Background

- PTR-MS is a soft chemical ionization technique that can simultaneously analyze and quantify a wide range of organic compounds, making it especially suitable for analysis of small molecules in vapor product aerosols as well as exhaled breath.

- Ionization occurs when proton affinity of the analyte is higher than that of the reagent ion.

- PTR-MS is a more sensitive technique compared to the offline methods traditionally used (collection of subsequent puffs, extraction of analytes from filter pad, derivatization, instrumental analysis), enabling quantitation of ppt concentrations.

- E-liquid can also be measured by PTR-MS by using a liquid calibration system, which evaporates the sample before introducing it to the instrument for ionization and detection.

- Online methods can be validated by adapting the ICH guidelines for LC/MS, making it especially suitable for technology transfer.

Methods & Results

aerosol analysis

- PTR-MS is used to analyze aerosols generated by electronic cigarettes, providing real-time analysis of volatile organic compounds (VOCs) in aerosol.

- Figure 1 shows the sampling setup for chemical profiling of VOCs in aerosol, where aerosol is diluted and vaporized prior to ionization by reagent gas and ToF detection.

- Figure 2 illustrates primary constituents of Electronic Nicotine Delivery System (ENDS) aerosol measured in a puff-by-puff manner.

- Comparison of acrolein measurements at end-of-liquid using PTR-MS and offline methods is shown, indicating improved detection with PTR-MS.

- Figure 4 compares aerosol measurements at end-of-liquid using PTR-MS and offline methods, showing improved detection with PTR-MS.

- Figure 6 demonstrates limit of detection improvements in the characterization of primary constituents of ENDS aerosol using PTR-MS.

e-liquid analysis

- Figure 3 shows puff-by-puff analysis enables deeper insight into device performance characteristics.

- Figure 5 illustrates sampling setup for chemical profiling of VOCs in e-liquid, where the sample is introduced to the PTR-MS via a liquid calibration system (LCS) that evaporates the sample before ionization in the ion-molecule reactor and detection by Time-of-Flight mass analyzer.

- Calibration is done by adjusting the liquid flow rate to introduce more or less sample.

Discussion

- PTR-MS enables puff-by-puff analysis, improves time resolution, and reduces resources required to analyze vapor product aerosols.

- Analysis of e-liquids can also be improved; online methods are faster and capture more analytes in a single acquisition method.

- Aerosol and e-liquid methods developed are qualitative and quantitative.

- PTR-MS methods can successfully be validated by following existing guidance on method validation.

- Tremendous improvement in the limit of detection makes it possible to analyze the chemistry of a single puff in real-time.

- This method is able to analyze a wide range of compounds simultaneously, eliminating the need to run multiple methods to capture all analytes of interest.

- Limitations of this technique include overlapping fragments of some molecules and a lack of isomer separation. These factors can make a clear assignment difficult, and they can be mitigated by employing different reagent ions or adding a fast gas chromatograph.

Further Reading: