Compositional and Structural Analysis of Silica Gel Fractions from Municipal Waste Pyrolysis Oils

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Results and Discussion

Hydrocarbon-rich pyrolysis oils produced from landfill waste and recycled plastics are potential sources for fuels and chemicals. It is well established that feedstock composition significantly affects pyrolysis oil composition; and hence its potential uses. For example, plastics waste pyrolysis oils contain a high concentration of hydrocarbons, whereas biomass pyrolysis oils have high oxygen content. Addition of plastics to a biomass feedstock increases the hydrocarbon content. However, a detailed analysis of hydrocarbons and polar species from pyrolysis oils produced from "real world" mixed municipal waste materials has not yet been done. Here, the silica gel fractions from unsorted landfill waste and mixed recycled plastics pyrolysis oils are analyzed by two-dimensional gas chromatography (GC×GC), field ionization mass spectrometry (FI-MS), Fourier transform infrared spectroscopy (FT-IR), and NHMFL's 9.4 T Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS). GC×GC and FI-MS for the saturated hydrocarbons show a range of alkanes, cycloalkanes, olefins, and 1-ring aromatics. Molecular elemental compositions from FT-ICR MS were correlated with structural assignments from GC×GC, and showed that the aromatic hydrocarbons from landfill are both peri- and cata- condensed (see Fig. 1). In contrast, plastics pyrolysis oil consists of polyphenyls and cata-condensed aromatic hydrocarbons. The polar species from the plastics pyrolysis oil contain more alcohol functionalities than the landfill pyrolysis oil, which contains non-carboxyl carbonyl functional groups. Improved structural understanding of both pyrolysis oils will provide better understanding of their properties and potential uses.

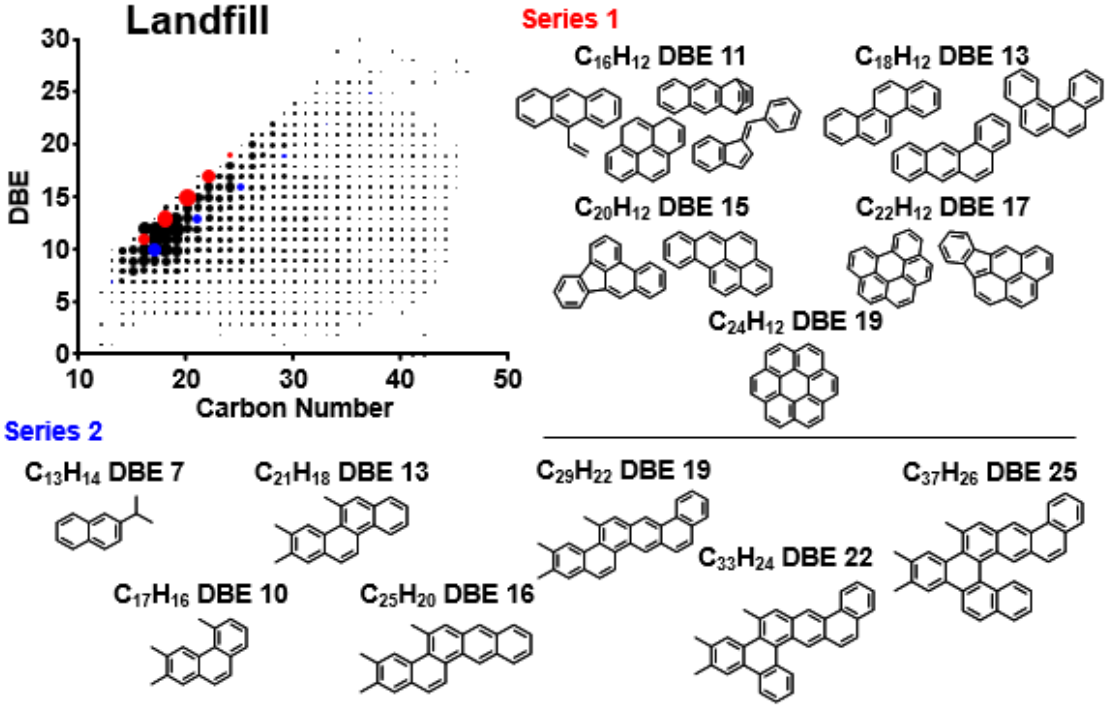

Fig. 1. 9.4T FT ICR-MS-derived isoabundance-contoured plots of double bond equivalents (number of rings plus double bonds to carbon) versus carbon number for the aromatic hydrocarbons from the landfill pyrolysis oil. Peri-condensed structures are seen in series 1; whereas series 2 shows cata-condensed structures.

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References

[1] Ware, R. L.; *et al.*, Energy & Fuels, **32**, 7752-7761 (2018).