Analysis of the polar constituents in mixed plastic waste pyrolysis oils using different extraction techniques

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Abstract

There is active research to seek alternative energy sources with the goal of reducing earthwide dependency on traditional fuels. Producing oil through the pyrolysis of plastic waste is seen as a viable and promising approach for future fuel and chemical feedstock generation. Plastic waste can be transformed into oils by heating the plastic at a very high temperature without oxygen, a process called pyrolysis. In the further processing of pyrolysis oils, heteroatoms can reduce efficiency, so heteroatom content must be well understood

Three techniques were used to examine the polar molecules in plastic waste pyrolysis oil. Stainless steel-coated blades with a coating were introduced to the sample to absorb the polar molecules. The blades were then inserted into different solvents to test the efficacy of desorption. Liquid-liquid extraction using polar solvents was also used to isolate the polar constituents. Finally, an experimental aerogel was evaluated and treated similarly to solid phase extraction.

The extractions were analyzed using supercritical fluid chromatography and gas chromatography. Larger and more polar compounds were isolated using these extraction techniques. Future analysis will lead to identifying and quantifying these compounds in the pyrolysis oil.

Introduction

Environmental Impact
- People are actively looking for alternative solution of traditional fuels.
- Build up of plastic waste is concerning people about its effect on the environment

Pyrolysis Oil
- Pyrolysis is the process of heating anything without the presence of oxygen
- Plastic waste can be used to produce fuels through pyrolysis

Sample Analysis
- Different Oils subjected through different extraction techniques

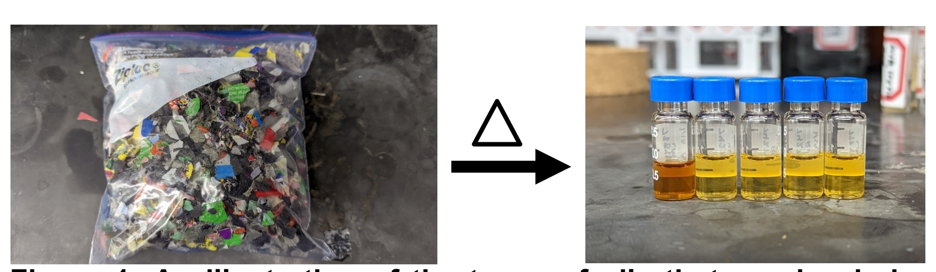

Figure 1: An illustration of the types of oils that can be derived from different plastic waste materials.

Instrumentation

Figure 2: An image depicting the Shimadzu Nexera UC supercritical fluid chromatography-fraction collector (SFC-FC) apparatus utilized in this study. Fraction collection was not used but could be in the future.

Supercritical Fluid (Polarity)
- The mobile phase of carbon dioxide exhibits characteristics of both a gas and a liquid, constituting a green analytical method that surpasses conventional techniques in speed.

Figure 3: A picture of the Shimadzu GC-MS/VUV

Gas Chromatography – Mass Spectrometry/ Vacuum Ultraviolet Spectroscopy
- GC separates volatile and semi-volatile compounds
- VUV provides a unique spectra
- Mass spectrometry provides mass data

SFC to examine Polar Compounds Mixes found in Pyrolysis Oil

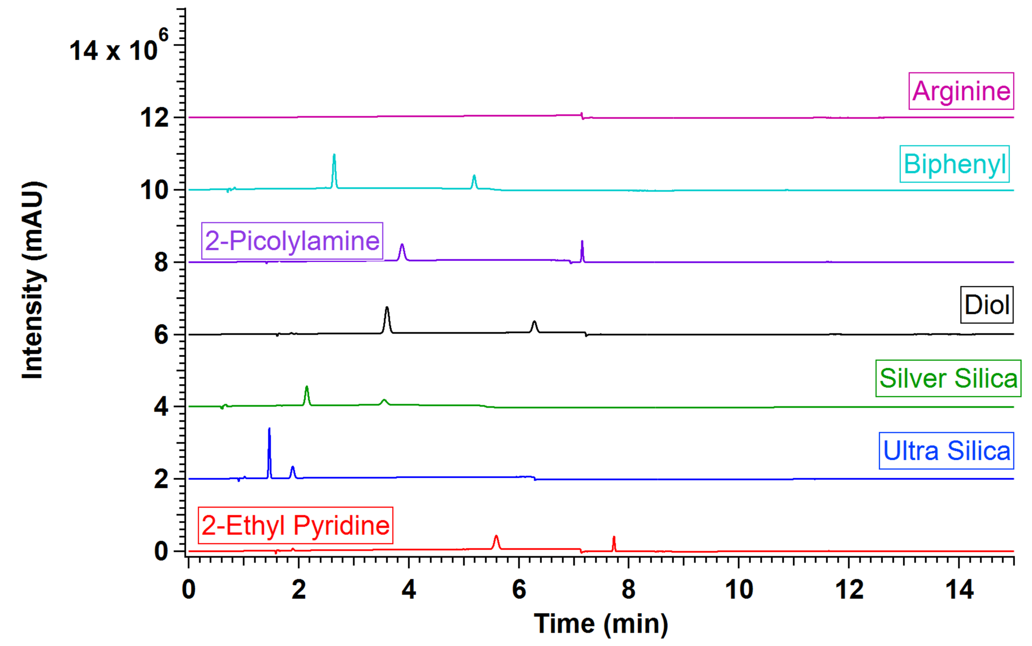

Figure 5: Chromatograms showing retention of a sulfur mix on different columns

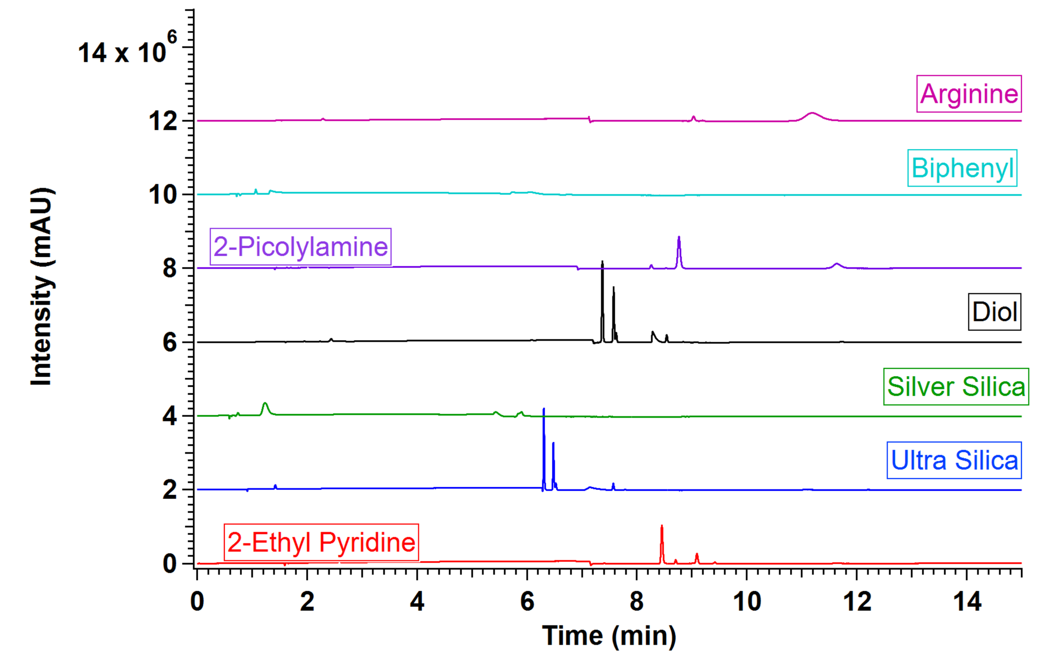

Figure 6: Chromatograms showing retention of an oxygen mix on different columns

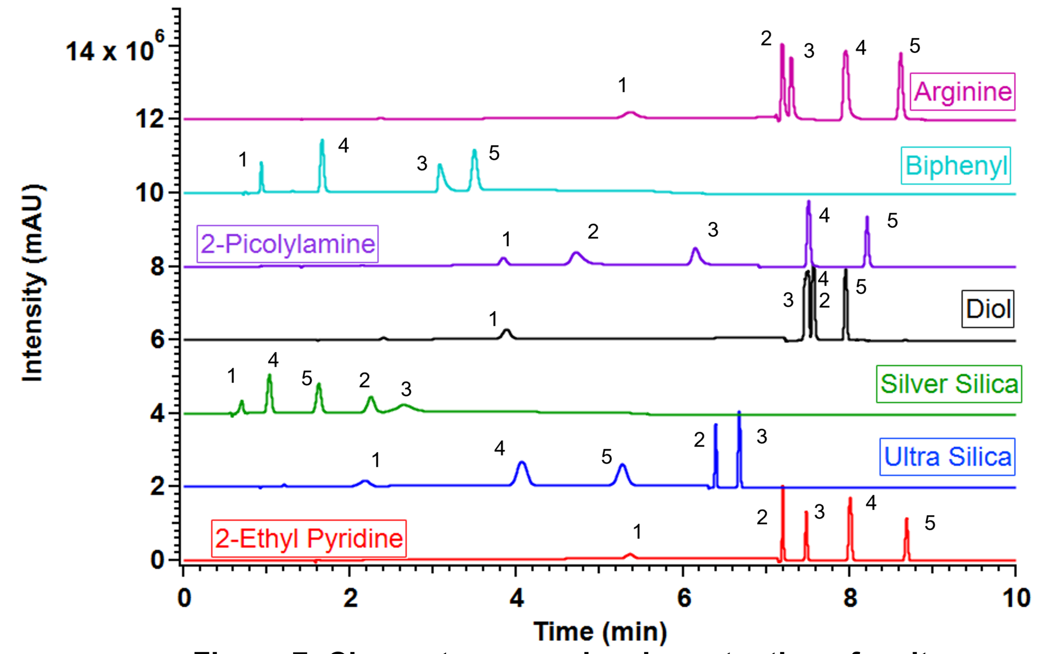

Figure 7: Chromatograms showing retention of a nitrogen mix on different columns

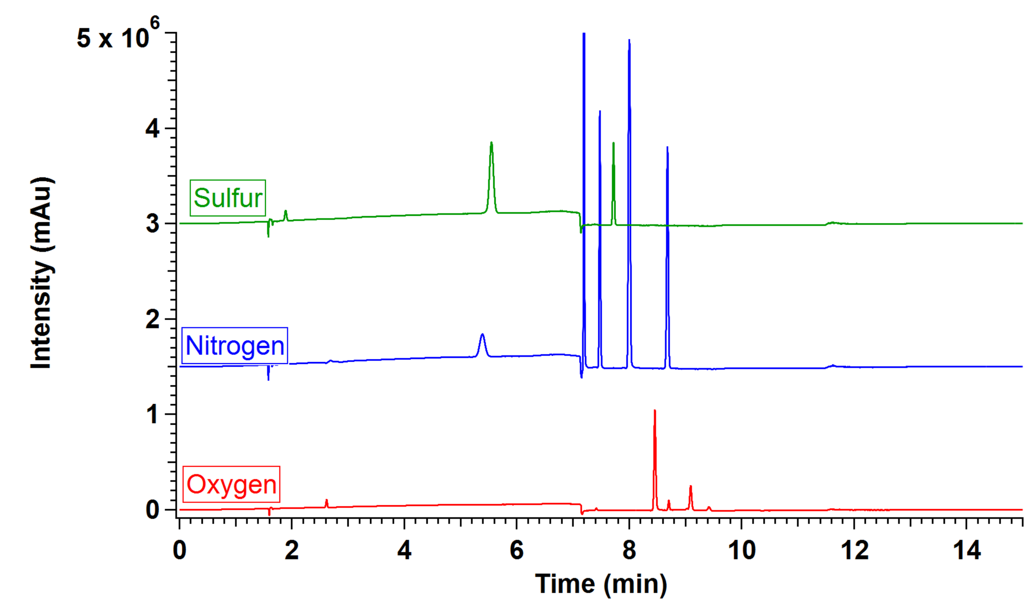

Figure 8: Chromatograms showing the different mixes on one single column, the 2-ethylpyridine column

Methodology - Extraction Techniques

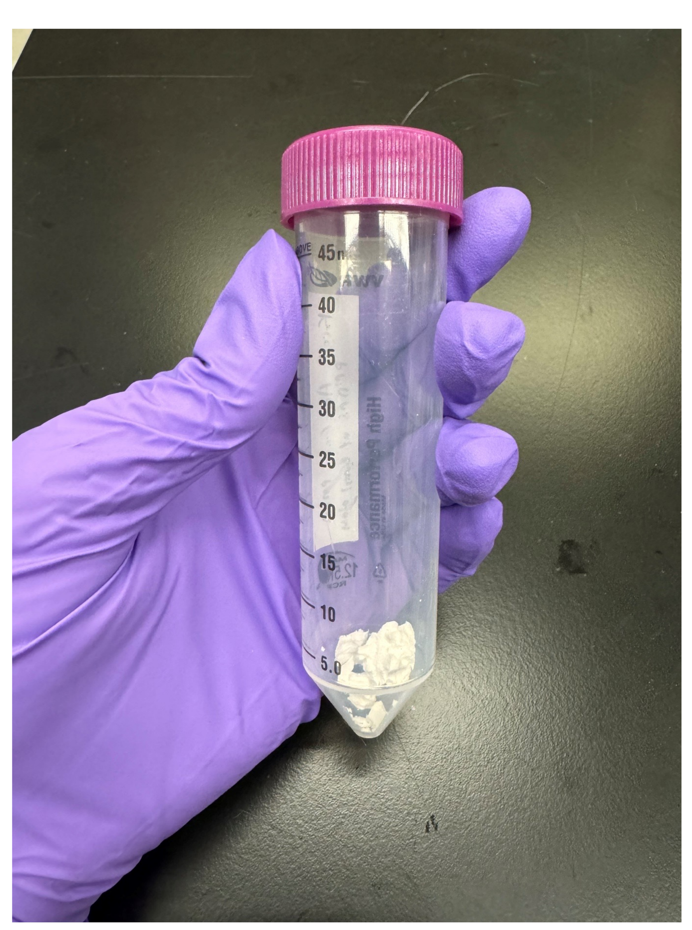

Figure 9: Aerogel as a pseudo solid phase extraction stationary phase

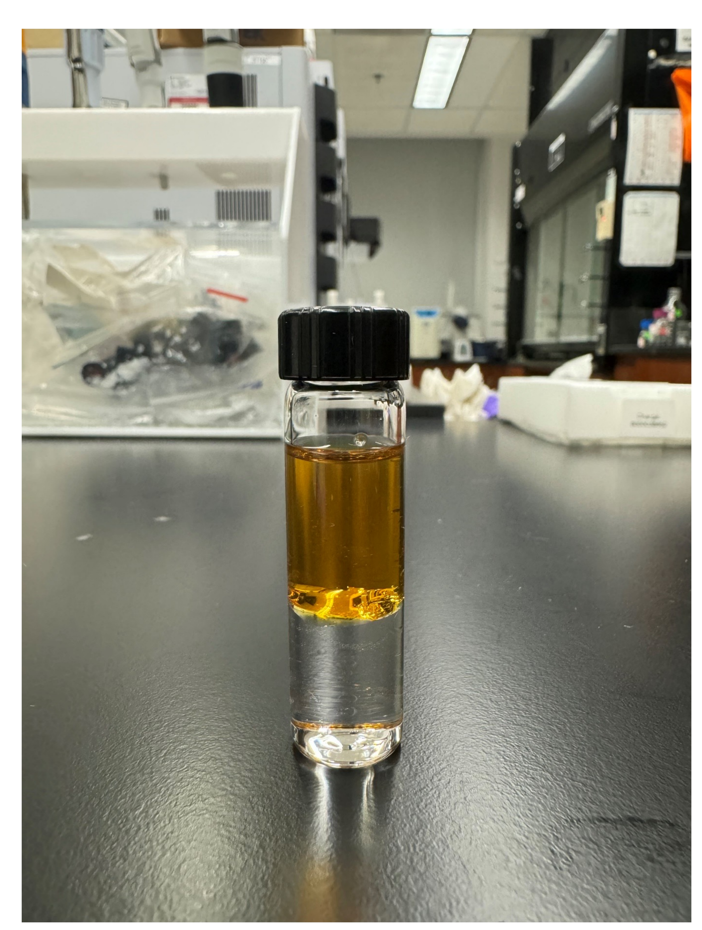

Figure :10: Liquid-Liquid extraction with water

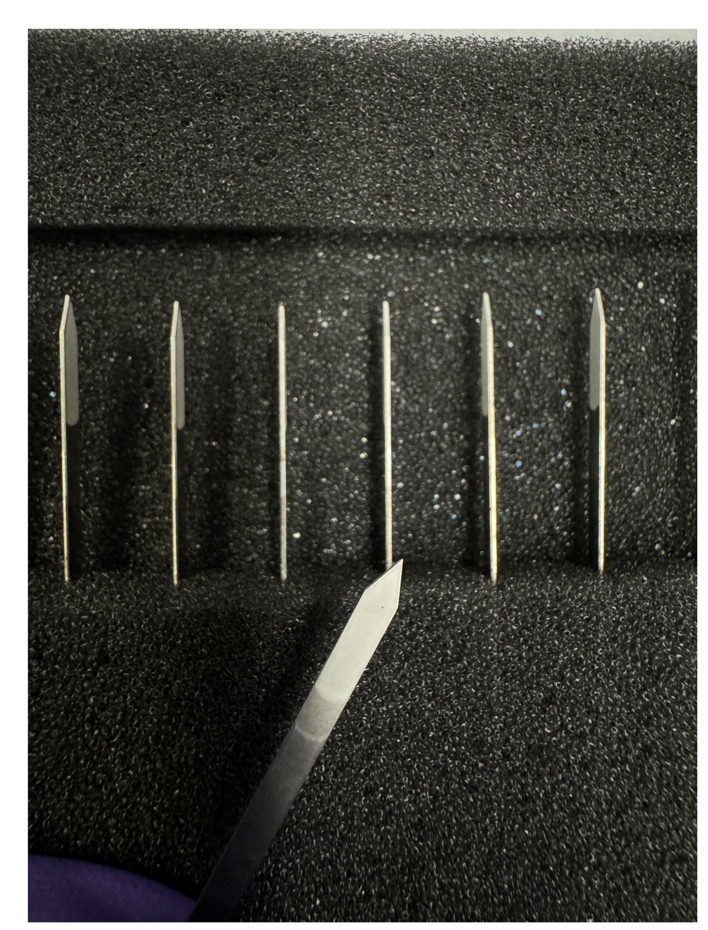

Figure 11: Stainless Steel Blades with a coated phase to examine absorption and desorption with different solvents

CBS Blade Extraction

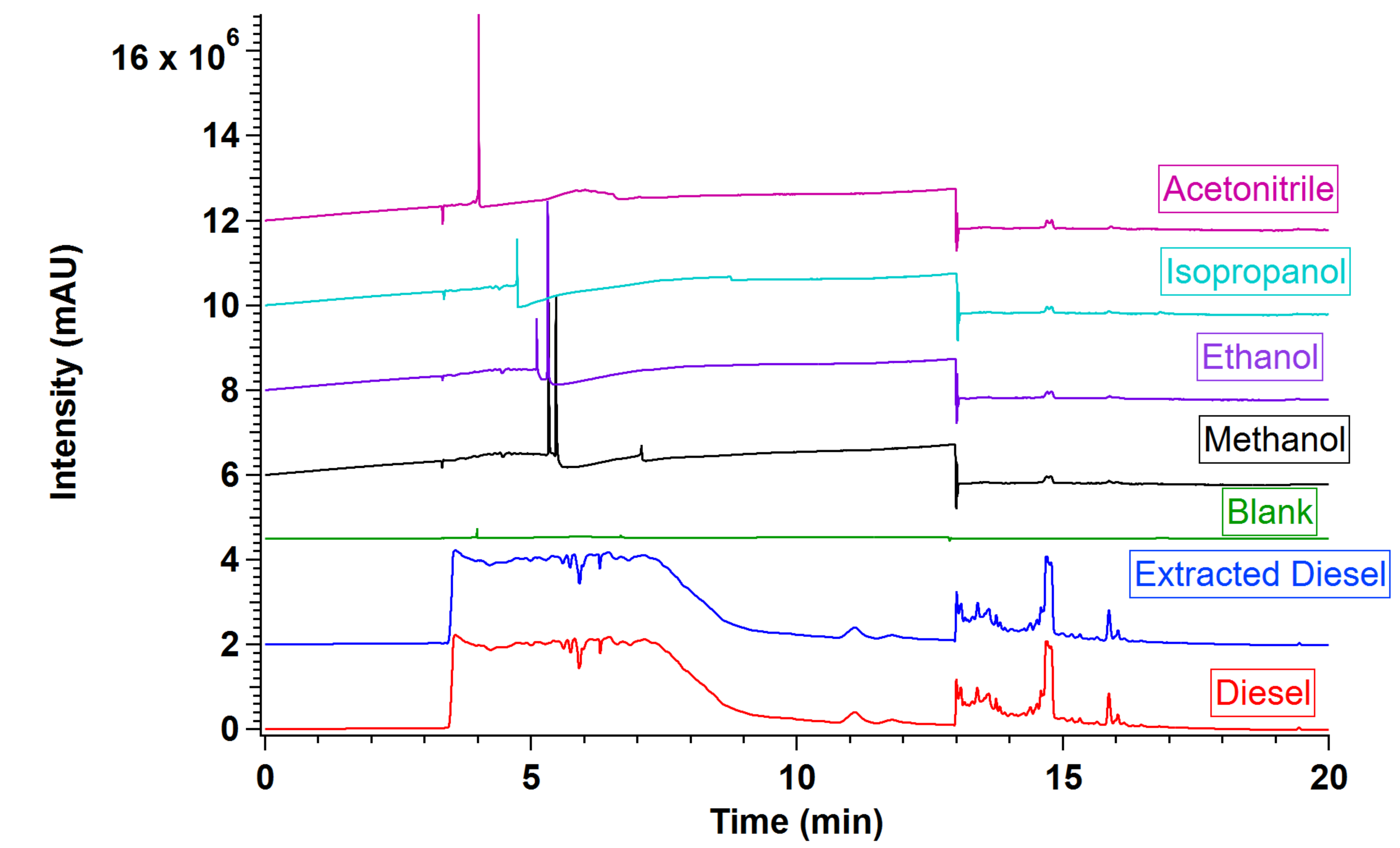

Figure 12: Chromatogram on SFC-UV of CBS blade desorption with selected solvents.

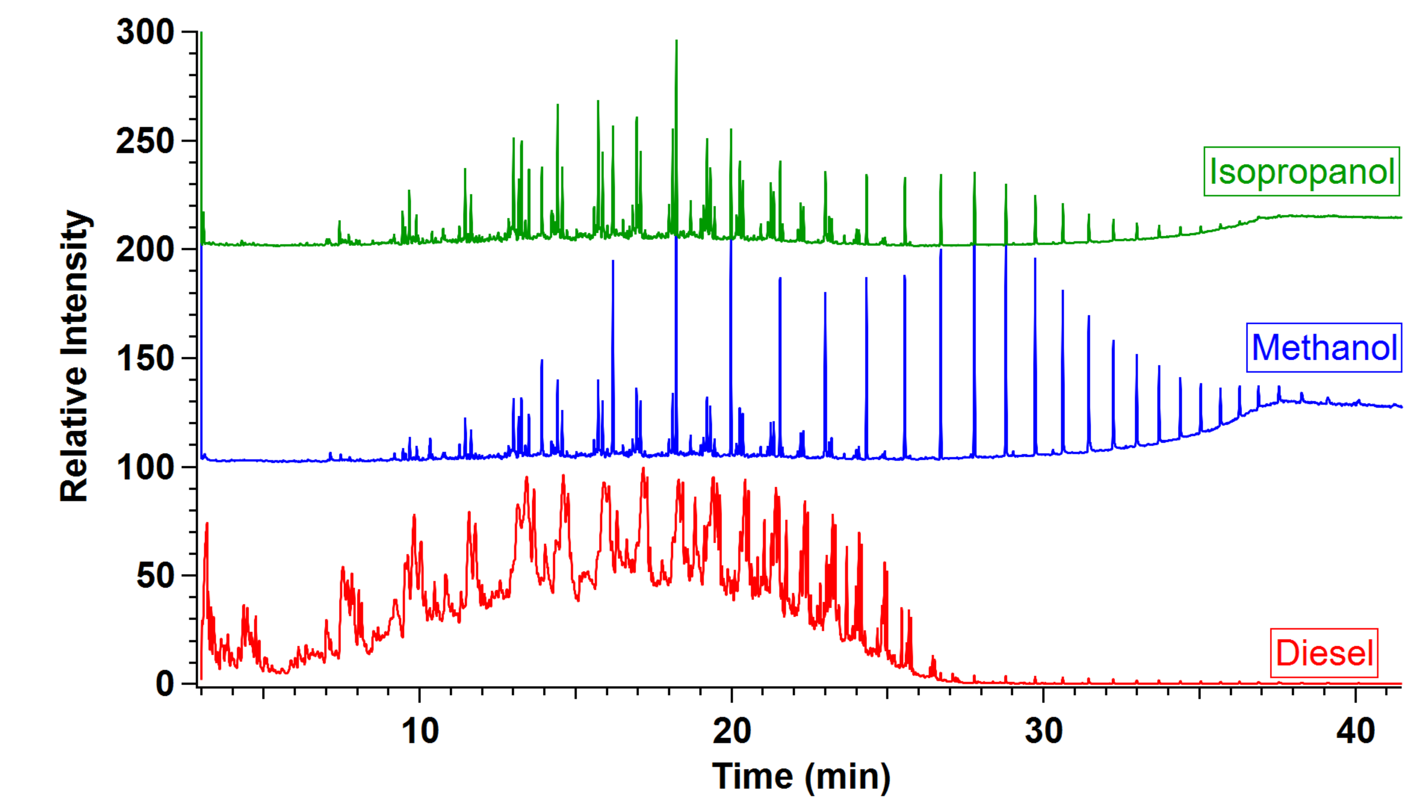

Figure 13: Chromatogram on GC-MS of CBS blade desorption with selected solvents.

Conclusions and Future Work

The future of fuel consumption depends on the alternative source of producing oil. Pyrolysis oil is one of the promising ways to produce new fuels and plastics. To check the quality of the fuel, the polar compounds present insides were analyzed using SFC-UV and GC-MS/VUV. The future of fuel consumption depends on the alternative source of producing oil. Pyrolysis oil is one of the promising ways to produce new fuels and plastics. In the future, more studies need to be performed with the different extraction techniques, particularly the aerogel and liquid-liquid extraction.

Acknowledgements

Shimadzu Scientific Instruments for funding.

Restek, Regis Technologies, and Waters for Columns.