**OBJECTIVE AND SIGNIFICANCE:** The objective of this project is to identify and characterize trace quantities of heteroatomic organic species (HOS) in aviation, maritime, and diesel fuels. New analytical methods under development can evaluate the composition of fuels currently in use and those stored as strategic reserves. The knowledge gained in this project will improve the understanding of the influences of HOS on fuel stability and guide efforts to preserve fuel quality.

**BACKGROUND:** Liquid fuels are, by nature, chemically complex. Many fit-for-purpose and stability issues are associated with trace quantities of HOS. Identification and quantitation of HOS are challenging due to their low concentration and complex composition of fuel matrix. Multidimensional gas chromatography (MDGC) typically uses sequential separations based on differences in polarity and boiling point as the basis for fuel sample analysis. The current state-of-the-art for MDGC is comprehensive two-dimensional GC (2D-GC).

HNEI began developing a fuel laboratory in 2012 and the current capabilities include standard analysis methods required by ASTM and military fuel specifications. Research conducted in the fuel laboratory has included investigating the impacts of long-term storage, oxidative conditions, contaminants, etc. of conventional and alternative fuels and their blends.

A 2D-GC was acquired in August 2018, expanding the fuel laboratory’s ability to identify and quantify fuel constituents present in trace amounts (≤100 ppm). The HNEI 2D-GC employs two injectors and three detectors (i.e. mass spectrometer, nitrogen chemiluminescence and sulfur chemiluminescence) to analyze fuel components and HOS with a single injection event. Neat fuels can be injected directly without requiring solvent dilution.

**PROJECT STATUS/RESULTS:** HNEI is currently collaborating with personnel from the U.S. Navy Fuels Cross-Functional Team on 2D-GC applications, including:

- Determining fuel hydrocarbon matrix;
- Investigating the distribution and contents of nitrogen and sulfur compounds in fuels;
- Participating in round robin tests to identify and quantify nitrogen compounds in various type of fuels;
- Exploring the relationships between fuel long-term storage and the content of antioxidant additives; and
- Utilizing HOS characterization methods to investigate the potential impacts of HOS on fuel properties and fuel stability.

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