Advanced Chemical Characterization of Pyrolysis Bio-Oils from Landfill Waste, Recycled Plastics, and Pine Forest Residue

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Introduction

Waste material pyrolysis has proven useful for the production of pyrolysis oils; however, the physical properties and chemical composition of pyrolysis oils are greatly influenced by the feedstock. It is well established that lignin- and cellulose-rich material produces pyrolysis oils high in aromatic oxygen-containing compounds, whereas pyrolysis oils produced from other sources such as plastics and household wastes are far less characterized. Here, three fast pyrolysis oils produced from landfill waste, recycled plastics, and pine forestry residue are compared by elemental analysis, Fourier transform infrared spectroscopy (FT-IR), comprehensive 2D gas chromatography (GC×GC), Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS), and liquid chromatography. GC×GC, FT-ICR MS, and liquid chromatography provide insight into the chemical composition of pyrolysis oils; whereas FT-IR analysis identifies functional groups.

Experimental

Here, three fast pyrolysis oils produced from landfill waste, recycled plastics, and pine forestry residue are compared by elemental analysis, Fourier transform infrared spectroscopy (FT-IR), comprehensive 2D gas chromatography (GC×GC), NHMFL's 9.4 T Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS), and liquid chromatography. GC×GC, FT-ICR MS, and liquid chromatography provide insight into the chemical composition of pyrolysis oils; whereas FT-IR analysis identifies functional groups.

Results and Discussion

Landfill and plastic pyrolysis oils were found to contain higher hydrocarbon content that resulted from little or no cellulosic material in their feedstock. In contrast, pine pyrolysis oil is more aromatic and contains a higher abundance of polar species due to the number of oxygen functionalities. The hydrocarbons in plastic pyrolysis oil are more saturated than in landfill and pine pyrolysis oils. Due to their lower oxygen content, landfill and plastic pyrolysis oils are more attractive than pine pyrolysis oil as potential fuel candidates (**Fig. 1**).

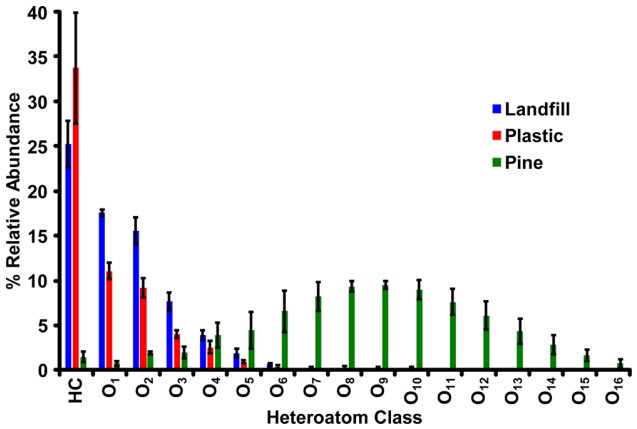

Fig. 1. Heteroatom class distributions derived from triplicate (+) APPI FT-ICR mass spectral analysis of dried landfill (blue), plastic (red), and pine (green) pyrolysis oils

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Reference

[1] Ware, R.L., *et al.*, Energy & Fuels, **31**, 8210-8216 (2017).