

Dynamic properties of exhaled e-cigarette aerosol vs. conventional cigarette smoke

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Introduction

- Growing discussion amongst public health organizations and the scientific community as to whether particles exhaled following the use of e-cigarettes has potential implications for indoor air quality and bystanders.
- There is little data available on the dynamic properties of exhaled e-cigarette aerosols and how they differ to those emitted when a conventional cigarette is smoked (i.e. smoke exhaled + side-stream smoke).

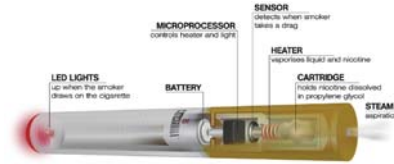
Objectives

- To investigate the spatial and temporal variations of exhaled aerosols following the use of an e-cigarette and a conventional cigarette in a room under controlled environmental conditions.

Indoor air quality study

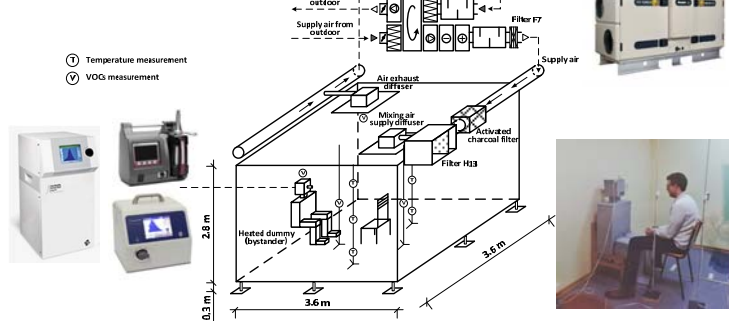
- Experienced adult volunteers smoked conventional cigarettes or vaped e-cigarettes in an exposure chamber under controlled conditions.
- The exposure chamber had a floor area of 13 m², a volume of 35.8 m³, and controllable ventilation rates. A bystander was simulated using a "dummy". The surface of the "dummy" was heated in the range 31-34°C, similar to the temperature of the surface of the human body.
- The concentrations and size distributions of airborne particles exhaled by the volunteer were measured at the bystander's position.

Representative typical cig-a-like e-cigarette:



Caponnetto et al., Journal of Medical Case Reports, 2011, 5:585.

Experimental setup:



List of instruments	Model	Parameter
Fast mobility particle sizer (FMPS)	TSI 3091	Particle number concentration and size distribution in the range 5.6-560 nm
Electrical low pressure impactor (ELPI)	Dekati ELPI+	Particle mass concentration and size distribution in the range 6 nm-10 µm
NanoScan	TSI 3910	Particle number concentration and size distribution in the range 10-420 nm

Results shown on this poster come from the FMPS.

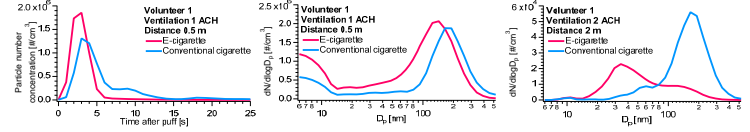
List of parameters	Values
Products	- cig-a-like e-cigarette (Puritane, UK market) - conventional cigarette (Marlboro Gold)
Volunteers	3
Distance between volunteer and bystander	0.5, 1.0, and 2.0 m
Ventilation rate	0, 1, and 2 air changes per hour (ACH)

Experiments:

- 1 puff every 30 sec during 3 min;
- In the case of the conventional cigarette, the cigarette is extinguished immediately after the last puff;
- The volunteer stays in the exposure chamber during 5 minutes after the last puff;
- Volume and puff duration, volume of inhalation during the puff up to the volunteer.

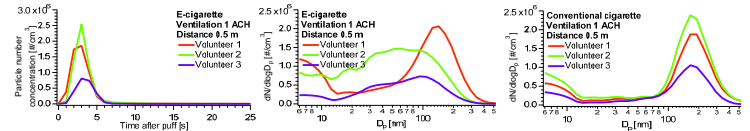
Results and discussion

Inter-comparison between products:



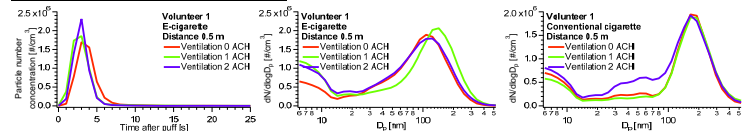
- At a short distance, no significant difference between products.
- At a large distance, the peak size of particles from e-cigarettes shrank from 150 to 30 nm due to evaporation.

Inter-comparison between volunteers:



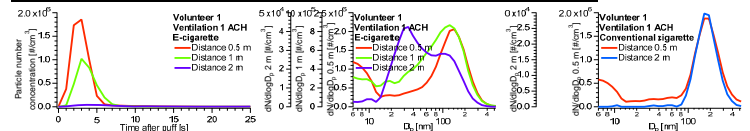
- In general, important differences among volunteers in terms of total particle concentration, sometimes also in terms of size distributions.

Influence of the ventilation rate:



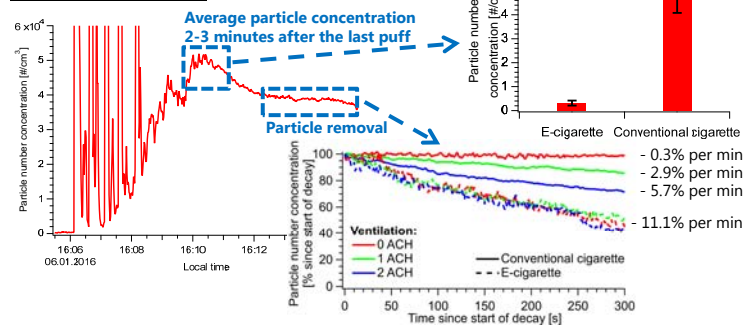
- No significant impact of ventilation rate on particle concentration and size distribution during puffs.

Influence of the distance between the volunteer and the bystander:



- Exponential decrease of the particle concentration with the distance.
- For e-cigarette, shrink of the particle size (evaporation) with increasing distance.
- For conventional cigarette, size distribution stable with distance.

Particle concentration and removal after successive puffs:



- After successive puffs, clear accumulation of conventional cigarette particles.
- The removal of conventional cigarette particles depends on the ventilation rate.
- E-cigarette particles are removed much faster by evaporation, independently of the ventilation rate.

Conclusion

- Particles exhaled after the use of e-cigarettes and conventional cigarettes have different behaviors:
 - E-cigarettes:** fast evaporation of volatile compounds, particles disappear 10-15 seconds after the puff.
 - Conventional cigarettes:** particles more stable than those from e-cigarettes, their removal is longer and depends on the ventilation rate.
- The spatial and temporal variations of particles reflect the different chemical compositions of conventional cigarette and e-cigarette particles:
 - ➔ solid combustion particles vs. liquid droplets.

Acknowledgements

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- This work was performed in Lithuania in accordance with the Code of Academic Ethics of the Kaunas University of Technology.