechanical Colleges. 1-0530 Tobacco Use Policy, 2013.

The Electronic Cigarette







Preliminary Studies



Solvents: Propylene Glycol; Vegetable Glycerin; Water

Future Liquid Analysis

- Analyze many new samples—create database
- Reanalyze old samples for sample aging
- Separate nicotine isomers

 Column specific for isomeric separation
- Compare to standard solutions

Working with Vapor



Particles and the Lung



Kleinstreuer, C., Zhang, Z. & Donohue, J. F. Targeted Drug-Aerosol Delivery in the Human Respiratory System. *Annu. Rev. Biomed. Eng.* **10**, 195–220 (2008).



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Electron Microscopy





= average area in shaded squares

Rogak, S.N., Flagan, R.C., Nguyen, H.V., 1993. The Mobility and Structure of Aerosol Agglomerates. Aerosol Science

Particle Size Testing



Marple, V. A. *et al.* Next Generation Pharmaceutical Impactor (A New Impactor for Pharmaceutical Inhaler Testing). Part 1: Design. *J. Aerosol Med. Off. J. Int. Soc. Aerosols Med.* **16**, 283–299 (2003)



Comparisons of the particle size distributions of HFA-BDP (*top*), *CFC-FP* (*middle*), *and CFC-BDP* (*bottom*) showing mass before radiolabeling, mass after

radiolabeling, and counts after radiolabeling.

Leach, C. L., Davidson, P. J., Hasselquist, B. E. & Boudreau, R. J. Lung deposition of hydrofluoroalkane-134a beclomethasone is greater than that of chlorofluorocarbon fluticasone and chlorofluorocarbon beclomethasone*: A cross-over study in healthy volunteers. *CHEST J.* **122**, 510–516 (2002).



Burgt, J. A. V., Busse, W. W., Martin, R. J., Szefler, S. J. & Donnell, D. Efficacy and safety overview of a new inhaled corticosteroid, QVAR (hydrofluoroalkane-beclomethasone extrafine inhalation aerosol), in asthma. *J. Allergy Clin.*



Schripp, T., Markewitz, D., Uhde, E. & Salthammer, T. Does e-cigarette consumption cause passive vaping? Indoor Air

Combined Tests

How does the solution chemistry affect size



Marple, V. A. *et al.* Next Generation Pharmaceutical Impactor (A New Impactor for Pharmaceutical Inhaler Testing). Part 15 I: Design. *J. Aerosol Med. Off. J. Int. Soc. Aerosols Med.* **16**, 283–299 (2003)

Combined Tests

What levels of nicotine and other chemicals does a vaper take in?



(S)-Nicotine

- Where does nicotine settle in the lungs with e-cigarettes compared to nicotine from tobacco?
- Are chemicals of interest found in larger lung generations?

Work Beyond This Project

- Designed as a precursor experiment to experiments in collaboration with biological specialists.
 - Confirm nicotine/cotinine levels in blood and saliva
 - Study particle interactions with lungs in animal specimens
 - Long term risk associated with other chemicals in the particulate matter
- Use this study to design future devices for more accurate bodily absorption. Not necessarily just for nicotine

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