Physicochemical Assessment of Biodiesel Vehicle Fuel Exhaust Emissions and the Effect of New Emission Control Devices: The EMITTED Study

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STUDY OVERVIEW

Background
The Exhaust Measurement and Inhalation Toxicology Testing for Emerging Diesel Fuels (EMITTED) Study addresses the effects of advancements in diesel technology on the toxicologically relevant characteristics of exhaust.

Specifically, the EMITTED Study will answer the following questions:
1. How does diesel fuel type (petroleum, biodiesel) affect the physicochemical characteristics of the exhaust?
2. How do emissions control technologies, such as oxidation catalysts (DOCs) and filters (DPFs), affect the physicochemical characteristics of the exhaust?

Research Objectives
(1) Develop a comprehensive measurement program (shown below) to characterize engine emissions considering regulated pollutants and unregulated pollutants.
(2) Quantify the effects of emissions control technologies (DOCs, DPFs) on engine emissions whencombusting alternative diesel fuels (biodiesels).

Diesel Fuel Type:
- Ultra-low sulphur diesel (ULSD)
- 20% Animal fat biodiesel (AF-B20)
- 20% Soybean biodiesel (S-B20)

Test Engine:
1997 Cummins B3.9 Off-road Engine
Engine Out Emissions: US EPA Tier 1
With DOC and DPF: US EPA Tier 4

Diesel Oxidation Catalyst
1) Pt/Pd Catalyst 1
2) Pt/Pd Catalyst 2

Diesel Particulate Filter
1) Bare
2) Base Metal

ISO8178 Engine Operation:
- Mode 2: 2500 rpm, 254 N-m
- Mode 9: 1400 rpm, 106 N-m

PRE-TREATMENT:
- Volatile phase removal: Dekati Thermodenuder
- Adsorptive filter: Teflon (AF-B20)

Sampling Port 1
Sampling Port 2
Sampling Port 3

To Atmosphere

Particle Sizer Equivalency Study
The Engine Exhaust Particle Sizer (EEPS) and Fast Mobility Particle Sizer (FMPS) are used to measure particle number, mass, and surface area concentrations upstream and downstream of the DPF, respectively. An equivalency study using diluted ISO8178 Mode 9 exhaust was used to determine size bin specific correction factors for the EEPS (Figure 1). Correction factors are approximately 1.0 in the size bins with the largest number concentration (22-60 nm). Size bins with the smallest number concentration were associated with larger confidence intervals.

DPF Collection Efficiency
Figure 2: Calculated DPF collection efficiency of the DPF. Shading represents confidence interval from correction factors. The impact of correction factor on the calculated DPF collection efficiency is estimated with 95% confidence to be ≤ 4%. Higher collection efficiency was observed in the <22 nm size fraction, potentially due to losses in volatiles downstream of the DPF or particle losses in the dilution systems.

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