End-Point Detection of ENDS and Tobacco Heated Products

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BACKGROUND

Electronic nicotine delivery systems (ENDS) and tobacco heated products (THPs) generate aerosol without the heat used for termination in machine smoking. Therefore termination systems using the aerosol's opacity (optical density) have been developed. Since both ENDS and THPs can be vaped on the same machine, a flexible end-point detection system is required to accommodate both types of product in their many guises.

OBJECTIVE

We present results from a system that provides both real-time and recorded characteristics of aerosol production of ENDS and THPs. It has a in-built calibration capability to reliably define a termination setting based on the decline of aerosol output. The system can be configured as a stand-alone application or fully integrated into a multi-channel vaping machine such as the CETI8, SM450 family and Chimera. For the latter it provides proof of continuous vapour production over long-term exposure trials.

Fig. 1 CETI8 with EPD system fitted

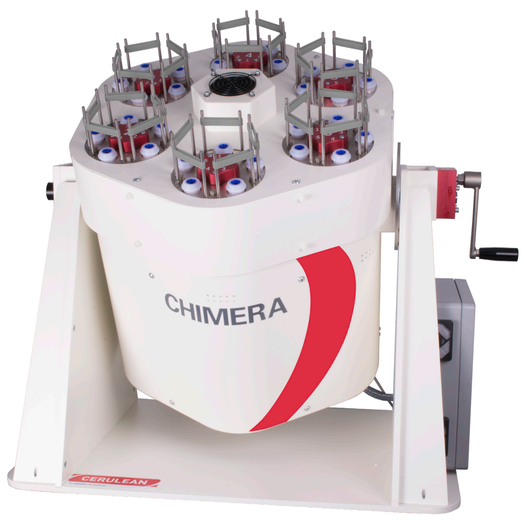


Fig. 2 Chimera, 30-channel vaping machine for continuous aerosol production

METHOD

Opacity is sensed via optical fibres set into the filter holder close to the outlet of the product. The output of each sensor is automatically normalised to '100% transmission' before each run.

Fig. 3 Cambridge Filter Holder with opacity sensor

A graphical user interface is used to set the opacity corresponding to 'amber warning' and termination levels and presents real-time opacity during the run via a live bar-graph. The peak opacity after each puff is recorded for later recall and analysis. The system can also characterise aerosol production in products that are terminated electronically after a fixed time or number of puffs.

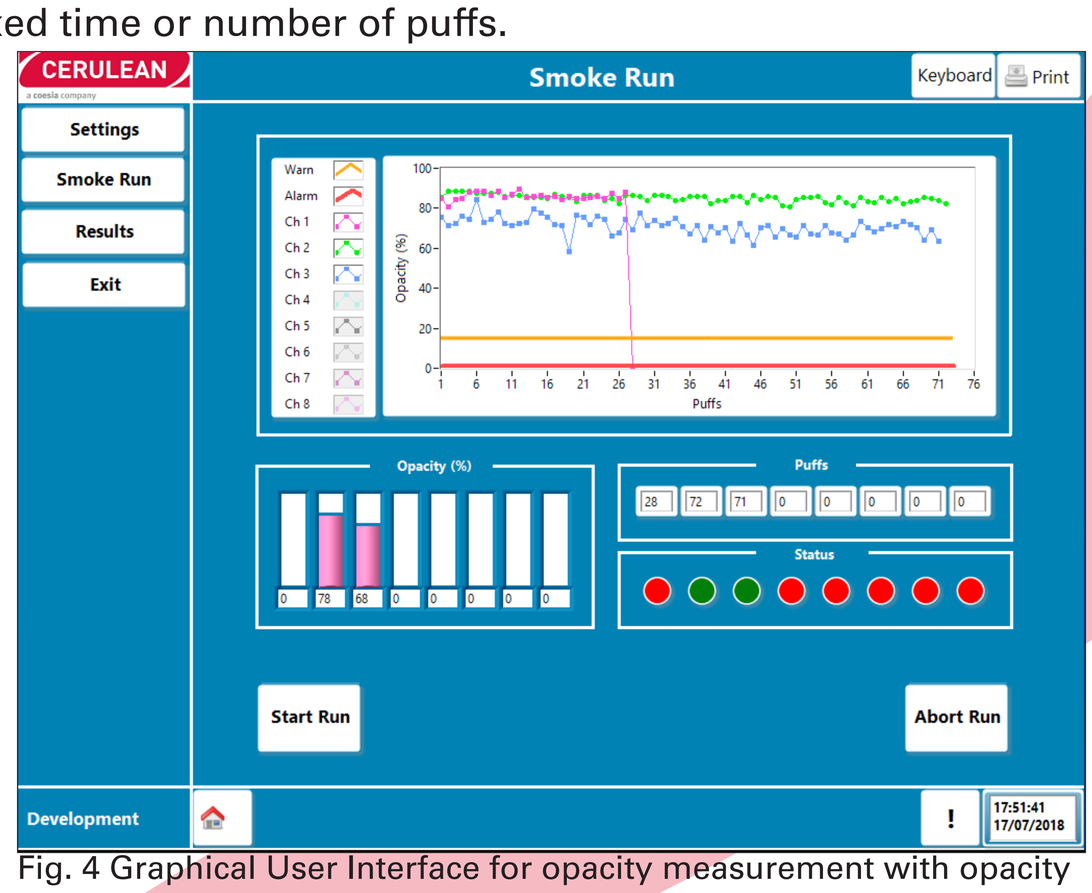
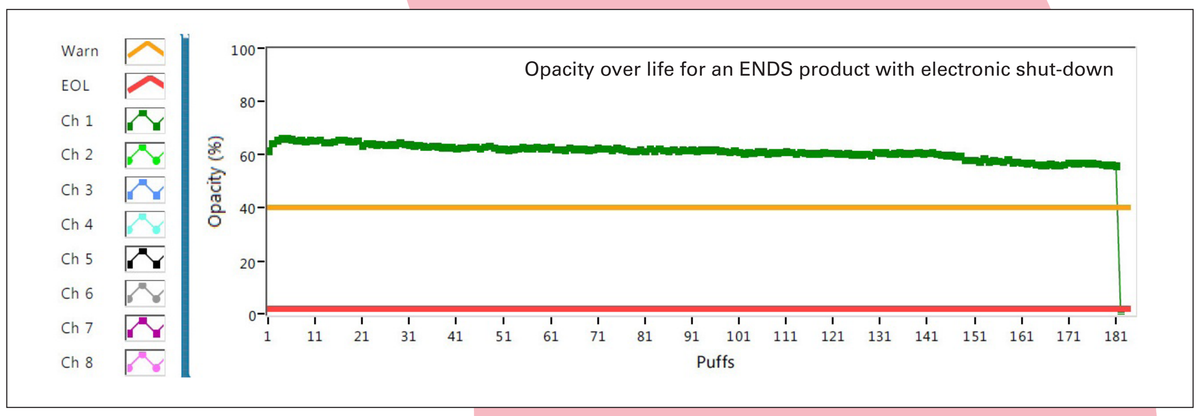
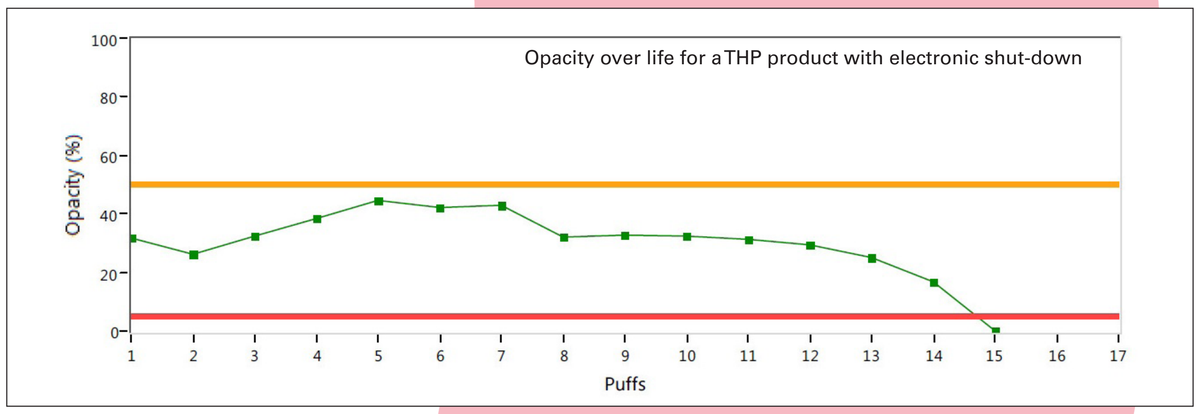


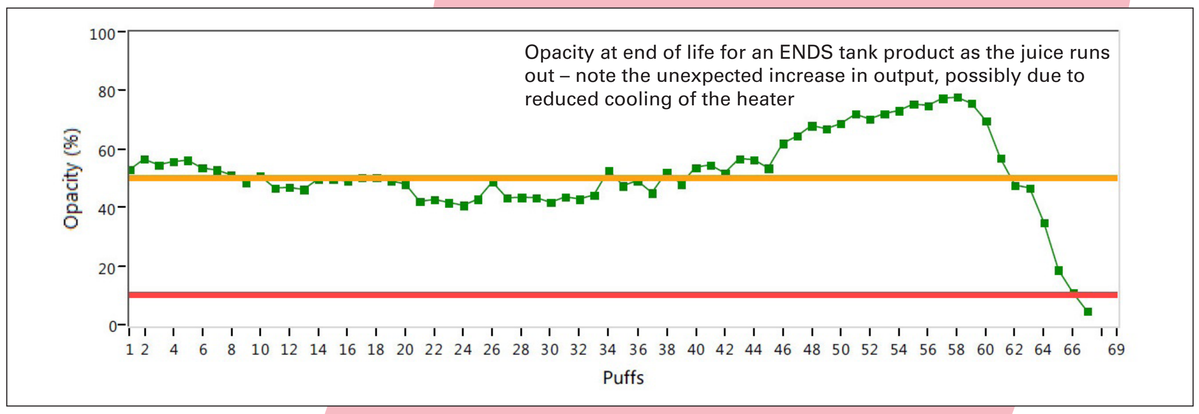
Fig. 4 Graphical User Interface for opacity measurement with opacity sensor

RESULTS

THP aerosol is less dense than that of ENDS and tends not to simply follow a gentle decline over life.







The Table present a broad comparison between the typical characteristics of ENDS and THPs.

FACTOR	ENDS	THPs
Aerosol Density	Typically 60% opacity for fresh product	Typically 30% opacity for fresh product
Stability	• Opacity stable for majority of product life • Apparent opacity can be affected by condensation	• Opacity can increase over the first few puffs
Termination Characteristics	Can be: • Gradual decline • Rapid decline • 'Switch off'	• Opacity gradual declines towards end of life • Generallyelectronic control of termination

Puff-to-puff noise can be significant for ENDS, such that a simple trigger level can underestimate true product life. Intensity calibration significantly reduces channel-to-channel variation and is important to mitigate the effect of light scattering due to condensation of aerosol in the sensor region.

We have shown previously (STPOST06, CORESTA Congress Quebec) that cumulative opacity is capable of providing yield information that is useful for both R&D and QA, and this is available via the user interface. Yield determination (aerosol mass) to within ~10% is possible without product-specific calibration.

CONCLUSIONS

Detection of the aerosol opacity can define product end-of-life in real time. In-built calibration enables direct comparisons of aerosol opacity to be made and enhances the flexibility of the system, particularly where a wide range of product and product types are vaped.

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