Reduction of Ultrafine Nanoparticles from Natural Gas Fuelled Heavy Duty Transit Bus Equipped with an "Alternative" Oxidation Catalyst

Arvind Thiruvengadam, Mridul Gautam, Mohan Krishnamurthy
Department of Mechanical and Aerospace Engineering, West Virginia University

OBJECTIVE

- The global objective of this study was to evaluate the emissions reduction potential of an alternative catalyst formulation which was designed to be cost-effective
- One of the specific objective was to study the effectiveness of the alternate formulation of the oxidation catalyst in reducing tailpipe emissions of ultrafine nanoparticles.
- The oxidation catalyst was manufactured by Engine Control Systems, Canada and was retrofitted on DDC Series 50 natural gas fueled vehicles.
- Two buses were tested on the transportable heavy duty chassis dynamometer part of West Virginia University, Engines and Emissions Research Laboratory.
- Steady state particle sizing tests were carried out during the warm-up period of the engine to asses the emissions of ultrafine nanoparticles during this period.

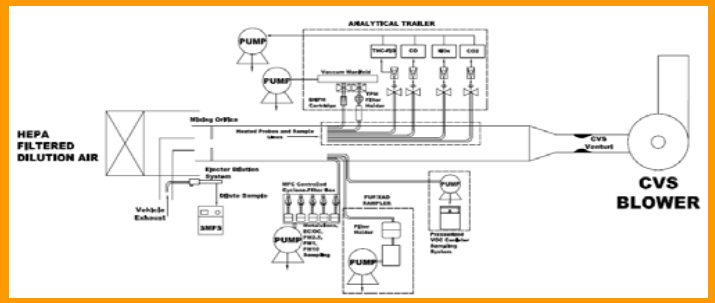
TEST VEHICLE AND ENGINE SPECIFICATIONS

	LACMTA	RTA
Vehicle Type	Transit Bus	Transit Bus
Vehicle Manufacturer	Neoplan	NABI, Inc.
Vehicle Model Year	1999	2002
Gross Vehicle Weight (GVW) (lb.)	40600	40600
Vehicle Total Curb Weight (lb.)	32660	33040
Vehicle Tested Weight (lb.)	37840	37840
Transmission Type	Auto	Auto
Transmission Configuration	4 speed	4 speed
Engine Type	Detroit Diesel S-50	Detroit Diesel S-50
Engine Model Year	1999	2005
Engine Displacement (Liter)	8.5	8.5
Number of Cylinders	4	4
Engine Rated Power (hp)	275	275

APPROACH

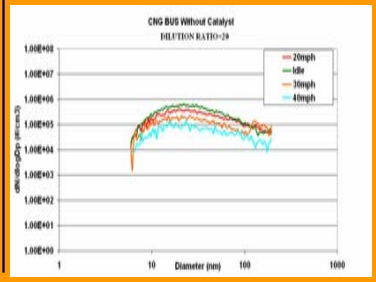
- Two natural gas fueled buses were tested on two configurations with and without the oxidation catalyst.
- Particle sizing was carried out using SMPS on four steady state speed points, in the order of 20 MPH, Idle, 30 MPH, and 40 MPH, to simulate the warm-up operation of a transit bus.
- The concentration of a single particle diameter was tracked over a double length Orange County Transit Authority (OCTA) cycle.

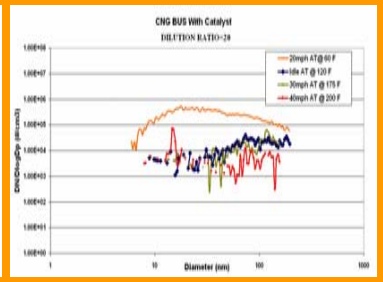
TEST SETUP

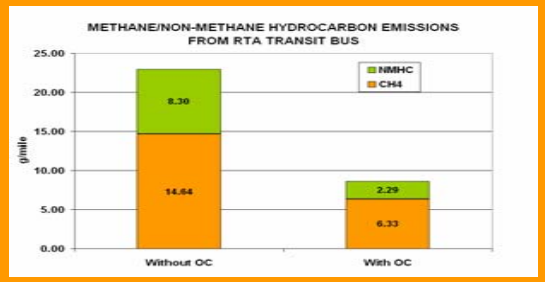


RESULTS

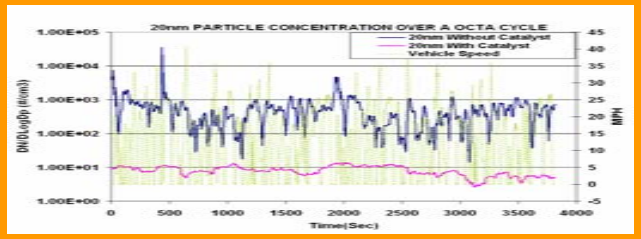
- In the absence of the OC nanoparticles size distribution peaked at 20nm particle diameter for all speed points.
- The presence of a warmed up catalyst was effective in preventing the nucleation of hydrocarbons by oxidizing them.

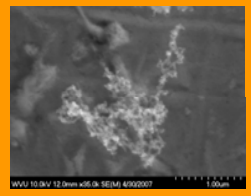


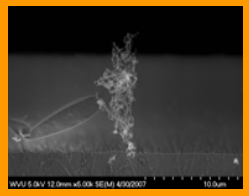




- The Pd based oxidation catalyst was 57% effective in reducing methane concentrations from the CNG vehicle exhaust.
- The unregulated speciation results also showed up to 90% reduction in lower chain hydrocarbon compounds, which have considerably high light-off temperatures.







- Particles were collected during the transient cycle for Scanning Electron Microscope analysis, using a Electrostatic Precipitator onto Copper grids.
- The SEM images revealed small agglomerates with very less solid carbon links.
- Particles underwent deformation during SEM analysis suggesting their volatile nature.

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