Title: Quantification of Gas-Phase Species in Biodiesel Exhaust Emissions using Fourier Transform Infrared (FTIR) Spectroscopy

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Abstract:
The push for renewable energy has led to increasing popularity in biodiesel use in place of petroleum diesel. While known to reduce most criteria air pollutants, studies have shown that biodiesel combustion may increase mobile source air toxics (MSATs) emissions. The effect of biodiesel use on MSAT emissions remains largely inconclusive. Some studies suggest that carbonyl emissions (a type of MSAT) may increase due to the oxygenated nature of biodiesel fuel, while others claim that biodiesel combustion can reduce carbonyl emissions. This project focused on identifying how biodiesel fuel content (Bxx) and engine load affected emissions of criteria pollutants and MSATs, which were quantified using FTIR spectroscopy. Infrared spectra collected at the University of Vermont from June-October 2013 of waste vegetable oil (WVO) biodiesel exhaust for B0, B10, B20, B50, and B100 blends were reprocessed using MKS MultiGas 2030 High Speed software for CO, CO₂, NOx, and 21 air toxics, including formaldehyde. The analysis found that of the MSATs, formaldehyde was present in the highest concentrations, while other MSATs were detected in very small quantities or were not measured consistently above the detection limit. Thus only formaldehyde provided sufficiently reliable data for observing the effects of biodiesel fuel content and engine load on MSAT emissions. Emissions for products of incomplete combustion (CO, formaldehyde) decreased with increasing engine load, as well as with higher Bxx. CO₂ emissions increased with higher engine load, but were not significantly affected by Bxx. At low engine load, NO emissions decreased with increasing Bxx, but were not affected at higher engine loads. NO₂ emissions decreased with increasing Bxx at higher engine loads, but were not affected by biodiesel at lower engine loads. Future work to investigate spectral interference between carbonyls should be conducted to improve the application of FTIR to biodiesel exhaust analysis.