Real-time Multi-point Temperature Mapping of Heating Products During Use

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Introduction

This study investigated heat transfer through heating products (HPs) during use via temperature mapping.

The glo™ heating device contains two heating zones to externally heat the substrate rod of HP causing a disparity of the substrate temperature during a heating session.

A heatmap can help further understand the relationship between device heating and the substrate.

Methodology

Test Items

Three different HPs were assessed in this study consisting of one rooibos (reconstituted) and two tobacco blends (lamina and reconstituted).

Temperature Mapping

Thermocouples were inserted along the length of the HP substrate rod at its centre, and differing radial positions. HP were heated with a glo™ device. Figure 1 illustrates the thermocouple positioning along the substrate rod.

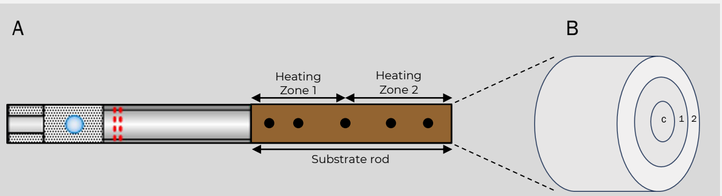

Figure 1. Thermocouple positions along the length of the substrate rod (A) and along the radial axis (B), c = centre, 1 = 1mm from centre, 2 = 2mm from centre

Puffing Parameters

HP consumables were puffed on a Körber Technologies LM5E smoking machine using a regime based on ISO 5501-1[1]:

- Puff volume 55ml; puff frequency 30s; puff duration 2s; vent blocking 0%

Data Analysis

Temperature data were plotted per puff and adapted into a heat map.

Results

Temperature Mapping

The heating of the substrate along the length of the rod demonstrated heat transfer and a progressive increase in temperature throughout the heating session.

The radial temperature mapping highlighted the effect of the device external heating mechanism and the temperature gradient across the diameter of the substrate rod.

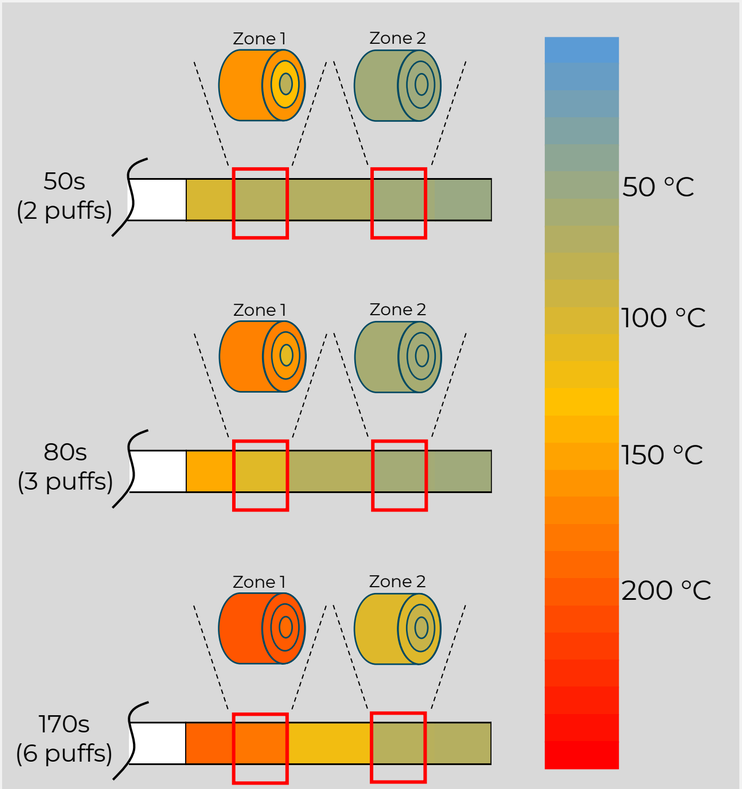

Figure 2. Representative heatmap of substrate temperature along the length of the substrate rod and along the radial axis after being heated and puffed for 50s, 80s, and 170s.

Observations

Temperature mapping has identified differences in the transfer of heat through different substrates, particularly in heating zone 1:

- Heat distribution is slower in lamina vs reconstituted substrate
- Heat distribution is slower in tobacco vs rooibos substrate

Table 1. Temperature difference as a percentage of 1mm radial measurement in Zone 1.

Heating duration	Temperature difference at 1mm vs centre (%)		
	Tobacco		Rooibos Reconstituted
	Lamina	Reconstituted	
50s (2 puffs)	41	35	26
80s (3 puffs)	21	9	4
170s (6 puffs)	3	0	1

Table 2. Temperature difference as a percentage of 2mm radial measurement in Zone 1.

Heating duration	Temperature difference at 2mm vs centre (%)		
	Tobacco		Rooibos Reconstituted
	Lamina	Reconstituted	
50s (2 puffs)	46	38	25
80s (3 puffs)	25	11	5
170s (6 puffs)	3	1	1

Conclusion

The use of real-time multi-point temperature mapping of HPs provides a method to study how device design, heating profile and HP design impact the heating of the substrate material.

Heat transfer along the HP substrate rod is observed during the early stage of a heating session, as is the radial heat distribution. The extent of this differs with the substrate matrix in question.

In addition to insights into substrate heating, data gathered from this temperature mapping method can aid developments in:

- Modelling and simulations
- Delivery of aerosol constituents
- Toxicological assessments

References

1. ISO 5501-1:2024. Tobacco heating systems – Definitions and standard conditions for aerosol generation and collection – Part 1: Electrically heated tobacco products (eHTPs).

Acknowledgements

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