ABSTRACT
Transit buses represent a significant source of particulate exhaust emissions, especially in urban areas, but few previous studies have quantified these emissions using real-world, onboard sampling while the vehicles operate in the transportation network. In this study, real-world particle number emissions for hybrid diesel-electric (HDE) and conventional diesel (CD) buses, are examined for various vehicle operating conditions and road types in the Hartford, CT region. The results presented in this paper are based on analysis of the unique second-by-second CT Transit on-road transit bus emissions and operations dataset collected between Jan-November, 2004 [13]. The results of this analysis indicate hybrid buses operate differently from conventional diesel buses. Although the distributions of vehicle specific power (kW) values were similar between the two bus types, the distributions of engine operation parameters (load and RPM) were different. Therefore, VSP alone cannot be used to distinguish between vehicle types when modeling engine operation (and possibly emissions) from hybrid and conventional vehicles. Furthermore, the modal analysis of ultrafine particle emissions indicates there are situations where the HDE buses do not outperform the CD, and may even produce higher emission rates than the CD buses tested. Thus, there are routes and conditions where transit authorities should avoid the use of HDE buses similar to those tested here when particle emissions are of concern.

TEST ROUTE
3 CT transit bus routes were combined to create a 62 mile test route for data collection

OPERATIONAL ANALYSIS

EMISSIONS ANALYSIS

EQUIPMENT
2 Conventional Diesel and 2 Hybrid Diesel Electric Buses
Electrical Low Pressure Impactor (ELPI) - Particle number (#/cm
Scantool - Engine speed (RPM), Engine load (%) and Vehicle speed (MPH)
Horiba OBS-1000 Exhaust Analyzer; Exhaust flowrate (L/Min)

CONCLUSIONS
Operations
• Vehicle operation (VSP) does not vary based on bus type. However, there are obvious differences in engine operation between CD and HDE buses.
• The diesel engines of these two bus types are operating differently as shown in the operational analysis. Therefore VSP is a measure of how the vehicle is operating. On HDE buses emissions are a function of how the diesel engine is operating not the vehicle as a unit. Thus VSP may not be an accurate predictor variable for HDE emissions.
• The operational analysis indicates that bus type is significant and that HDE bus operation should not be modeled using the same equations as CD buses.

Emissions
• The emissions analysis indicates, driving routes and vehicle type have a significant impact on the mean particle number emissions rate generated by the bus.
• The results of this analysis are contradictory to the common belief that a HDE will produce significantly lower emissions than a CD, at least with respect to PN emissions.

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