Limitations in the characterisation of cigarette brands using different machine smoking regimes

Stephen W Purkis, Valérie Troude, Gerald Duputié
Christian Tessier, Xavier Cahours
Background

- It is recognized that no single machine smoking regime can represent the different behaviors of individual human smokers.

<table>
<thead>
<tr>
<th>ISO 3308 ISO</th>
<th>Massachusetts MA</th>
<th>Canadian &quot;Intense&quot; CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable in:</td>
<td>International Standard</td>
<td>Texas, Massachusetts MA</td>
</tr>
<tr>
<td>Stated Purpose:</td>
<td>Cigarette Yield Ratings for Product Comparison</td>
<td>Estimate Nicotine Yield for an &quot;Average&quot; Consumer</td>
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</tbody>
</table>

- Intense regime mandated for testing in Canada with 100% vent blocking is proposed for product characterization.

- But what scenario does CI regime represent? “average” or “maximum” yields as related to human intake.
Previous Findings - Initial results on temperature profiles

- Higher filter temperature in the last puffs
- Loss of efficiency of carbon filter for the retention of volatiles during CI smoking regime

- Blocking 100% filter ventilation does not allow the smoke cooling effect during the smoking period.
- High filter temperatures associated with the CI regime lead to a significant desorption of volatiles from carbon leading to an increase of mainstream smoke yield.


Objectives

- What about the filter $T^\circ$ increase in natural conditions for smoker? Are the CI conditions realistic? What are the limitations of using alternative machine smoking regimes?

- Smokers modify their smoking behaviour on a per puff basis in ways not well reflected by the 100% ventilation blocking regime.

1. Human Smoker Yields & Topography results from a former smoking behaviour study

2. Selection of a “representative panelist” for duplication

3. Recording duplication outcomes: lit PD, puff Volume, filter $T^\circ$ & smoke concentration under different regimes
2 commercial brand Tar (ISO) mg/cig. smokers (own brand)

<table>
<thead>
<tr>
<th></th>
<th>product A</th>
<th>product B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tar’ (mg/cig) ISO</td>
<td>3.4</td>
<td>12</td>
</tr>
<tr>
<td>Nicotine (mg/cig) ISO</td>
<td>0.32</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Datasource and handling

Delarue, B. et al, 2001

Human Smoker Yields

Temperature issue

ad lib. smoking behavior measurements

butt collections

Smoking topography

range mean sd

all french female smokers aged smoking at least (cig/day) for at least 2 years

CO exhaled breath (ppm) Product A 13.5 – 56.5 24.3 11.8

Product B 13 – 61 33.1 13.3

Butt length (mm) 35 29

Cigarette length (mm) 83 83

Filter length (mm) 27 21

Filter Ventilation (%) 49.3 0.5

Unlit PD (mm W.G.) 104 130

Unlit PD Vents Closed (mm W.G.) 155 130

Tobacco weight (mg) 620 773

Blend Style USB USB

Filter type Acetate Acetate

Brand specifications
Topography: puffing behavior

Key points:
- Calibration of the flow was performed
- No human vent blocking using the device
How to select a representative profile?

*Filter Butt study: natural vs lab.*

- How to take into account the over-estimation due to the lab condition (artificial setting)?

- Human Smoker Yields
  *Filter butt study:* amount of ‘tar’ on the filter proportional to the amount of ‘tar’ emerging from the filter.

90th percentile natural conditions
~ average Laboratory conditions
= representative smoker selected for duplication
How to select a representative profile?

The rise in temperature mainly influenced by the puff volume. The temperature is a cumulative effect. Throughout the inter-puff duration, the temperature is likely to decreased.

Selection based on 2 criteria:
1. Average puff volume
2. Puff volume decrease per % smoking time

Slope : -16.7 mL/% an estimate in the volume decrease. Smoker decreases by 16.7 mL between the first puff volume and the last puff volume.
## Smoking regime parameters

<table>
<thead>
<tr>
<th>Machine smoking regimes</th>
<th>ISO</th>
<th>MA</th>
<th>WG9B</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puff volume</td>
<td>35 ml</td>
<td>45 ml</td>
<td>60 ml</td>
<td>55 ml</td>
</tr>
<tr>
<td>Puff duration</td>
<td>2 sec</td>
<td>2 sec</td>
<td>2 sec</td>
<td>2 sec</td>
</tr>
<tr>
<td>Puff flow rate</td>
<td>1.05 l/min</td>
<td>1.35 l/min</td>
<td>1.80 l/min</td>
<td>1.65 l/min</td>
</tr>
<tr>
<td>Puff frequency</td>
<td>60 sec</td>
<td>30 sec</td>
<td>30 sec</td>
<td>30 sec</td>
</tr>
<tr>
<td>Vent blocking</td>
<td>No</td>
<td>Yes 50%</td>
<td>Yes 50%</td>
<td>Yes 100%</td>
</tr>
</tbody>
</table>

### Representative smoker

**average value**

- Puff volume: 51.5 ml
- Puff duration: 2.3 sec
- Puff flow rate: 1.44 l/min
- Puff frequency: 21.4 sec
- Vent blocking: No
Temperature in the filter (°C)

Method: 1 cig/smoking. K type thermocouple. 20 mm inside mouth end 55ms time profile.
Temperature in the filter-maximum

Method: 1 cig/smoking. 6 replicates per regime.
Maximum temperature,
Normalized X axe.
K type thermocouple. 20 mm inside mouth end
55ms time profile
Increases in lit PD due to temp. increases

The observed rise in lit PD was likely to explain the reductions in the observed human puff flow rates and puff volumes.
Smoke concentration

Changes in per puff total particulate matter (TPM) during the course of machine and human smoking of product A

- CI smoking regime: higher TPM compared to all other regimes
- Flatter duplicated profile compared to the machine smoking regimes

Method: Sodim DFC D-87 Duplicator machine.
TPM was collected on a 25 mm CFP. Smoking runs performed using an iterative procedure.
The TPM in mg per puff was determined by subtracting ‘TPM-puff 2’ from ‘TPM-puff 3’.
2 replicates per regime
Sum up

- On a per puff basis, smokers reduce their smoking intensity in response to increases in smoke temperatures, in draw resistance and smoke concentrations.

- These findings suggest that to base a smoking regime on extreme human smoking behaviour

  using a combination of the highest puff volume linked to the longest duration,
  the shortest puff interval as obtained from any databank of human smoking data
  and use it in combination with 100% ventilation blocking

will provide data that will give a misleading characterisation of cigarette smoke.

Purkis. S.W, et al., 2010. Limitations in the characterization of cigarette products using different machine smoking regimes. Regulatory Toxicology and Pharmacology, in press
Thank you for your attention