Analysis of Organic Compounds Associated with Biodiesel Exhaust
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Project Overview
Current research at Keene State College measures levels of airborne particulate matter produced from biodiesel and petroleum diesel engine exhaust. Particulate matter from fuel exhaust can contain potentially toxic and hazardous organic compounds. This project aims to develop analytical chemistry methods to determine the concentrations of organic compounds on collected particulate matter from the Keene Recycling Center. Organic compounds such as polycyclic aromatic hydrocarbons, fatty acid methyl esters, and olefins are analyzed using a gas chromatography mass spectrometer. The instrument is calibrated with standard chemicals and the selectivity and sensitivity will be optimized. Airborne particulate matter collected on filters will be extracted and analyzed for the aforementioned chemicals. The analysis of locally collected samples using analytical instrumentation will provide new data on the chemical composition of particulate matter produced from different fuel types.

Project Significance and Goals
- Composition data will inform our understanding of the potential health effects from particulate matter generated by biodiesel and petroleum diesel combustion.1-3
- A wide range of PAHs are well documented as carcinogenic, many of which are associated with the particulate matter emitted from combustion of fuels of interest.4-6
- Composition data will investigate whether combustion of biodiesel generates particulate matter that is more or less harmful than petroleum diesel.1

Particulate Matter Collection Sampling Plan
- Particulate matter was collected from two different locations at the Keene Recycling Center, inside the cab of a John Deere 624K front loader and on the sidewalk next to a loading bay.
- The two sites represent the breathing zone (front loader) and ambient air (loading bay) that employees are exposed to. Vacuum pumps were used to draw air through Stoules impactors (Figure 1) over a seven hour work period.
- The Stoules impactor separates particulate matter into different size plates ranging from 2.5 μm to 0.25 μm on quartz filters, thus separating out dust and smaller particulates that are associated with fuel combustion.

Targeted Compound Classes
- Polycyclic Aromatic Hydrocarbons (PAHs)
  - 16 target PAHs
    - Non-cyclic
    - Non-polar
  - Formed from incomplete combustion of organic matter
  - Carcinogenic/mutagenic
- Fatty Acid Methyl Ethers (FAMEs)
  - 31 targeted FAMEs
  - Spectrum polarity
  - Free fatty acids are methylated to FAMES for fatty acid quantification
  - Naturally found in biodiesel

Instrumental Analysis of Particulate Matter
Gas Chromatography – Mass Spectrometry
- The GC-MS is used to analyze organic compounds found on particulate matter such as PAHs and FAMEs (Figure 2).
- Samples are immediately volatilized and the molecules then enter the column where a gas phase separation occurs based on polarity and boiling point. The column is in a programmable oven used for tailoring the separation of complex chemical mixtures.
- Upon exiting the column, molecules are both ionized and fragmented. The ions then enter a mass analyzer, which measures the mass to charge ratio.
- Separated mixtures are presented in a chromatogram and a mass spectrum can be generated for any particular peak.

Future Research
- Collect diesel particulate matter samples for comparative analysis to biodiesel data.
- Identify free fatty acid derivatization protocol, and reanalyze samples.
- Chemically characterize high mass filters collected for cell exposure studies.

References

Acknowledgements
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