Solid particle investigations in the mainstream of 3R4F reference combustible cigarettes and the Tobacco Heating System THS2.2

P. Pratte[1], S. Cosandey[1] and C. Goujon Ginglinger[1]

[1]Department of Testing Laboratories Governance, Philip Morris International R&D, Philip Morris Products S.A., Neuchâtel, 2000, Switzerland (part of PMI group of companies)
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Presenting author email: pascal.pratte@pmi.com

An aerosol is a mixture containing liquid droplets and potentially solid particles suspended within a gas.

The combustion process is likely to produce solid carbon particles whereas their production is kinetically much less favoured when an organic substrate like tobacco material is heated (K. C. Oha et al.). To verify if this is the case, the potential release of particles in the mainstream aerosol generated by the heat-not-burn product THS2.2 was assessed in comparison with the smoke produced from the 3R4F combustible reference cigarette. For this purpose, a methodology using a Dekati commercial Thermo-denuder operating at 300°C associated with chemical characterization was developed.

Prior to investigating the possible presence of solid particles in the mainstream of tobacco products, the Thermo-denuder removal efficiency was quantified using model glycerine-based droplets. In separate experiments, a thermo-resistant aerosol constituted by NaCl dry crystals was used to determine the thermo-denuder average aerosol penetration for sizes ranging from 20 to 300 nm. From findings, the effective glycerin removal efficiently was determined to be 86 ± 2 %.

This means that to enable the quantification of solid particles in the mainstream of 3R4F reference combustible cigarette and Tobacco Heated System THS2.2, their fraction should exceed 14% in number otherwise they would be indistinguishable from remaining liquid droplets. For chemical characterization of particles, the Thermo-denuder was coupled in a separate experiment with a two stages impactor trap (T. Jalanti and P. Henchoz) used to perform Scanning Electron Microscope (SEM) and EDX analyses of the collection substrates.

From experiments conducted using 3R4F reference combustible cigarette, the methodology allowed to determine that approximately 80% in number of the total particulate matter was neither evaporated nor removed in the Thermo-denuder. This was likely attributed to the presence of solid particles or low volatile liquid droplets. For the experiments with THS2.2, the removal of the particulate matter from the mainstream was slightly larger than the determined glycerin effective removal efficiency. To confirm the absence/presence of solid particles in the mainstream of 3R4F reference combustible cigarettes and THS2.2, similar experiments were conducted and potential solid particles were trapped in the impactor. The collection substrates used to trap particles present in the mainstream of 3R4F reference combustible cigarette and THS2.2 were analysed separately using a SEM and EDX analyses. Figure 1 presents blank experiments (left hand side pictures) against 3R4F (A) and THS2.2 (B)

From the pictures related to 3R4F experiments (A), solid particles were identified and composed mainly of carbon based material, oxygen and traces of potassium/chlorine whereas a related Count Median Diameter (CMD) of 75 nm was determined. When considering the picture for THS2.2 (B) in comparison to the blank (experiments prior aerosol generation started), no particle were identified using SEM imaging. This result is consistent with the fact that no combustion process takes place in THS2.2.

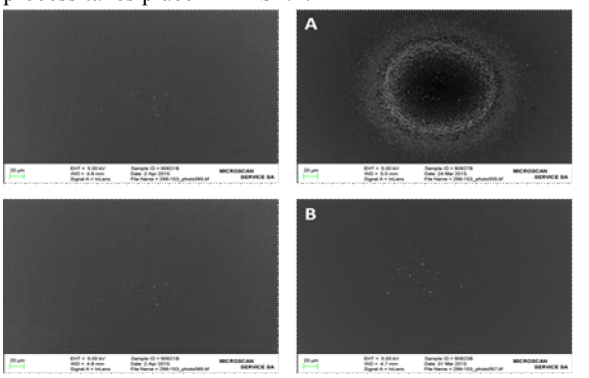

Figure 1: Pictures of trapped particles from mainstream aerosol/smoke after its passage in the Thermo-denuder operating at 300°C. A) 3R4F B) THS2.2. Left side: blank

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