Characterisation of a novel tobacco heating product THP1.0(T): Indoor air quality

M. Forster, J. McAughey, C. Liu, K. McAdam, J. Murphy and C. Proctor

British American Tobacco, R&D, Southampton, U.K.

Poster **69** at SRNT Annual Meeting, 7th-11th March 2017, Florence, Italy.

INTRODUCTION

Indoor air quality testing indicates that novel tobacco-heating products (THPs) have the potential to have less of an impact on environmental emissions compared with cigarette smoke (CS).

METHODS

- Environmentally controlled room of 37.8 m^3 volume (Figure 1)
- Ventilation conditions equivalent to residential (1.2 ACH) or hospitality (7.7 ACH) environment (EN 15251: 2007 standard)
- Make-up air was HEPA + carbon filtered
- 4 volunteer smokers (from whom informed consent had been obtained) used 20 or 32 'sticks' for the residential and hospitality conditions respectively.
- Cigarettes or THPs used at fixed intervals for 4 hours.
- Background samples were run pre-test exposures for 4 hours with room occupied by same volunteers

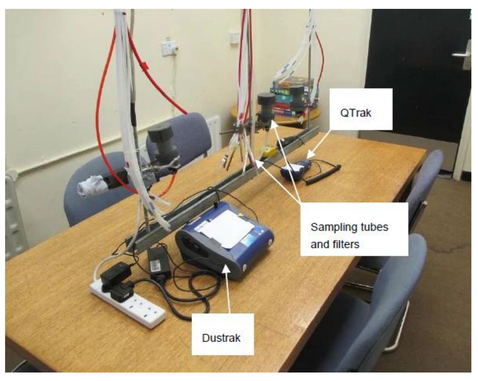


Figure 1 : Environmental room with sampling bar

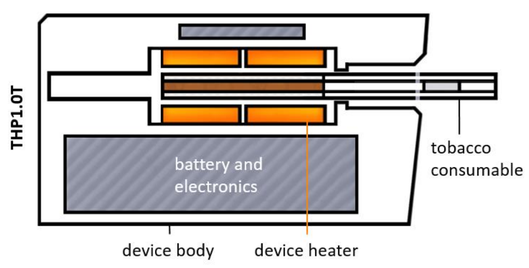


Figure 2 : Schematic of THP1.0 (T)

Products

THP1.0(T) is a novel tobacco heating product, designed to heat tobacco below 250°C. It works by a user inserting a superslim (5.4 mm diameter) tobacco rod into a heating device (known as Glo), which is powered by a rechargeable battery in the same housing. The tobacco rod has approximately 250 mg reconstituted and cut tobacco, with added ca. 14.5%dwb glycerol as the main aerosol agent.

The control cigarette (T189) is a factory manufactured commercial king-sized cigarette (8.6 mm diameter; 7 mg ISO tar) containing approximately 700 mg tobacco.

Sampling

- Sample collections were conducted at an independent laboratory over a 4 hour period onto various filter and adsorbent tube media with subsequent chemical analysis at accredited independent laboratories
- Real-time measurements were carried out :
  - @ 60s frequency for $PM_{1, 2.5, 10}$, NO, NO_2, O_3, CO, CO_2, T, RH
  - @ 10s frequency for PM, particle number (P#) and mass median diameter (MMD) by electrical mobility spectrometry

RESULTS - General

- THP VOCs < BGD for Total and 7 specific VOCs; of which isoprene, benzene and toluene were quantifiable
- THP carbonyls formaldehyde and acetaldehyde > BGD but < CS; acrolein and crotonaldehyde were < BGD
- Analyses for 15 PAHs, 4 TSNAs, glycerol and CO were < LoD for both the THP and cigarette
- THP nicotine < CS nicotine
- All PM was < 1 µm diameter

RESULTS - Chemistry

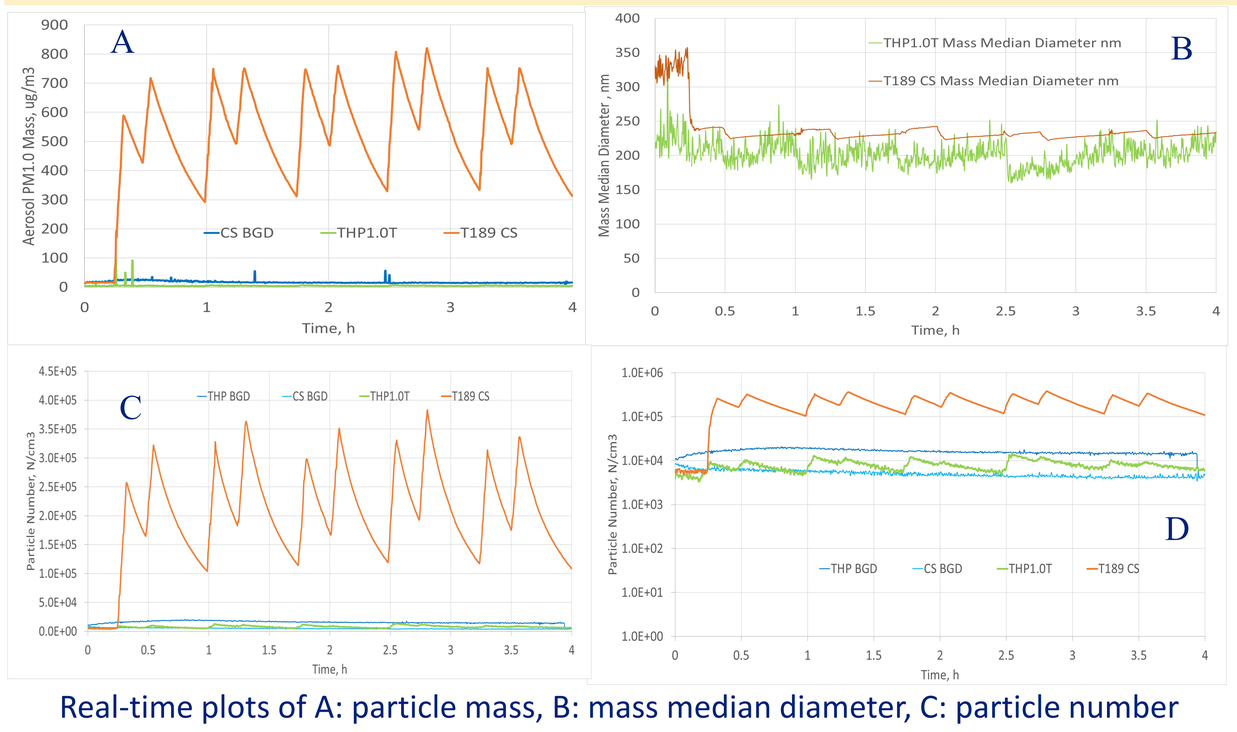
Chemical	BGD	THP1.0T 1.2 ACH	T189 1.2 ACH	BGD	THP1.0T 7.7 ACH	T189 7.7 ACH
VOCs (µg.m^{-3})						
1,3-butadiene	< 5	< 5	< 5	< 5	< 5	< 5
Isoprene	17	16	197	4	4	86
Acrylonitrile	< 5	< 5	< 5	< 5	< 5	< 5
Benzene	1	1	17	< 1	5	9
Toluene	2	3	31	2	2	13
Propylene glycol	< 5	< 5	< 5	< 5	< 5	< 5
Acrylamide	< 5	< 5	< 5	< 5	< 5	< 5
TVOC	101	48	321	44	21	120
Carbonyls (µg.m^{-3})						
Formaldehyde	16	18	36	9	9	23
Acetaldehyde	5	10	100	3	6	42
Acrolein	< 2	< 2	< 2	< 2	< 2	< 2
Crotonaldehyde	< 2	< 2	< 2	< 2	< 2	< 2
Other (µg.m^{-3})						
Nicotine	<0.2	0.32	58	<0.2	0.44	33
3-ethenyl pyridine	< 0.1	< 0.1	9.4	< 0.1	< 0.1	5.3
TSNA[1] (µg on filter)	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
PAH[2]	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Glycerol	<100	<100	<100	<100	<100	<100
CO (ppm)	< 1	< 1	< 1	< 1	< 1	< 1
NO (ppm)	20	4	44	5	3	13
$PM_{1.0}$ –light scattering[3]	10	6.5	1090	4	6	524
$PM_{1.0}$ – mobility[3]	17	5.5	505	1.1	3.5	242
Particle Number (cm^{-3})	4.85e3	7.87e3	2.01e5	2.32e3	4.70e3	1.43e5
MMD (nm)	-	210	231	-	180	218

[1] TSNA- 4-N-Nitrosonornicotine (NNN), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), N-Nitrosoanatabine (NAT), N-Nitrosoanabasine (NAB)

[2] PAH - Acenaphthene, Acenaphthylene, Anthracene, Benzo[a]anthracene, Benzo[a]pyrene, Benzo[b/k]fluoranthene, Benzo[ghi]perylene, Chrysene, Dibenzo[ah]anthracene, Fluoranthene, Fluorene, Indeno[123-cd]pyrene, Naphthalene, Phenanthrene, Pyrene

[3] $PM_{1.0}$ – mobility values verified as accurate from gravimetric data in separate experiment

RESULTS – Aerosol Dynamics (Residential 1.2 ACH)



Real-time plots of A: particle mass, B: mass median diameter, C: particle number (linear scale) and D: particle number (logarithmic scale)

- Particle mass and number generation were significantly less for the THP versus CS, with the THP near baseline
- Log scale data highlighted build up and decay from THP & CS
- Peak mass concentrations for CS were significantly greater than observed in field studies; experimental conditions were extreme

CONCLUSIONS

- The THP1.0(T) has less of an impact on environmental emissions in the indoor environment compared with cigarette smoke, although these qualities do not necessarily mean this product produces less adverse health effects than other tobacco products.
- This arises from both the enclosed THP heater design and lower operating temperatures effectively removing intra-puff emissions.

Correspondence: chuan_liu@bat.com

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