TARTA Biodiesel Study

Characterization of Emissions and Indoor Air Quality of Public Transport Buses using Biodiesel

Biodiesel is a young renewable alternative fuel that would play a significant role in the near future since it has the competitive edge of being a sustainable energy resource over other conventional fuels. This research reports the results of a field program carried out using the Toledo Area Regional Transit Authority (TARTA) buses running on biodiesel. The research was carried out to study the effect of biodiesel on both the exhaust emissions and indoor air quality (IAQ) of the bus.

A comprehensive analysis of exhaust emissions resulting from the use of different blends under different operating modes will be reported. The effects of biodiesel on vehicular emissions varied from pollutant to pollutant and are primarily dependent on the type of engine, engine speed and engine load, ambient conditions, and blends of biodiesel. Regression analysis of the various engine parameters showed that engine temperature, exhaust temperature, and engine operating conditions such as acceleration, load, rpm, and boost pressure contributing significantly to affect vehicular emission levels.

Indoor air quality in buses operating on B20 grade biodiesel and ULSD were studied for more than two years. Two different statistical analyses, namely, regression analysis and regression tree analysis were used in determining the factors affecting IAQ levels. It was observed that the factors affecting in-vehicle pollutant levels varied for each month, season, and year. Vehicular pollutant trends have been plotted and the possible reasons for variations were discussed in detail in different papers. The average indoor air concentrations of measured pollutants were found higher during the periods of heavy traffic in the morning and evening. Also, higher concentrations were observed during the winter months compared to the other seasons due to lower air exchange in winter.

Exposure study revealed that the average 8-hr. exposure of B20 drivers to CO_2, CO, NO, NO_2, SO_2, and $PM_{2.5}$ were 559.67 ppm (± 45.01), 18.33 ppm (± 9.23), 2.76 ppm (± 0.81), 0.03 ppm (± 0.01), 0.13 ppm (± 0.01), and 22.22 $\mu g/m^3$ (± 5.12), respectively; while for ULSD bus occupants the average exposures were 632.20 ppm (± 102.70), 8.08 ppm (± 1.41), 0.59 ppm (± 0.17), 0.01 ppm (±0.01), 0.39 ppm (± 0.04), 20.74 $\mu g/m^3$ (± 4.57). The study found that travelling in a biodiesel bus is safe for both the passengers as well as drivers with the monitored indoor pollutant levels being well below the available health guidelines.

The physical and chemical characterization of particulate matter was carried out with non-destructive techniques such as X-ray Diffraction, Fourier Transform Infrared Spectroscopy, Magnetic Susceptibility, Raman Spectroscopy, X-ray photoelectron spectroscopy and Scanning Electron Microscope with Energy Dispersive Spectroscopy in order to understand the particle characteristics. The research work provided the results on the characteristics of particles found inside the bus during this sampling program. The surface of most particles was coarse with a fractal edge that could provide a suitable chemical reaction bed in the polluted atmospheric environment. The three sorts of surface patterns of squares were smooth, semi-smooth, and coarse. The three sorts of square surface patterns represented the single inhalable particle's morphology characteristics in the air inside the bus in the Toledo, Ohio. The size distribution was generally multi-modal for the ULSD but uni-modal for the B20-fuled bus. The aspect ratio found for different filters collected inside the bus fueled by both the B20 blend and ULSD were in the average value range 2.4-3.6 and 2.3-2.9 with standard deviation range 0.9-7.4 and 1-7.3 respectively. The square and oblong-shaped particles represented the single inhalable particle's morphology characteristics in the air of a Toledo transit bus.

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