RESEARCH APPROACH FOR AGING AND EVALUATING DIESEL EXHAUST CATALYSTS

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The Diesel Emissions Control-Sulfur Effects (DECSE) Program is a joint government/industry project to determine the impact of diesel fuel sulfur levels on emissions control devices that could lower emissions of oxides of nitrogen (NO_X) and particulate matter (PM) from on-high-way trucks and buses in the 2002-2004 model years. West Virginia University performed the evaluations of diesel oxidation catalysts (DOC) and lean-NO_X catalysts to determine the effects of fuel sulfur content on emissions reduction efficiency and catalyst durability in the first 250 hours of operation. Two types of DOC and two types of lean-NO_X catalysts are being evaluated with fuel sulfur levels of 3ppm, 30ppm, 150ppm and 350ppm. High-temperature DOC and lean-NO_X catalysts were aged and evaluated using a Cummins ISM 370ESP engine while low-temperature DOC and lean-NO_X catalysts were be-ing aged and evaluated using a Navistar T444E engine. Each catalyst was aged over a cycle composed of 4 steady state modes using water-brake dynamometers.

Lean-NO_X catalysts require the addition of secondary hydrocarbon reductant into the exhaust upstream of the catalyst. An electronically controlled fuel injection system was assembled and calibrated to precisely meter the amount of secondary hydrocarbon injected into the catalyst as a function of engine speed and load and exhaust stream temperature. Before beginning catalyst aging, the hydrocarbon injection rate was optimized to produce maximum NO_X reduction without unacceptably high HC and CO slippage.

The high-temperature DOC catalysts are evaluated using the Federal heavy-duty transient emissions certification (FTP) cycle and a stabilized 4-mode steady state cycle. The low-temperature DOC catalysts are evaluated using an engine dynamometer version of the light-duty FTP-75 chassis dynamometer emissions certification cycle and a stabilized 4-mode steady state cycle. The lean-NO_X catalysts are evaluated over the steady state cycles only. Engine-out and catalyst-out emissions are measured using a full flow dilution tunnel critical flow venturi constant volume sampling system and research grade HC, CO, NO_X, and CO_2 analyzers. Particulate matter is collected on 70-mm fluoro-carbon coated glass fiber filters and measured gravimetrically.

In order to perform the thermal aging on both the DOC and lean-NO_X catalyst simultaneously and economically, each catalyst was sized to accommodate half of the engine exhaust. During catalyst aging approximately half of the exhaust stream flows through each device. During measurement of catalyst out emissions, approximately half of the exhaust is directed through the catalyst being evaluated and into the dilution tunnel. The remaining exhaust is directed through a physically identical dummy catalyst (substrate without washcoat) and vented from the test facility. The ratio of exhaust flowing in the measurement and bypass legs of the split exhaust system is calculated based on CO_2 concentration and emissions were corrected to reflect full exhaust flow levels. The challenge and effectiveness of using split exhaust systems for evaluation of aftertreatment devices is discussed and a comparison of full flow and split flow emissions results is presented.