

Chemical Composition of an E-cigarette Aerosol – A Quantitative **Comparison with Cigarette Smoke**

J. Margham, K.G. McAdam, C. Wright, D.C. Mariner, M. Forster, C. Liu and C. Proctor



Next Generation Products, Group R&D, British American Tobacco, Southampton, SO15 8TL United Kingdom Correspondence: jennifer_margham@bat.com

Despite growing use of e-cigarettes, to date there have been few publications examining the broad chemical composition of e-cigarette aerosols, with most studies focusing on specific compound groups. Here we report the most complete chemical comparison to date (142 compounds) of emissions from an e-cigarette and a tobacco cigarette, including FDA Harmful and Potentially Harmful Constituents (HPHC)¹ and species previously found in e-cigarette emissions.

TEST ITEMS AND METHODS

Test items were Vype® e-Pen with Blended Tobacco flavour e-liquid and the Kentucky Reference Cigarette 3R4F

Figure 1: Vype ePen® with blended tobacco e-liquid and Kentucky Reference Cigarette 3R4F



Vype e-Pen was puffed in two separate 100-puff blocks using a 55/3/30 puffing regime (volume(cm³)/ duration(s)/interval(s))², and 3R4F smoke was collected, in a separate room, using the Health Canada 55/2/30 regime (ventilation blocked)³ With anticipated low levels of some e-cigarettes constituents, air/method blank analyses were made at the same time, location and method as the e-cigarette measurements. Independent contract labs used ISO17025 accredited methods to quantify the following emissions: carbon/nitrogen oxides, carbonyls/dicarbonyls, alcohols/di-alcohols, phenols, o-heterocycles, chlorinated dioxins/furans; volatile, substituted and, polycyclic aromatic hydrocarbons; amides, azines, aromatic and aliphatic amines, nicotine & related compounds, nitrosamines, metals and radionuclides (shown below). Five replicates were measured.

COMPOUNDS ANALYSED and Potentially Harmful Constill Figure 2: HPHC Analytes

Table 1:: Additional analytes tested

3-aminobiphenyl	Iron		
Benzidine	Acetyl propionyl		
Anatabine	Glycidol		
Myosmine	Menthol		
Nicotine-N-Oxide	Ethylene glycol		
Cotinine	Diethylene glycol		
ß-Nicotyrine	Diacetyl		
NDiPA	Allyl alcohol		
NDPA	Glyoxal		
NDBA	Methyl Glyoxal		
Copper	Acetoin		
Zinc	Glycerol		
Tin	Propylene Glycol		

After consideration of air/method blank contaminants, a relatively small number of compounds were identified that were generated (wholly or in-part) by e-Pen. These included metals (presumably from device components), nicotine impurities (present in pharmaceutical grade nicotine) and products of glycerol/propylene glycol (PG) decomposition (e.g. carbonyls), and a small number of other compounds. All of these compounds, and their levels in the e-cigarette emissions, are amenable to quantitative risk assessment to allow the identification of priority toxicants in e-cigarettes

Table 2: Compounds for which ePen emissions were statistically higher than the air/method blank

Smoke Constituent	Units per collection	ePen per puff	Air/Method Blank per puff	Kentucky Reference 3R4F per puff
Formaldehyde	[µg]	0.122	0.067	8.79
Acetaldehyde	[µg]	0.106	0.042	160
Acrolein	[µg]	0.070	0.007	15.9
Allyl alcohol	[ng]	5.37	0.338	1.63E+03
Glyoxal	[µg]	0.056	0.004	1.93
Methyl Glyoxal	[µg]	0.046	0.002	1.72
Glycerol	[mg]	1.58	0.002	0.195
Propylene Glycol	[mg]	0.709	0.000	2.92E-03
Chrysene	[ng]	0.011	0.003	3.57
Myosmine	[ng]	27.4	1.59	883.7
Cotinine	[ng]	10.84	0.382	4582
Nitrosonornicotine	[ng]	0.054	0.014	24.97
Chromium	[ng]	0.399	0.293	0.27

Table 3: Compounds showing no significant difference between ePen and air/method blank emissions

Smoke Constituent	Units per collection	ePen per puff	Air/Method Blank per puff	Kentucky Reference 3R4F per puff
Acetone	[µg]	0.073	0.106	67.2
Methyl Ethyl Ketone	[µg]	0.069	0.158	18.7
CO	[mg]	0.057	0.057	2.74
Toluene	[µg]	0.020	0.020	11.0
Naphthalene	[ng]	0.054	0.053	97.6
o-toluidine	[ng]	0.006	0.004	10.9
NDBA	[ng]	0.104	0.118	0.03
NPYR	[ng]	0.079	0.073	1.77
NDELA	[ng]	0.112	0.098	0.05
Copper	[ng]	1.89	0.937	2.26
Zinc	[ng]	12.34	13.1	23.6
Iron	[ng]	4.17	4.03	3.17
Styrene	[µg]	0.004	0.007	1.7

Per-puff comparisons of toxicant emissions are shown between Vype® e-Pen and 3R4F. Values were averaged across a toxicant group. Air/ method values were not subtracted. Substantial reductions were found in the e-Pen emissions for all four toxicant groups, in excess of 99% for WHO TobReg4 and FDA truncated lists, and 92% for the full FDA HPHC list. Four aerosol constituents were measured at higher per-puff levels than from 3R4F: PG, glycerol, menthol and chromium



Figure 3: Calculated pre-puff percentage reductions from ePen in comparison to

CONCLUSIONS

This study shows substantial chemical differences between emissions from ecigarettes and tobacco cigarettes. Most cigarette toxicants examined were not detected in the e-cigarette emissions. Measuring air/method blanks is an essential step for identifying experimental artefacts amongst trace-level ecigarette aerosol constituents. Further testing should be conducted on higher yield devices to investigate the toxicant profile of e-cigarettes.

conference, June 17-18 2016, Warsaw, Poland.

www.bat-science.com