**On-board sensor-based characerization of Real-World NOx Emissions and HeAVy-duty vehicle activity in CAlifornia**

Rasik Pondicherry, [prpondicherry@mix.wvu.edu](mailto:prpondicherry@mix.wvu.edu); Marc Besch, [Marc.Besch@mail.wvu.edu](mailto:Marc.Besch@mail.wvu.edu); Berk Demirgok, [bedemirgok@mail.wvu.edu](mailto:bedemirgok@mail.wvu.edu); Arvind Thiruvengadam, [Arvind.Thiruvengadm@mail.wvu.edu](mailto:Arvind.Thiruvengadm@mail.wvu.edu); Daniel Carder, [Daniel.Carder@mail.wvu.edu](mailto:Daniel.Carder@mail.wvu.edu);

*West Virginia University, 280 ESB Addition, Evansdale Dr. Morgantown, wv 26505*

On-road heavy-duty diesel trucks are a significant ‘workhorse’ for the trucking industry in California and are deployed in a wide range of applications. The variety of vocations comprise different engine operational demands to meet the applicational objective. Advancements in emissions control technologies have led to development and introduction of Selective Catalytic Reduction (SCR) technology aftertreatment systems to ensure real-world emissions compliance and to meet U.S.EPA 2010 emissions standards for oxides of nitrogen (NOx) emissions. The SCR technology is greatly dependent on the thermodynamic conditions of the exhaust gas. Typically, the SCR system requires a minimum of ~200 °C to attain the effectiveness in reducing NOx emissions. The exhaust gas thermodynamic conditions are dependent on the engine power produced associated with the real-world duty cycle experienced by the vehicle as well as any thermal management strategies applied by the engine controller. Therefore, it is important to characterize in-use operational trends from a wide range of vehicles to critically understand the vehicle/engine activity and associated in-use NOx emissions rates.

The technological advancements in the Zr-O2 NOx sensor measurement capabilities and remote ECU data acquisition allows a broader evaluation of real-world vehicle activity and in-use NOx emissions rates form a large sample of heavy-duty diesel trucks. This provides an advantage of acquiring data over a longer course of time while the truck is performing its in-use fleet operation. To be implemented as a cost-effective approach to monitor in-use NOx emissions rates, tail-pipe NOx sensor technology requires a solid understanding of the measurement accuracy and cross-interference to other gaseous constituents available in the exhaust gas. The current on-board NOx sensors are not in-use at exhaust gas conditions below a certain temperature threshold to avoid structural damage to the sensor cavities due to the presence of condensed water droplets during low temperature activity.

The study focuses on installation and use of external tail-pipe NOx sensors and remote ECU data loggers aimed at capturing entire operational activity (including cold-start operation and low-load engine operation) from a large sample of vehicles deployed in a wide range of applications, spanning from short and long-haul goods movement to cement mixers and construction trucks. The in-depth analysis of the large sample of real-world vehicle operational data will focus on identifying the characteristic trends of vehicle activity as well as provide a broader classification of in-use NOx emissions rates as a function of real-world duty cycle. The presentation also briefly describes some of the data handling techniques outlined as an alternative for missing ECU parameters required for estimation of exhaust mass flow rate.