

Formaldehyde from different format electronic cigarettes compared to the WHO air guideline

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INTRODUCTION

Much has been published about the release of formaldehyde from electronic cigarettes and other vaping products, including the importance of measuring the carbonyls under consumer relevant circumstances, rather than under artificially created dry puff conditions¹. What conditions are consumer relevant (e.g. power, PG/VG ratio of e-liquid used) depend on the vaping product and will be reflected in the instructions for use.

This poster reports measurements of formaldehyde from three formats of vaping products, vaped under realistic usage conditions. Daily exposure is estimated for the different products and compared to a variety of safety bench marks, including the WHO indoor air quality guideline.

FORMALDEHYDE MEASUREMENTS IN E-CIG AEROSOL

Aerosol was generated using 80 ml puff volumes, 3 second puff durations and 30 second puff intervals. These values were based on topography data obtained on 60 users². Volatile carbonyls were measured using a DNPH- derivation method.

FORMALDEHYDE MODE OF ACTION

Formaldehyde has been classed by IARC as carcinogenic in humans³. Formaldehyde is genotoxic and cytotoxic. Cell proliferation due to cytotoxicity is considered a key element in the development of airway cancer. For this type of locally exerted effect that requires longer term exposures, air concentrations over time are the relevant exposure measure.

CONSUMPTION SURVEY

An on-line questionnaire was developed to determine the consumption & usage of vaping products across:

- Disposable
 - Rechargeable with cartridges
 - Refillable, open tanks
- 400 respondents per product format

Results indicated refillable, open tanks had the highest consumption, both in e-liquid and in puffs/day. Overall, 350 puffs/day represents a realistic, high end daily use for the combined product formats. A study reporting on a million electronically registered puffs from a refillable, open tank product, reported an average use of 127 puffs/day, whereas 80% of puffs/day ranged up to 346 puffs/day⁴. An earlier survey amongst 2,896 users concluded median use (and 25th and 75th %-ile, respectively) were 120 (80, 200) puffs/day⁵. Overall, 350 puffs/day is thus a reasonable approximation for heavy use across the three product formats measured here.

AVERAGE DAILY AIR CONCENTRATION FROM HEAVY E-CIGARETTES USE

Daily exposure = Measured amount of formaldehyde/puff * 350 puffs/day
Standard human breathing volume is 20 m³ per 24 hours

Thus reasonably heavy daily formaldehyde exposure from the different formats vaping products, equates to continuous exposure to an air concentration in mg/m³ of:

Measured amount of formaldehyde/puff [µg/puff] * 0.001 [mg/µg] * 350 puffs/day / 20 m³

Figure 1. Examples of the formats of vaping products tested.



Vaping product	Average µg formaldehyde/puff ± standard deviation
Rechargeable cigalike	0.18 ±0.39 (N=5)
Closed modular, tested at high voltage conditions A	0.39 ±0.75 (N=7)
Closed modular, tested at high voltage conditions B	0.06 ±0.04 (N=5)
Refillable open tank A	0.93 ±0.78 (N=10)
Refillable open tank B	0.02 ±0.02 (N=5)

For perspective, formaldehyde levels from the reference cigarette 3R4F have been reported to be 20.0 µg/cigarette when measured under standard ISO conditions and 68.1 µg/cigarette when smoked under the Health Canada Intense (HCI) regime¹¹.

Average daily air concentration equating to heavy e-cigarette use [mg/m ³]	Safety related bench marks [mg/m ³]
Cigalike 0.003	0.1 WHO indoor air quality guideline ⁶
Modular A 0.007	0.1 Inhalation DNEL (Derived No Effect Level) for general public ⁷
Modular B 0.001	0.12 Safe level for cancer and respiratory tract irritation in humans (0.1 ppm) ⁸
Open tank A 0.016	0.26 EU recommended 8-hr occupational exposure level (0.2 ppm) ⁹
Open tank B 0.0004	1 US 8-hr occupational permissible exposure level (0.75 ppm) ¹⁰

CONCLUSIONS

- Inhalation exposure to formaldehyde from the three different formats of vaping product considered here are all significantly below a variety of recognised safety bench marks.
- Even reasonably heavy use of the different formats of vaping products still only results in daily formaldehyde exposures that are less than a sixth of the exposure from breathing indoor air that complies with WHO air quality guidelines.

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