Development of an Exhaust Dilution System for Real-World Particle Number Emissions Quantification between Petroleum-based Diesel and Biodiesel Fuels

Abstract

Particulate matter (PM) is one of the six criteria pollutants addressed by the Environmental Protection Agency's (EPA) National Ambient Air Quality Standard (NAAQS) (EPA, 08NOV2011). PM can cause adverse health effects because it is readily inhaled. As particle size decreases, the risk of these adverse health effects increases because smaller particles can penetrate farther into the human respiratory system to reside in the deep lung (EPA, 06JUL2011).

Transportation vehicles are main contributors to PM pollution in urban areas. Recently, there has been an increase in the use of biofuels for transportation. Bio-diesel is the biofuel of choice for vehicles powered with compression ignition (CI) engines. In this work, a sampling system was developed to enable measurement of the differences in exhaust particle number distributions from a CI engine fueled by both petroleum-based diesel and soy-based biodiesel fuel. This system draws a sample of the raw exhaust out of the tailpipe and dilutes it with clean, dry air. Reasons for this dilution include:

1. When the raw exhaust exits the tailpipe of a vehicle, it dilutes as it mixes with the atmosphere. This diluted mixture is what enters the respiratory system and is, therefore, what should be studied.
2. Instrumentation used to measure particle number distributions emissions cannot sample raw CI engine exhaust because the particle concentrations and exhaust temperatures are too high.

The dilution ratio of this sampling system must be closely monitored to ensure that measurements taken from test to test are equivalent. This has proven to be a difficult task primarily due to the pressure pulses found in an engine exhaust system. After extensive testing and modification, the measure of dilution ratio has improved greatly. Preliminary particle number distribution data is presented here for Petroleum-based diesel fuel, B20, B50, and B100.

1. EPA (U.S.) (08NOV2011). Air and Radiation. "National Ambient Air Quality Standards (NAAQS)", http://www.epa.gov/air/criteria.html, Last Accessed 22FEB2012
2. EPA (U.S.) (06JUL2011). Particulate Matter., http://www.epa.gov/pm/, Last Accessed 22FEB2012