Chemical Composition Of An E-cigarette Aerosol – A Quantitative Comparison With Cigarette Smoke

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

Next Generation Products, Group R&D, British American Tobacco, Southampton, SO15 8TL United Kingdom

Correspondence: kevin_mcadam@bat.com

BRITISH AMERICAN TOBACCO

Introduction:

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 HPHC compounds, and species previously found with e-cigarettes.

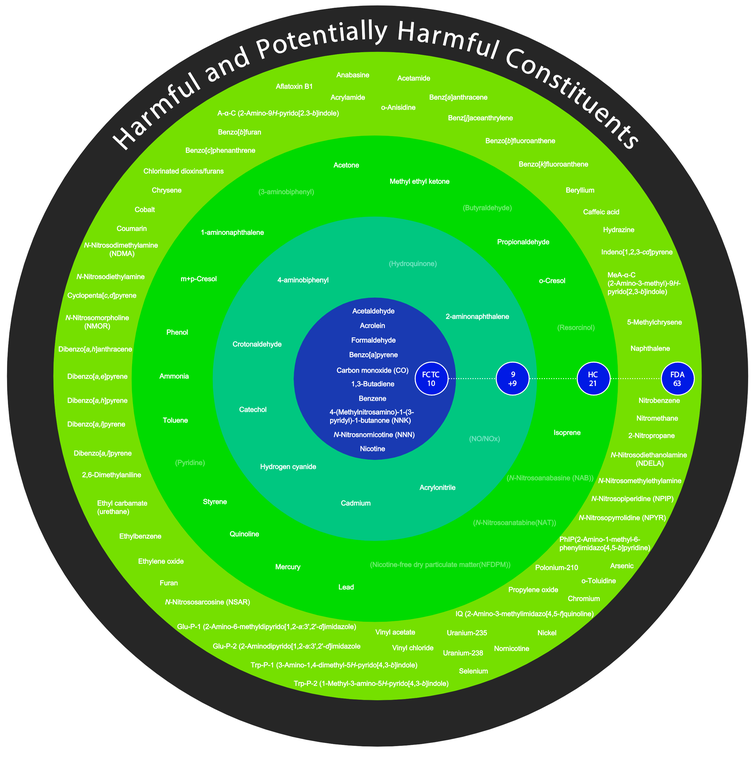
Vype e-Pen

University of Kentucky Reference Research Cigarettes

Test pieces and methodology:

Test-pieces were Vype e-Pen Blended Tobacco flavour, and the 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)), and 3R4F smoke was collected, in separate rooms, using the Health Canada 55/2/30 regime (ventilation blocked). With anticipated low levels of some e-cigarettes constituents, air/method blank analysis was 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, polynuclear aromatic hydrocarbons; amides, azines, aromatic and aliphatic amines, nicotine & related compounds, nitrosamines, metals and radionuclides (shown below).

Compounds Analysed in this Study



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

Results:

Detectability of compounds in e-cigarette emissions

Parameter	Number from 142 compounds		
	ePen	Air Measurement	3R4F Cigarette
Number of compounds measured below detection limit	98	106	36
Number of compounds measured below quantification limit	17	19	9
Number of compounds measured in quantifiable levels	27	17	97

Comparing e-Pen emissions with air/method blank levels

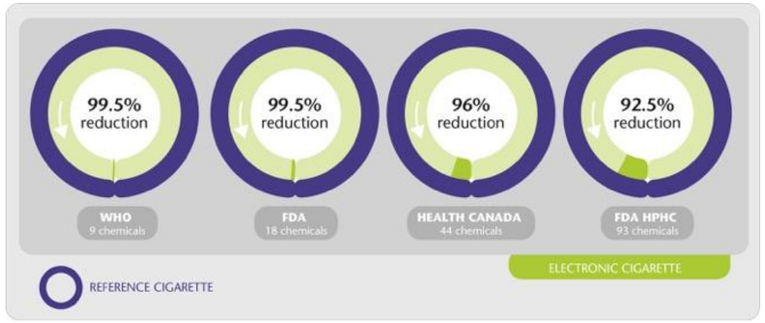
Compounds arising from air/method blank contamination/artefacts			Compounds partially arising from air/method blank contamination/artefacts		
Compound	ePen Average Level (200 puffs)	Air/Method Average Level (200 puffs)	Compound	ePen Average Level (200 puffs)	Air/Method Average Level (200 puffs)
Acetone (µg)	14.5	21.08	Formaldehyde (µg)	24.4	13.38
MEK (µg)	13.8	31.45	o-toluidine (ng)	1.13	0.88
Zinc (ng)	2467.6	2619.1	NNN (ng)	10.77	3.11
CO (mg)	11.49	11.43	NDELA (ng)	22.45	19.69
Toluene (µg)	4.98	4.96	Chrysene (ng)	2.10	0.62
NDBA (ng)	20.74	23.66	Iron (ng)	850.6	607.58
NPYR (ng)	15.86	17.95	Copper (ng)	378.11	187.36
Naphthalene (ng)	10.88	10.59	Chromium (ng)	69.59	58.66
Styrene (µg)	0.77	1.30			

Aerosol emissions generated by e-Pen

After removal 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 (from pharmaceutical grade nicotine) and products of glycerol/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.

Emission chemistry comparisons between Vype e-Pen and the tobacco cigarette

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



Conclusions:

This study shows substantial chemical differences between emissions from e-cigarettes and tobacco cigarettes. Most cigarette toxicants examined could not be detected in the e-cigarette aerosol. Measuring air/method blanks is an essential step for identifying experimental artefacts amongst trace-level e-cigarette aerosol constituents.

Poster 3597: Poster Board - P289: Toxicants in E-Cigarette Aerosols—A Quantitative Survey and Comparison with Cigarette Smoke. 55th Annual Society of Toxicology Thursday 17th March 2016

www.bat-science.com

@BAT_Sci