PMI SCIENCE
PHILIP MORRIS INTERNATIONAL

Dos and don’ts in the design of indoor air quality studies on smoke-free products

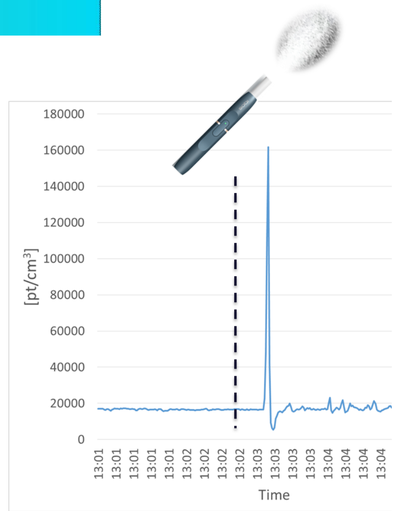
Maya I. Mitova, Catherine Goujon-Ginglinger, Maria Gomez Lueso, Michel Rotach, Serge Maeder
PMI R&D, Philip Morris Products S.A., CH-2000 Neuchâtel, Switzerland

2020 Online CORESTA Congress

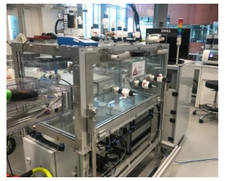
2020 CORESTA ONLINE Congress
12 October – 12 November 2020

The research described in this presentation was sponsored by Philip Morris International.

Introduction



- Electrically heated tobacco products (EHTP) and e-vapor products (EVP) are consumer products with intermittent emission patterns
- No officially standardized assessment procedures exist
- Different research groups assess the environmental aerosols of EHTPs and EVPs using various settings



Exposure chamber with controlled environmental parameters

Simulation in model room with controlled environmental parameters

Simulation in real-life environment with no control on environmental parameters

- Some discrepancies in research findings

Markers of environmental aerosols

Particulate-phase markers

Non-specific: RSP-gravimetry; UVPM, FPM, Particulate Matter (PM_1-PM_{10}), ultrafine particles (UFP)

Specific: Solanesol, glycerin

Partitioning between particulate and gas phases: NNK and NNN

Gas-phase markers

Non-specific: Acetaldehyde, acrolein, crotonaldehyde, formaldehyde, acrylonitrile, benzene, 1,3-butadiene, isoprene, toluene, Total Volatile Organic Compounds TVOC (C_6-C_{16} window), catechol, hydroquinone, CO, CO_2, NO, NO_x, NH_3, O_3

Specific: 3-Ethenylpyridine, nicotine, propylene glycol

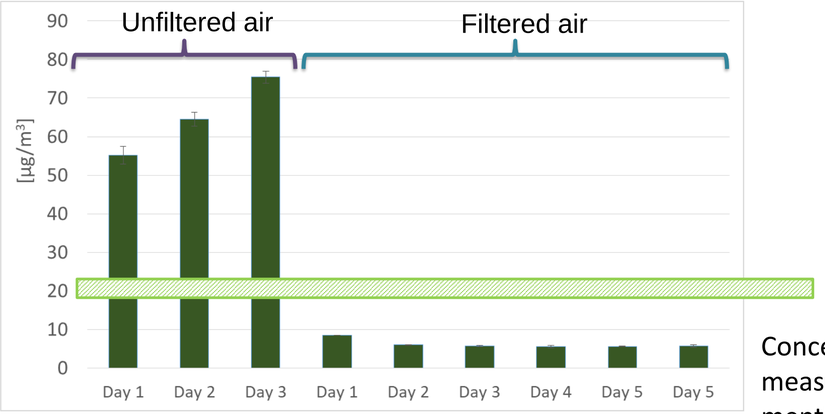
Majority of studies on the environmental aerosols of EHTPs and EVPs evaluate airborne nicotine, PM, UFP, carbonyls and TVOC.

Model environment

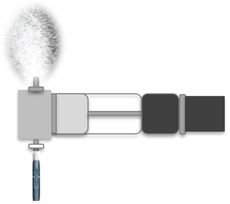
Environmentally controlled exposure room

24.1 m², 72.3 m³
Air change: 0.5 to 12.2 per hour
Air filtration (dust, microparticles, VOCs)
Low-emission/washable furniture
Temperature (23 ± 3°C) & pressure controlled
Fans to homogenize air
Humidity monitored (40–56 RH%)

TVOCs in unoccupied room



Concentration of TVOCs measured during use of non-mentholated THS 2.2



Machine puffing: Surrogate environmental aerosol
- Lower variability
- Overestimation of airborne constituent levels

Human users
- Genuine puffing regimen
- Realistic retention of mainstream aerosol constituents after inhalation

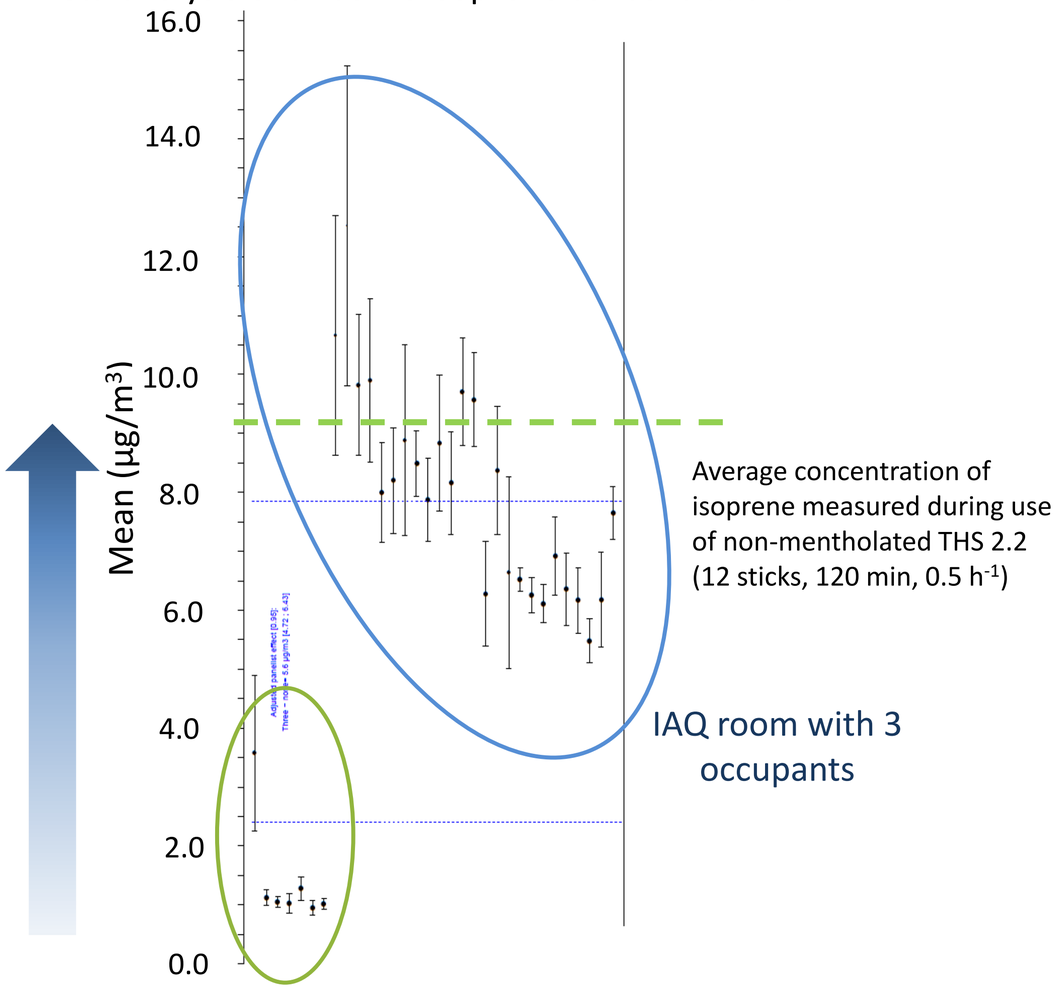
Data for the figures were published in doi: 10.1007/s11869-019-00697-6 and 10.1007/s11869-019-00697-6

PMI SCIENCE
PHILIP MORRIS INTERNATIONAL

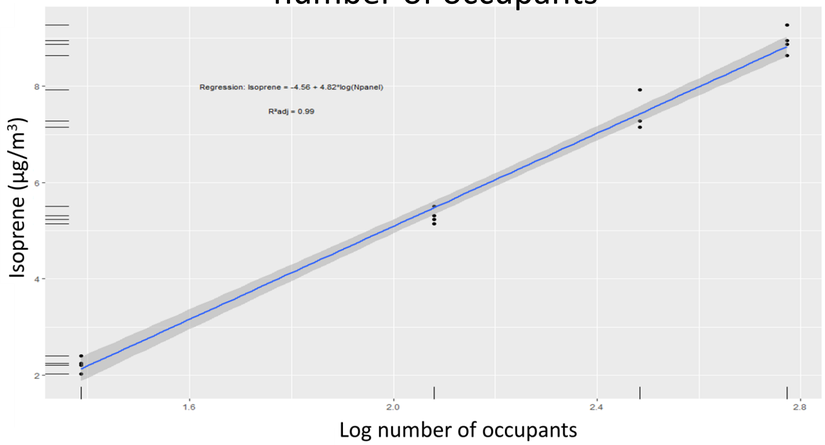
Do people make a difference?

Human presence leads to increase of indoor concentrations of isoprene, TVOC, formaldehyde and acetaldehyde.

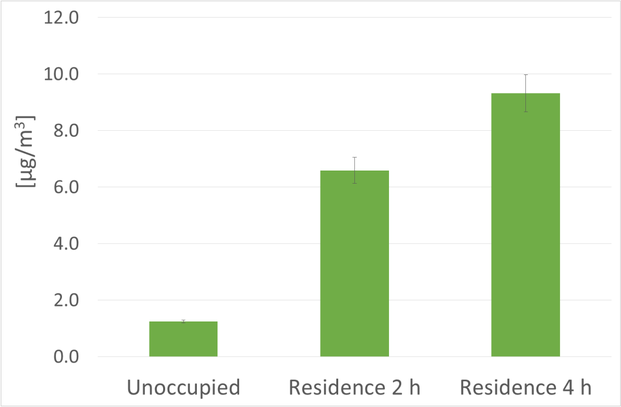
Meta-analysis of airborne isoprene concentrations



Regression of airborne isoprene concentrations to increasing number of occupants



Airborne isoprene concentrations at different durations of residence



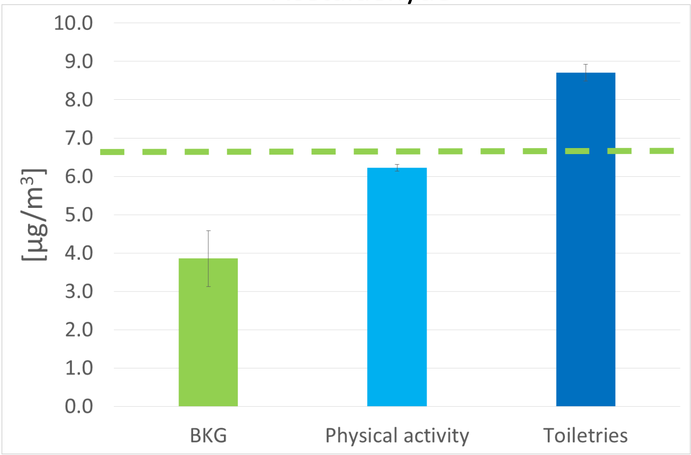
Data for the figures were published in doi: 10.1007/s11869-019-00697-6 and 10.1007/s11869-019-00697-6

Do human activities make a difference?

Daily living and recreational activities lead to increase of indoor concentrations of carbonyls, VOCs and particulate matter.

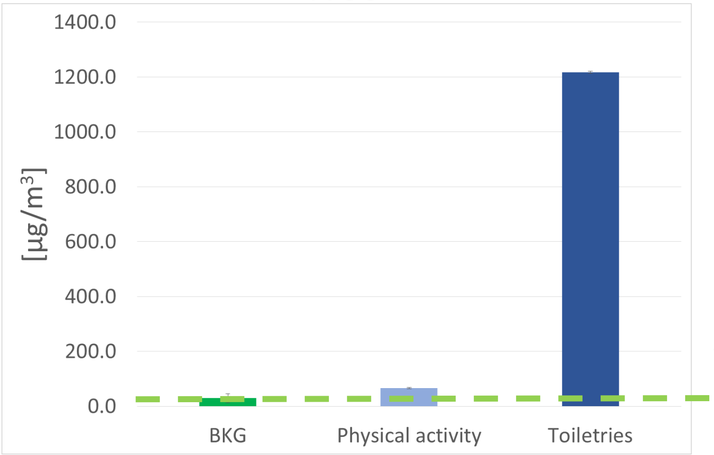
Impact of physical activity and using scented toiletries

Acetaldehyde



Average concentration of acetaldehyde measured during use of non-mentholated THS 2.2 (12 sticks, 120 min, 0.5 h^{-1})

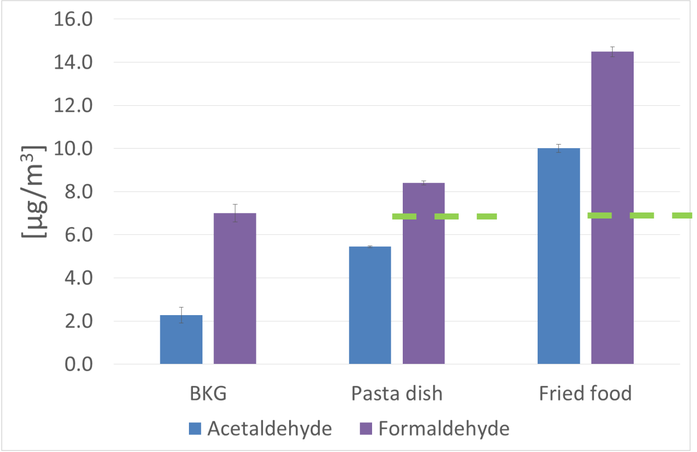
TVOC



Average concentration of TVOC measured during use of non-mentholated THS 2.2 (12 sticks, 120 min, 0.5 h^{-1})

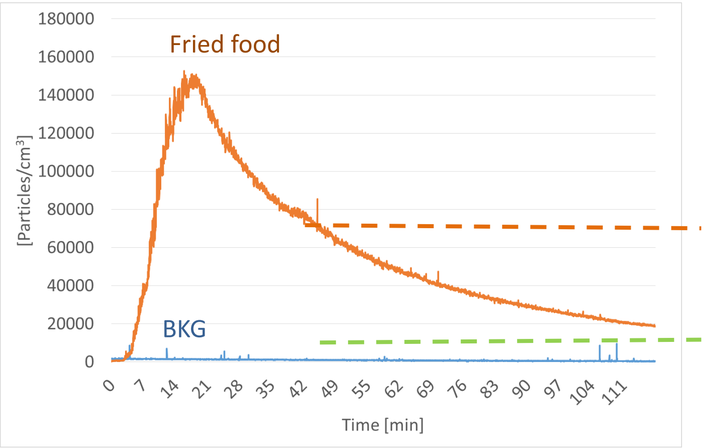
Impact of serving hot food

Acetaldehyde and formaldehyde



Average concentration of acetaldehyde measured during use of non-mentholated THS 2.2 (12 sticks, 120 min, 0.5 h^{-1})

Ultrafine particles



Average concentration of UFP measured during serving of fried food

Average concentration of UFP measured during use of THS 2.2 (12 sticks, 120 min, 0.5 h^{-1})

Data for the figures were published in doi: 10.1007/s11869-019-00697-6 and 10.1007/s11869-019-00697-6

PMI SCIENCE
PHILIP MORRIS INTERNATIONAL

Design requirements for simulations with human users

- Air in an unoccupied room is an appropriate background only for experiments with machine puffing
- Experiments with human users: “room air” obtained in the presence of the same number of panelists as those during experiments with EHTPs and EVPs
- Experiments conducted in sequence: compulsory purge of experimental location to remove human-related emanations
- Restrictions on the use of personal care products
- Real-life environments: count the number of persons and keep record of food and drinks served
- The experiments must be replicated

Does EHTP and EVP use increase formaldehyde concentrations?

Formaldehyde: carcinogen group 1, indoor air quality marker, emitted by numerous indoor sources.

Publication 1: Yes


Aerosol Science and Technology

ISSN: 0278-6826 (Print) 1521-7388 (Online) Journal homepage: http://www.tandfonline.com/loi/uast20

Environmental pollution and emission factors of electronic cigarettes, heat-not-burn tobacco products, and conventional cigarettes

Ruprecht et al (2017), Aerosol Science and Technology 51, 674-684
https://doi.org/10.1080/02786826.2017.1300231

Furnished living room (48 m^3, 1.5 h^{-1}, 180 min)
No control of environmental parameters
2–3 persons
10–14 tobacco sticks of THS 2.2
13 vaping session for EVP

- ❑ Background for carbonyls: outdoor air
- ❑ Lack of baseline control of indoor levels with human presence but without any product use

Publication 2: No


Contents lists available at ScienceDirect

International Journal of Hygiene and Environmental Health

journal homepage: www.elsevier.com/locate/ijheh

Passive exposure to pollutants from conventional cigarettes and new electronic smoking devices (IQOS, e-cigarette) in passenger cars

Schober, W. et al (2019), International Journal of Hygiene and Environmental Health 222, 486-493, https://doi.org/10.1016/j.ijheh.2019.01.003

Passenger cars (2–5 m^3, natural ventilation, 20 min)
No control of environmental parameters
2 persons
2 tobacco sticks of THS 2.2
Continuous vaping session for EVP

- ➢ Background for carbonyls: same driving route, 2 persons present in the car, no product consumption

Does EHTP and EVP use increase formaldehyde concentrations?

Publication 3: Possibly

toksik_1-2-2017_toksik_1_2_2013.qxd 09.10.2017 13:01 Page 5

ПРОБЛЕМНІ СТАТТІ

UDK 614.7:351.777:663.977

POTENTIAL RISK ASSESSMENT OF THE ELECTRICALLY HEATED TOBACCO SYSTEM (EHTS) USE

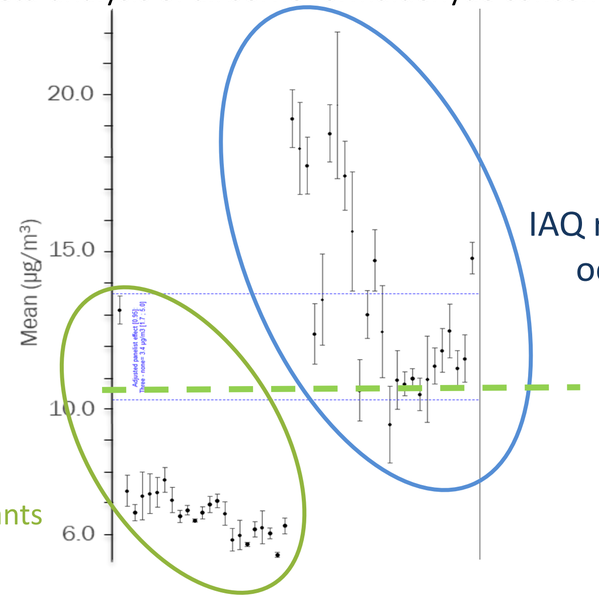
Prodanchuk et al (2017), Problemni statii 1/2, 5/14
https://doi.org/10.1016/j.ijheh.2019.01.003

Room in catering facility (625 m^3, no ventilation, 60 min)
No control of environmental parameters
80 persons
80–100 tobacco sticks of THS 2.2

- Background: baseline unoccupied room, baseline with the same number of persons present but no product consumption
- No air purge after background session with human presence
- No replication of experiments

Airborne formaldehyde concentrations at different durations of residence

Meta-analysis of airborne formaldehyde concentrations



IAQ room with 3 occupants

Average concentraion of formaldehyde measured during use of non-mentholated THS 2.2 (12 sticks, 120 min, 0.5 h^{-1})

IAQ room with no occupants

Data for the figures were published in doi: 10.1007/s11869-019-00697-6 and 10.1007/s11869-019-00697-6

PMI SCIENCE
PHILIP MORRIS INTERNATIONAL

Conclusions

- Recommended model rooms with filtered air and control of environmental parameters
- Consider confounding sources of pollution
- Implement requirements of international norms
- Need for standardization of procedures and protocols

The standardization of procedures and protocols will be beneficial not only to researchers working in this field, but more importantly, it will give clarity to the end users on the influence of environmental aerosols of EHTPs and EVPs on indoor air quality.

Thank you!

Presentation by: Maya Mitova
maya.mitova@pmi.com

Catherine Goujon – Manager Chemistry Research
Serge Maeder – Director Product Research

Anne Jaquier
Anne Guenin
Anneke Glabasnia
Camille Cluse
Carol, Medan
Chantal Pitton
Daniela Correia
Josée Polier-Calame
Kelly Crespo
Maria Gomez Lueso
Mathieu Schaller
Michel Rotach
Noel Bielik
Samuel Kleinhans
Sara Garcia Moreno
Vladimir Zaugg

PMI SCIENCE
PHILIP MORRIS INTERNATIONAL