

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 an ongoing field program using the Toledo Area Regional Transit Authority (TARTA) buses running on biodiesel. The research is being carried out to study the effect of biodiesel on both the exhaust emissions as well as on the indoor air quality 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 has been studied for more than two years. Two different statistical analyses namely regression analysis and regression tree analysis have been used in determining the factors affecting indoor air quality levels. It was observed that the factors affecting in-vehicle pollutant levels varied for each month, season, and year from these analyses. Vehicular pollutant trends have been plotted and the possible reasons for variations have been 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 CO₂, CO, NO, NO₂, SO₂, and PM_{2.5} are 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 µg/m³ (± 5.12) respectively while for ULSD bus drivers the average exposures are 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 µg/m³ (± 4.57). The study found that travelling in a biodiesel bus is safe for both the passengers as well as drivers with the indoor pollutant levels being well below the available health guidelines.

The physical and chemical characterization of particulate matter is being carried out with non-destructive techniques such as X-ray Diffraction, Fourier Transform Infrared Spectroscopy, Magnetic Susceptibility, and Scanning Electron Microscope with Energy Dispersive Spectroscopy in order to understand the particle characteristics. The research work provides 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-fueled 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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Student Posters:

- A. Vijayan, "Trend Analysis of Indoor Air Quality of Public Transport Buses", 99th Annual A&WMA Conference Student Poster Session, New Orleans, Louisiana, June 2006.
- A. Vijayan, "Determination of Emission Characteristics of Public Transport Bus Fleets Operating on Alternative Diesel Fuels", Presented at the 100th Annual A&WMA Conference Student Poster Session, Pittsburg, PA, June 2007.
- A. Vijayan, "Characterization of Indoor Air Pollutant Behavior Inside Public Transport Buses", Presented at the 100th Annual A&WMA Conference Student Poster Session, Pittsburg, PA, June 2007.
- V. Garimella, A. Vijayan, "Determination and Evaluation of Emission Rates from the City of Toledo Garbage Disposal Trucks", Presented at the 100th Annual A&WMA Conference Student Poster Session, Pittsburg, PA, June 2007.
- K.K. Shandilya and A. Kumar, "Deep Insight in Biodiesel Exhaust Emissions in Public Transit Buses", Poster Presentation in 101st Annual Conference & Exhibition, AWMA, June 24-27, 2008 in Portland, Oregon.

- V.V.K. Nerella, “Comparison of Real World Emissions from B20 and ULSD fuels for Transit buses”, student poster #22, Poster presentation in 101st Annual Conference & Exhibition. AWMA, June 24-27, 2008 in Portland, Oregon.
- K.K. Shandilya and A. Kumar, “Biodiesel Exhaust in Public Transit Buses”, Poster Presentation in the UT Graduate Research Symposium, May 14-15 2008 in Toledo, Ohio.
- V. Garimella, “Exhaust Emission Characterization from the City of Toledo Garbage Disposal Trucks”, Poster Presentation in 101st Annual Conference & Exhibition, AWMA, June 24-27, 2008 in Portland, Oregon.
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2. A. Kadiyala, Identification of Factors Affecting Contaminant Levels and Determination of Infiltration of Ambient Contaminants in Public Transport Buses Operating on Biodiesel and ULSD Fuels, Master’s Thesis, University of Toledo, 2008.

Student Thesis/Dissertation (in progress):

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Presentation only:

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