

Plume temperatures of current and future low GWP pMDI propellants measured in an anatomical throat geometry

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The EMMACE throat is widely used for in-vitro testing of inhalation products. A novel instrumented EMMACE throat has been developed as a diagnostic tool enabling measurement of temperatures within the oral cavity. Plume temperature is an important factor in patient acceptability of a product, as was seen during the CFC to HFA transition. Plume temperature should therefore be considered when developing future pMDI products with new low GWP propellants, as plume temperature of these propellants and their effect on patient 'feel' is currently unknown.

The instrumented EMMACE throat was produced using SLA 3D printing incorporating small holes to allow instrumentation with fine wire thermocouples in the oral cavity. Placebo pMDIs of various current and potential future propellants were fired using an actuator with 0.3 mm diameter spray orifice into the instrumented throat with 30 lpm air co-flow. The thermocouple voltages were amplified with bespoke equipment and digitised and logged using a Kistler 5165A LabAmp.

Temperature profiles measured in the oral cavity were very similar in trend showing a sharp reduction in temperature as the cold spray plume passed over the thermocouple followed by a temperature recovery to ambient conditions. Liquid propellant evaporation during the actuation causes self-cooling of the propellant and produces cold vapour. For a given device and metered dose, the temperature drop and therefore minimum temperature observed varies according to the thermodynamic properties of each propellant. We found that HFA227ea had the overall warmest spray plume, followed by HFO1234ze, HFA134a and the coldest was HFA152a.