RECYCLED PLASTIC PYROLITIC OIL CHARACTERISATION WITH GC-VUV TECHNOLOGY

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ABSTRACT

Plastic waste is a major concern in this era and many efforts are underway to establish a plastics circular economy by reusing or recycling it instead of resorting to incineration or landfill disposal. Two primary methods of recycling plastic waste are mechanical recycling and feedstock (chemical) recycling, with the latter involving gasification or pyrolysis technologies. The pyrolysis process produces oils with variable compositions depending on the charge and necessitate accurate analysis for proper processing as feedstock. For this scope, is possible to employ gas chromatography coupled to vacuum ultraviolet detection (GC-VUV) for speciating classes (paraffins, isoparaffins, olefins, naphthenes, and aromatics – PIONA) in pyrolysis oils ranging from C5 to C64. The limit of detection for these analyses was 0.2 wt.%.

INTRODUCTION

The VUV is a GC detector operating in the spectral region between 120 and 240 nm where many organic compounds show strong absorption. The possibility of recording a spectrum attributable to these molecular electronic transitions therefore allows us to unambiguously recognize molecules and classes. Furthermore, VUV software lets to deconvolve coeluted compounds automatically reducing post-acquisition data analysis.

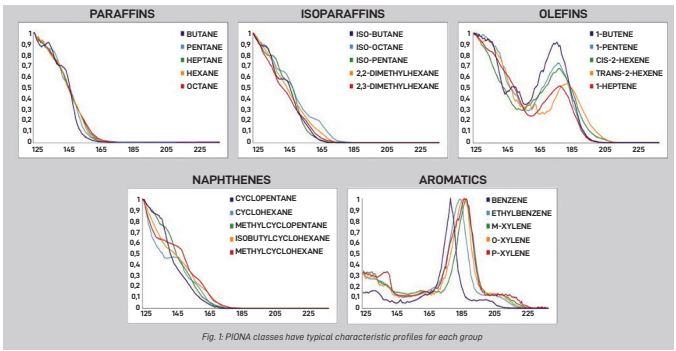

Fig. 1: PIONA classes have typical characteristic profiles for each group

METHOD DEVELOPMENT

System was validated with a reference mixture prepared by weight containing linear alkanes, styrene, mono/di/tri aromatics, naphtenes and isoparaffins and another mixture composed just by linear alkanes ranging from C5 to C64. Peak identification and quantification of the GC-VUV chromatograms were performed using a time interval deconvolution method which considers the UV spectra and corresponding relative response factors incorporated into the spectral library. In order to accurately identify the hydrocarbon composition of the pyrolysis oil blend, a multitude of VUV spectra, together with calculated response factors, were added to the spectral library.

RESULTS

First of all, different compositions between a liquid HC blend and a pyrolytics oils were compared. Chromatograms shown below are under same GC conditions.

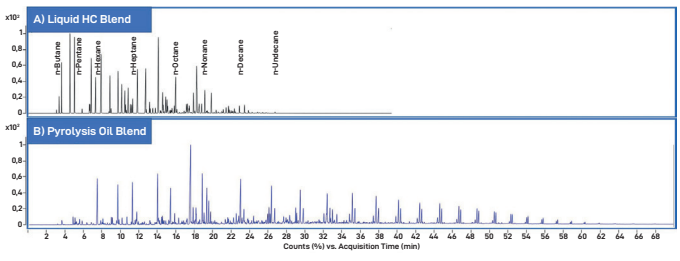

Fig. 1. GC-VUV chromatograms (average 130 – 240 nm) obtained under the method conditions given in the Experimental above for A) liquid hydrocarbon (HC) blend and B) pyrolysis oil blend.

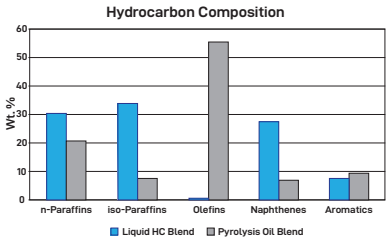

Fig. 2. PIONA quantification of the liquid hydrocarbon (HC) blend and pyrolysis oils blend from the GC-VUV data shown in Fig. 1

Comparison among different pyrolytic oils:

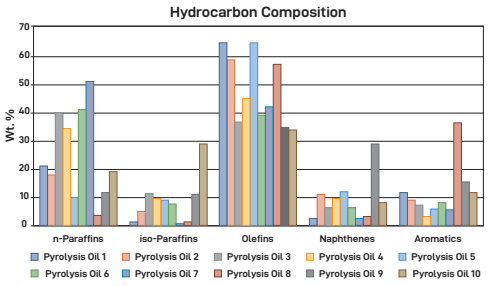

Fig. 3. PIONA quantification from the GC-VUV analysis of 10 different liquid hydrocarbon samples from mixed waste plastic.

CONCLUSIONS

This study highlights that the GC-VUV is able to characterize pyrolytic oils in its main groups constituents. VUV analysis automatically identify and quantify groups and this led to detailed and reliable results, with no limitation to charge chemical composition. By understanding the composition of these oils, plastic wastes can be effectively processed as feedstock, contributing to waste circularity and the development of a sustainable plastics' circular economy.

BIBLIOGRAPHY

Dunkle et All. - "Method development and evaluation of pyrolysis oils from mixed waste plastic by GC-VUV"

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