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Air Quality assessment during indoor use of the Tobacco Heating System 2.2

THS 2.2. is commercialized under the IQOS brand name

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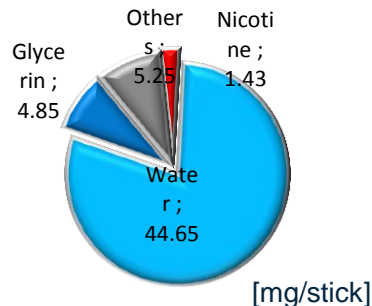
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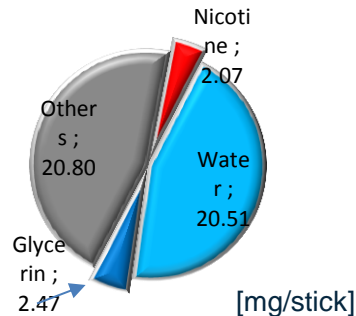
PMI Tobacco Heating System 2.2 vs. cigarette



Tobacco Heating System



Cigarette

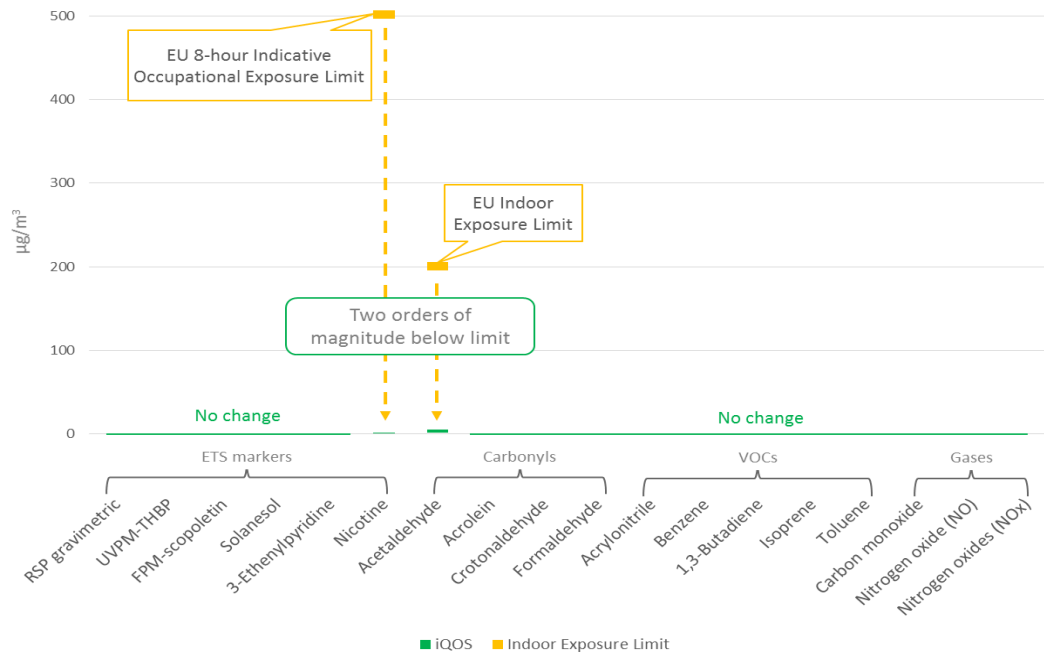


Heating maintains the tobacco temperature below combustion, which creates an aerosol with a very different composition compared to cigarette smoke

- Main constituents are water, glycerin and nicotine
- The concentrations of Harmful or Potentially Harmful Compounds (HPHCs) in THS 2.2 aerosol are reduced on average by 90 to 95% compared with smoke from a 3R4F standard reference cigarette (HC smoking regime)*.

*Schaller et al, 2016. Evaluation of the Tobacco Heating System 2.2 Part 2: Chemical composition, genotoxicity, cytotoxicity, and physical properties of the aerosol. *Regul. Toxicol. Pharmacol.*

THS 2.2 in simulated indoor environments



Following the use of THS 2.2 under Residential category I and II, Office and Hospitality environments (EN 15251:2007)*:

- Only two compounds increased above background: nicotine and acetaldehyde
- Their levels much lower than maximum exposure levels in air quality guidelines

*Mitova et al, 2016. Comparison of the impact of the Tobacco Heating System 2.2 and a cigarette on indoor air quality. *Regul. Toxicol. Pharmacol.*

IAQ room and simulated environments

Simulated environments: EN 15251:2007

Environments	Air changes [per hour]	Design Occupancy [m ² /person]	Test items
Residential I	1.68	8	12
Residential II	1.20	8	12
Residential III	0.50	8	12
Office	2.16	8	16
Hospitality	7.68	4.8	32



Air change: 0.5 to 12.2 per hour

Ventilation: 37 to 879 m³/h

Air filtration (dust, microparticles, VOCs)

Low-emission / washable furniture

Fans to homogenize air

Temperature (23±3°C) & pressure controlled

Humidity monitored (40-56 RH%)

Selection of markers

Category – (Norm) -[unit]	Constituents	Rationale for selection
ISO measurement standards for ETS (ISO Norms 15593, 2001; 18144, 2003; 18145, 2003; 11454, 1997) - [µg/m ³]	RSP gravimetric, UVPM-THBP, FPM-scopoletin, Solanesol, 3-Ethenylpyridine, <u>Nicotine</u>	PM2.5 & tobacco smoke related particulate matter markers Gas-phase tobacco smoke specific markers
ISO measurement standard for TVOCs (ISO 16000-6, 2011) - [µg/m ³]	Total Volatile Organic Compounds (TVOC)	Air quality marker
Carbonyls - [µg/m ³]	<u>Acetaldehyde, Acrolein, Crotonaldehyde, Formaldehyde</u>	Relevance for air quality
Volatile Organic Compounds (VOCs) - [µg/m ³]	<u>Acrylonitrile, Benzene, 1,3-Butadiene, Isoprene, Toluene</u>	Relative abundance in THS2.2 aerosol (i.e. the most abundant)
Tobacco-specific Nitrosamines (TSNAs) - [ng/m ³]	<u>N-nitrosonornicotine (NNN)</u> <u>Nicotine derived nitrosamine ketone (NNK)</u>	Carbonyls, VOCs, TSNAs: part of the FDA list of HPHCs
Product-specific compounds: aerosol formers- [µg/m ³]	Glycerin, Propylene Glycol	Product-specific markers
Inorganics (CO [ppm], NO [ppb], NO _x [ppb])	<u>Carbon monoxide</u> , Nitrogen oxide, Nitrogen oxides	Gas-phase tobacco smoke non-specific markers Gas-phase combustion marker



How to measure the impact of THS 2.2?

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 used according to study protocol		End of the sessions



Background (BKG)
How people contribute to indoor air pollution



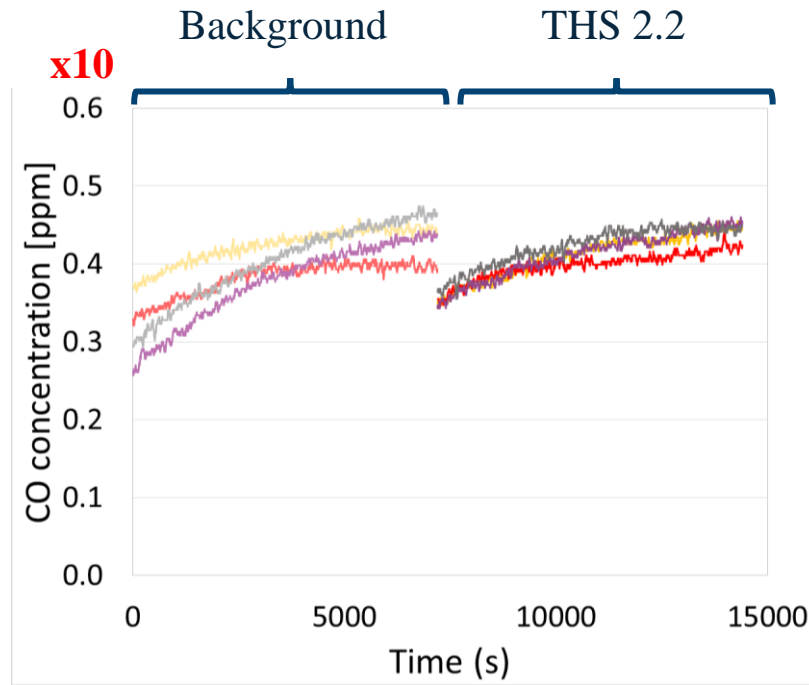
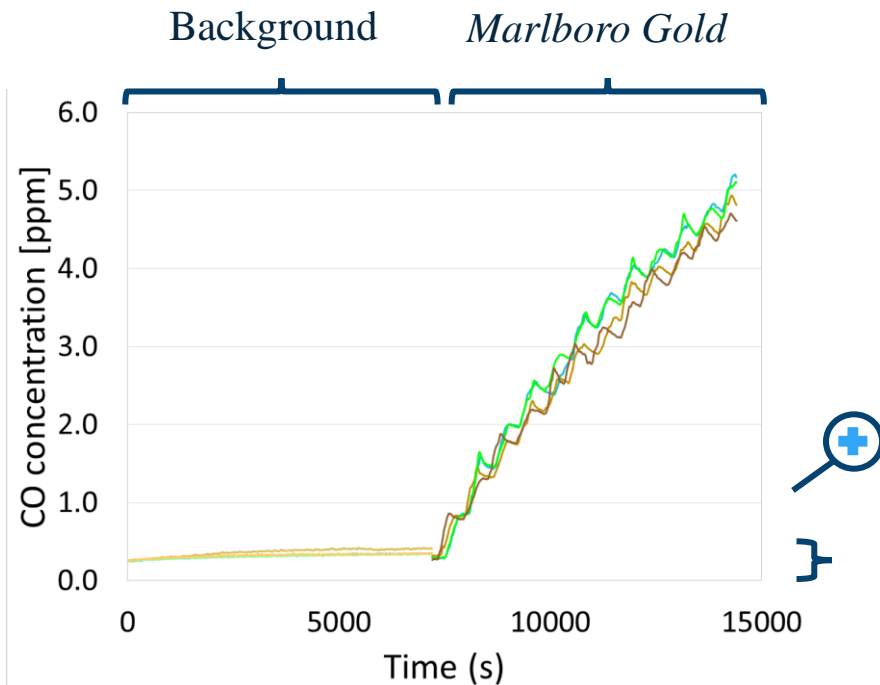
Product-use session
How product contributes to indoor air pollution



- Concentration in product-use sessions is not increased above BKG: **NO IMPACT ON IAQ**
- Concentration is different between BKG and product-use sessions: **THE IMPACT IS THE DIFFERENCE BETWEEN PRODUCT-USE SESSION AND BKG**
- Concentrations are compared to existing air quality guidelines (e.g. WHO, EU, MOH)

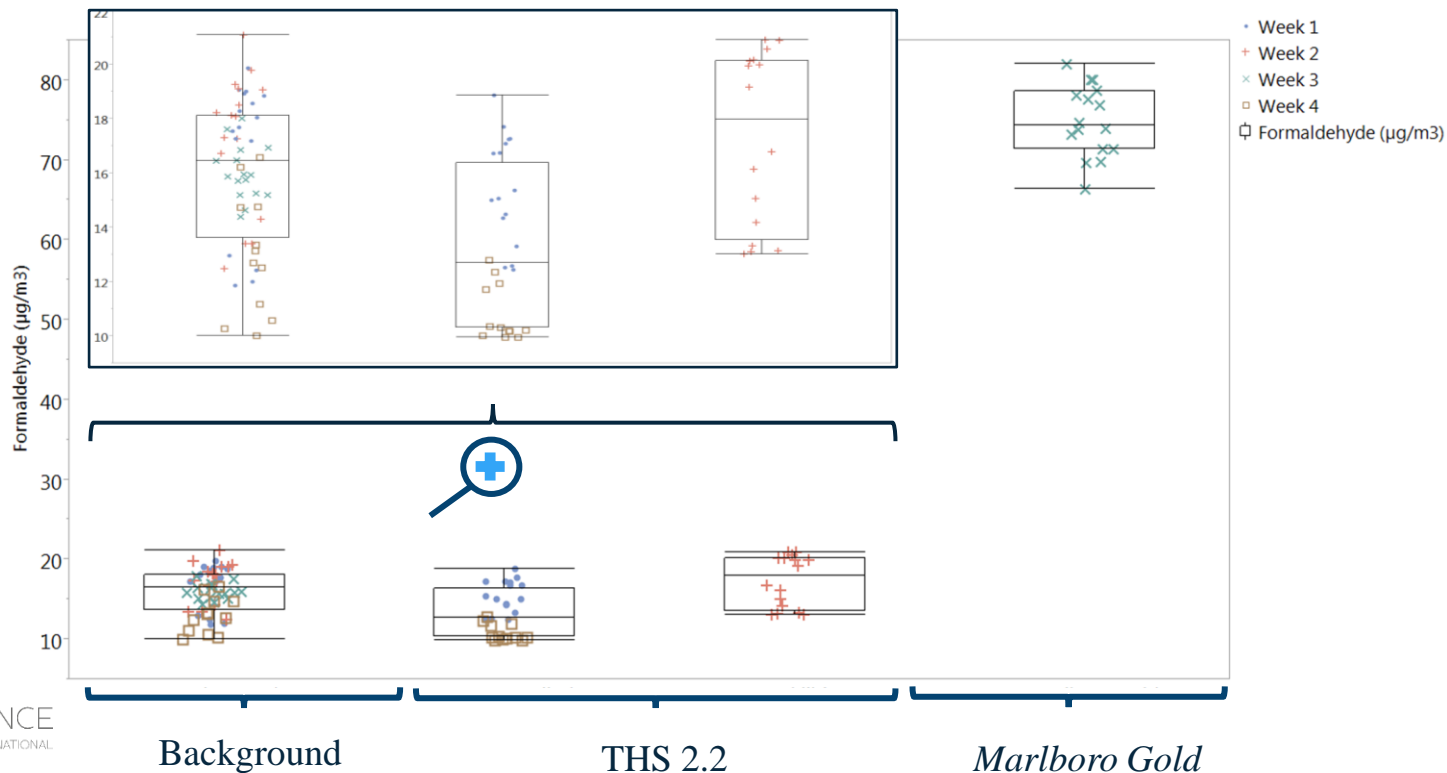
Example: Carbon monoxide

Non-specific marker of ETS. IAQ marker: **10 ppm (WHO)**



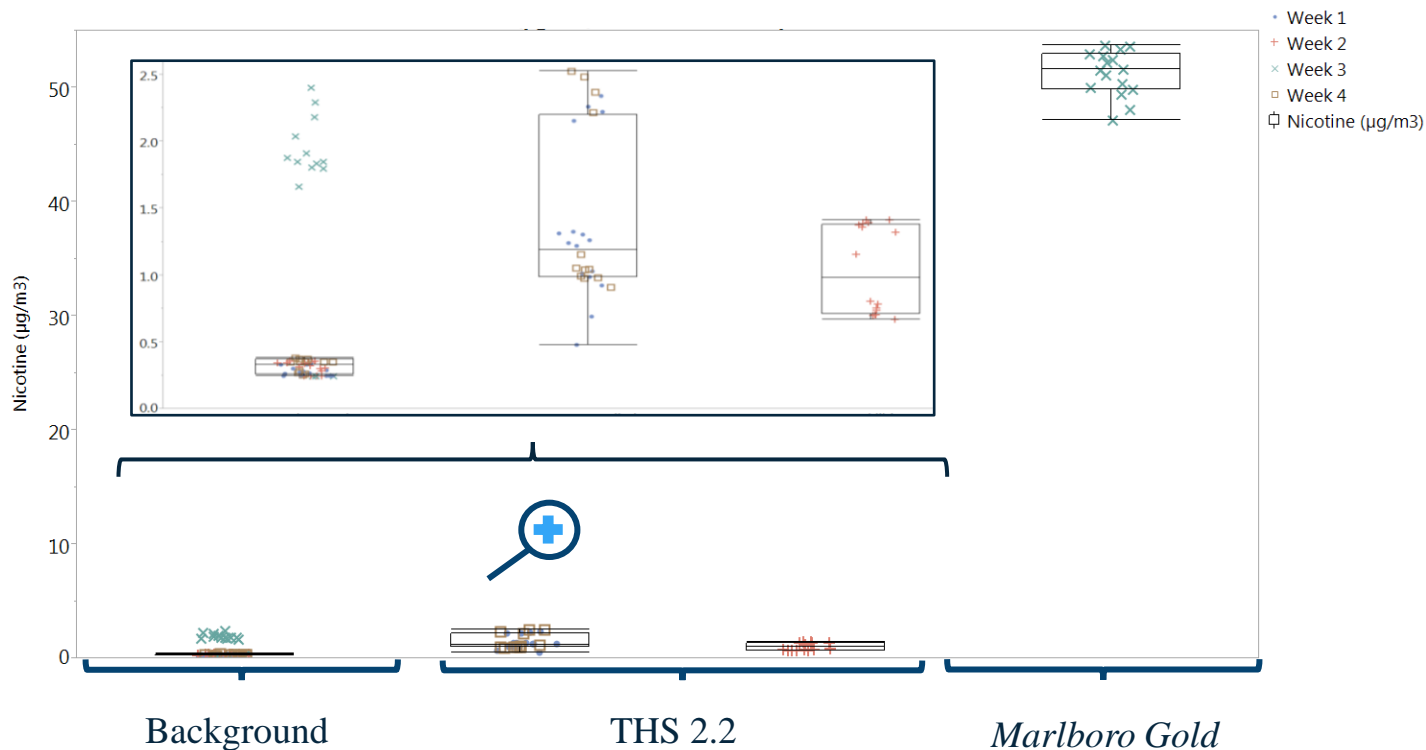
Example: Formaldehyde

Non-specific marker of ETS. IAQ marker: **100 $\mu\text{g}/\text{m}^3$ (WHO)**



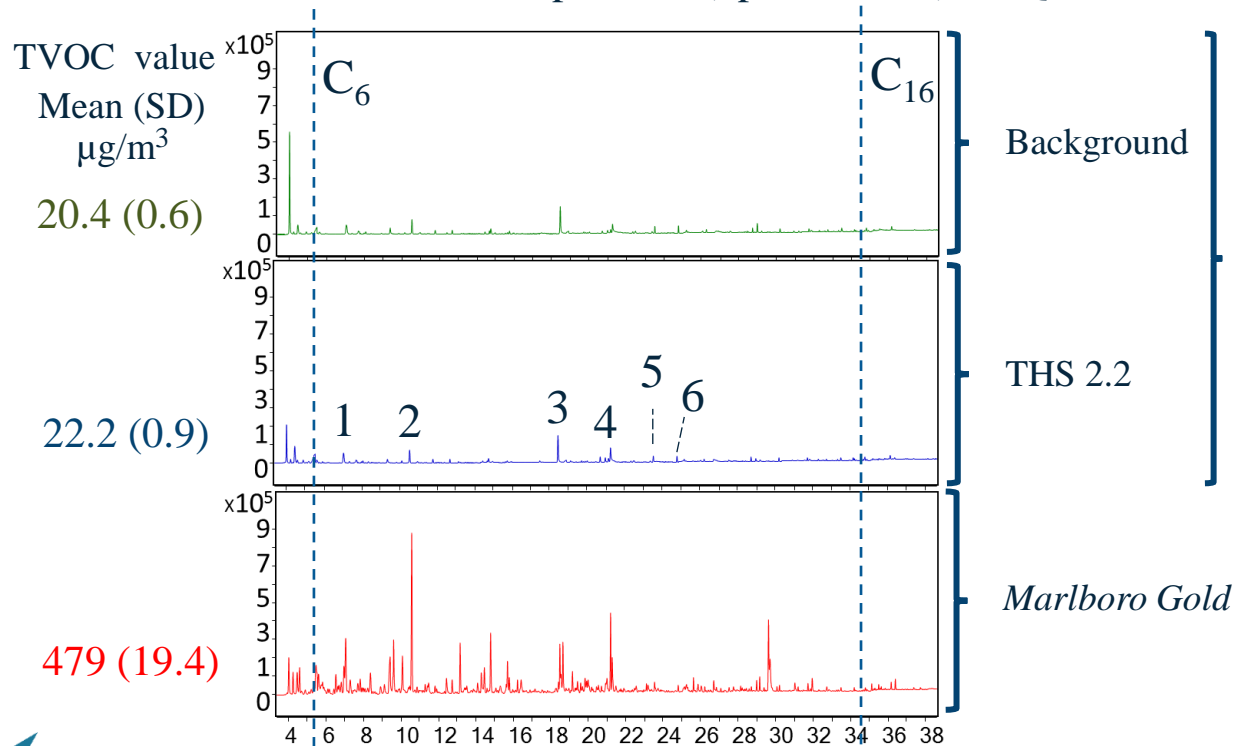
Example: Nicotine

Above background in THS 2.2 session but significantly lower compared with cigarette. **EU: 500 $\mu\text{g}/\text{m}^3$.**



Example: Total Volatile Organic Compounds

Broader view of chemical composition (bp 69-287°C). IAQ marker: **400 $\mu\text{g}/\text{m}^3$ (MOH, Japan)**

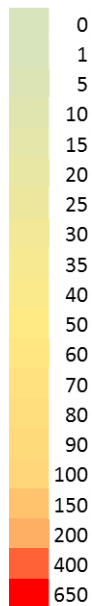


Compounds above $2 \mu\text{g}/\text{m}^3$: butanol (1), cyclotrisiloxane (2), benzaldehyde (3), benzyl alcohol (4), nonanal (5), decamethylpentasiloxane (6)

The chemical compositions of Background & environmental aerosol of THS 2.2 are comparable in contrast to ETS

Table of results

$\mu\text{g}/\text{m}^3$



Analyte [unit]

RSP gravimetric [$\mu\text{g}/\text{m}^3$]
 UVP-THBP [$\mu\text{g}/\text{m}^3$]
 FPM-scopoletin [$\mu\text{g}/\text{m}^3$]
 Solanesol [$\mu\text{g}/\text{m}^3$]
 3-Ethenylpyridine [$\mu\text{g}/\text{m}^3$]
 Nicotine [$\mu\text{g}/\text{m}^3$]
 Acetaldehyde [$\mu\text{g}/\text{m}^3$]
 Acrolein [$\mu\text{g}/\text{m}^3$]
 Crotonaldehyde [$\mu\text{g}/\text{m}^3$]
 Formaldehyde [$\mu\text{g}/\text{m}^3$]
 Acrylonitrile [$\mu\text{g}/\text{m}^3$]
 Benzene [$\mu\text{g}/\text{m}^3$]
 1,3-Butadiene [$\mu\text{g}/\text{m}^3$]
 Isoprene [$\mu\text{g}/\text{m}^3$]
 Toluene [$\mu\text{g}/\text{m}^3$]
 TVOC [$\mu\text{g}/\text{m}^3$]
 NNN [ng/m^3]
 NNK [ng/m^3]
 Glycerin [$\mu\text{g}/\text{m}^3$]
 Propylene glycol [$\mu\text{g}/\text{m}^3$]
 CO [ppm]
 NO [ppb]
 NO_x [ppb]

Residential I
 Residential II
 Residential III
 Office
 Hospitality

THS 2.2 is not a source of Environmental Tobacco Smoke (absence of combustion markers)

2 compounds listed as HPHCs clearly attributable to the use of THS 2.2:
Nicotine & acetaldehyde

Concentrations of **glycerin** 100 times below the existing guideline levels

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THS vs Background
 (difference in units)

Residential I
 Residential II
 Residential III
 Office
 Hospitality

236 268 642 204 147

39.6 40.8 92.1 38.5 18.4

8.05 8.5 20.4 7.88 4.04

10.2 9.84 23.8 10.2 4.68

6.02 7.61 10.5 6.39 3.94

29.7 29.1 49.8 34.7 34.6

70.2 83.8 123 58.8 33.1

6.94 5.65 11.6 6.42 3.03

2.19 2.11 3.54 2.04 0.99

27.1 35.5 58.4 28.9 17.5

2.53 3.61 5.26 2.61 1.36

7.09 9.24 14.4 6.58 3.5

13 16.8 17.4 12.6 5.79

71.5 99.4 164 75.9 37

11.1 26.1 25 14.9 8.76

nm 144 451 nm nm

nm nm 8.89 nm nm

nm nm 1.49 nm nm

nm nm 10.3 nm nm

nm nm 60.5 nm nm

1.63 2.17 2.66 1.58 0.92

26.2 35.6 59.4 27 14.8

29.4 39.7 62.8 29.4 15.3

Cigarette vs Background
 (difference in units)

nm – not measured

PM2.5 & tobacco smoke-related chemical markers

Compounds selected based on:

- Relevance for air quality
- Relative abundance in THS 2.2 aerosol (i.e. the most abundant)

Product specific markers

Gas-phase combustion marker

In simulations of residential environment with low air change and high consumption of THS 2.2 :

- Markers of combustion **are absent**
- THS 2.2 **does not emit** Environmental Tobacco Smoke (ETS)
- Out of the measured compounds only three compounds, **nicotine, acetaldehyde** and **glycerin** were found at very low concentrations. These levels are below the maximum exposure levels as defined in existing air quality guidelines.

Using THS 2.2 indoors has no negative impact on the overall air quality