Assessment of the total volatile organic compounds in indoor air during use of the Tobacco Heating System THS 2.2

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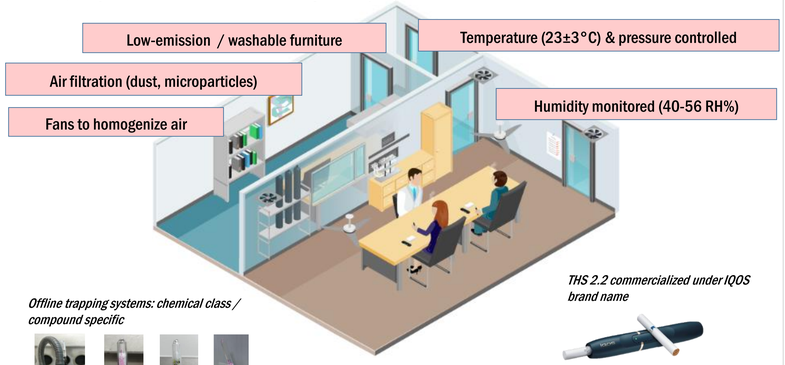
Introduction and Objectives

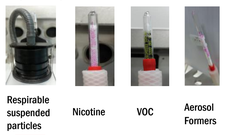
- The Tobacco Heating System (THS) heats the tobacco instead of burning it and has the potential to present less risk of harm to smokers who switch to these products versus continued cigarette smoking.
- To evaluate presence of potential polluting substances during indoor use of THS, a portfolio of methods have been established [1]. One of these methods aims at the determination of total volatile organic compounds (TVOC) based on ISO 16000-6-2011, as this parameter allows to indicate the joint exposures to several VOCs in indoor air [2].
- Objective of this study was to evaluate the contribution of real-life use of THS 2.2 on indoor air quality (IAQ). The determination of the TVOC value was found to be very challenging for matrices with low chemical content. Thus additional aspects than those detailed in ISO method 16000-6 needed to be considered.

Facility

To evaluate the influence of THS 2.2 use on IAQ, 23 analytes were investigated (covered by eleven accredited methods; adapted from ISO standards or newly developed).



Offline trapping systems: chemical class / compound specific



THS 2.2 commercialized under IQOS brand name

Environmental specifications according to CEN Standard (EN 15251:2007)

Environments	Ventilation Rate [m^3/h]	Air changes [per hour]	Design Occupancy [m^2/person]	Total no of test items
Residential I	121	1.68	8	12
Residential II	87	1.20	8	12
Residential III	**37**	**0.5**	**8**	**12**
Office	156	2.16	8	16
Hospitality	555	7.68	4.8	32

Organization of sessions

9:00	10:00	11:00	12:00	13:00	14:00	15:00
Preparation of the room	**People present in the room not using any product**		Break Room ventilated	**Same people, THS 2.2 or cigarette used according to study protocol**		End of the sessions

Background (BKG)
How people contribute to indoor air pollution

Environmental Tobacco smoke (ETS) or Environmental Aerosol (EA)
How do products contribute to indoor air pollution

Method Adaptation

- According to ISO norm 16000-6, the TVOC value expresses the sum of VOCs eluting between C_6 – C_{16} on a non-polar column by converting the total area of peaks eluting in that chromatographic window to a nominal mass (using the chromatographic response for toluene).
- For an appropriate determination of the TVOC value, especially for low concentrated matrices like background indoor air or indoor air enriched with EA, the applied method needs to limit to the utmost influences due to analytical or environmental contaminations.
- Thus the control of further parameters, beyond those described in the ISO norm 16000-6, were found essential to determine the TVOC values for such matrices.

	TVOC parameters
Analytes	- Volatile organic compounds eluting between C_6-C_{16} on a non-polar column - External standard calibration with toluene
Sampling	- 200 mg Tenax TA® tubes; sampling flow rate 15-30 mL/min
Instrumental parameters	- Tubes desorption at 280°C with a Perkin Elmer Turbomatrix 650 ATD - non-polar GC column (Restek Rxi-5MS; 60 m x 0.25 mm ID, 0.25 µm) - Passive column splitter for FID and MS (mass range 29-500 AMU) - Oven: 40°C (5min) – 5°C/min – 120°C (0min) – 10°C/min – 260°C (0min) – 100°C/min to 300°C (4.6min)
Adaptations from ISO 16000-6-2011	- TVOC value is expressed as sum of concentrations from peaks above 7 ng/tube (equivalent to 2 µg/m^3 when sampled at 30 mL/min for 2 h) - Parallel detection with FID and MS - Inclusion of certified reference standard (Markes BTX tube) in each sequence
Additional parameters considered	- Filtration of incoming air (activated charcoal and dust filters) - High ventilation and cleaning of the room between sessions to limit cross-contamination from previous sessions - Control of Tenax TA® tubes (every tube is conditioned and checked prior sampling) - Replacement of thermal desorber seals after ~500 injections (requires 50-80 bake-out cycles on instrument or conditioning of seals and particle filters at elevated temperature for 2 h under vacuum) - Use of brass caps with PTFE ferrules for storage (other type of caps led to contaminations) - Dedicated laboratory for TVOC sample preparation and instrumental analysis (avoid use and storage of chemicals) - Control of environmental conditions (food, beverages, newspaper, cosmetics, etc.)

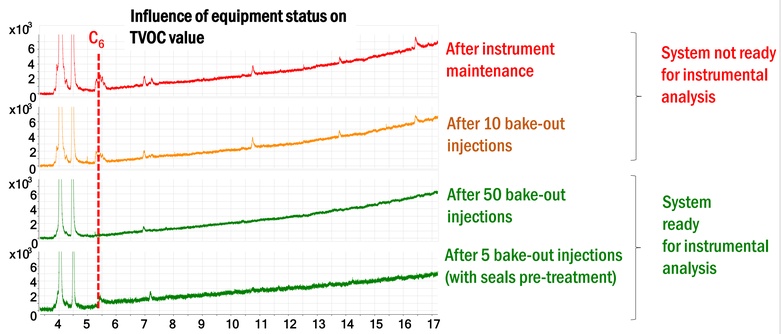


Figure 1: TVOC chromatograms obtained from blank tubes after instrument maintenance

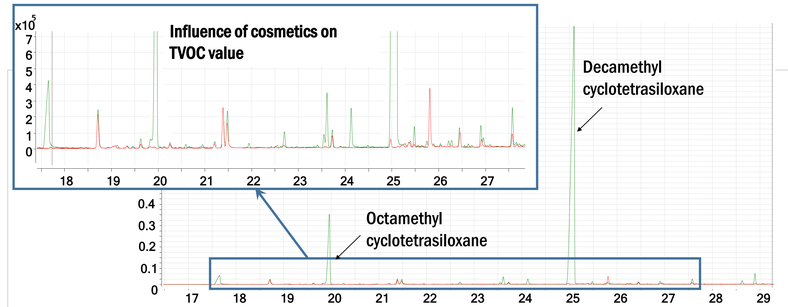


Figure 2: TVOC chromatograms obtained for indoor air with panelists using defined cosmetic kits or free choice cosmetics in the sampling room

Peaks > 2µg/m^3: 10 with imposed cosmetics (TVOC value 52) ,
26 with free choice cosmetics used in the sampling room (TVOC value 1217)

Results

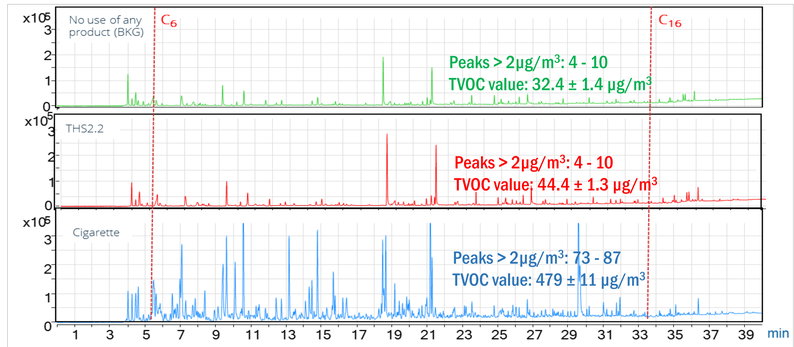


Figure 3: TVOC chromatograms obtained for indoor air, and indoor air enriched with EA of THS 2.2 or ETS of cigarettes

Conclusion

- TVOC analysis for matrices with low chemical pollution (e.g. EA or BKG) is challenging
- Consideration of diverse sources of analytical contamination is essential (e.g. storage of tubes, bake-out of seals, dedicated analytical laboratory)
- Consideration of environmental conditions as source of contaminations (e.g. cross-contamination from previous sessions, food and beverages, cosmetic articles)
- The TVOC analysis, conducted in the frame of an IAQ study applying extreme conditions (low air exchange / high consumption), revealed highly similar chemical profiles as well as TVOC values for the background air and air during use of THS 2.2.

Reference

1. N. Mottier et al., Validation of selected analytical methods using accuracy profiles to assess the impact of a Tobacco Heating System on indoor air quality, Talanta, 2016, 158, 165-178
2. European Commission, Indoor air quality & its impact on man, report No 19, Total Volatile Organic Compounds (TVOC) in indoor air quality investigations, EUR 17675, 1997

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Smoke Science and Product Technology
(SSPT 2017), Kitzbühel, Austria
08. – 12. October 2017

Competing Financial Interest
The research described in this poster was sponsored by Philip Morris International