PROJECT BRIEF

Title: Exhaust and Aftertreatment Modeling of an SCR and DPF System
SwRI Project: 03-12044
Client: North American LD Vehicle Manufacturer

Background

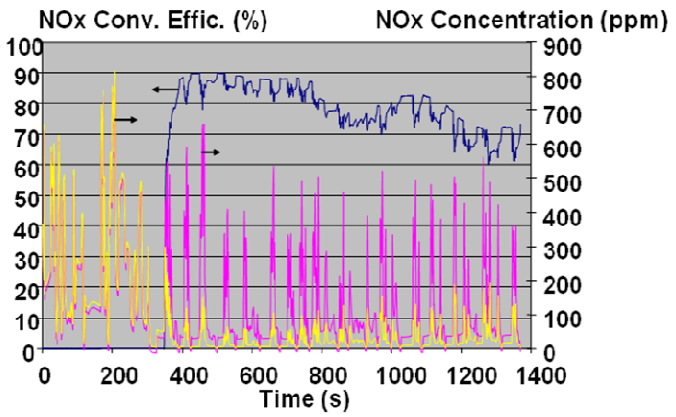
A major North American automobile manufacturer was considering the use of SCR and DPF technology to meet future U.S. emissions standards for light-duty truck applications with a small diesel engine. As a part of this evaluation effort, SwRI was contracted to estimate the aftertreatment performance over FTP-75 and US06 light-duty vehicle test cycles used in the United States.

Work Scope

Temperatures and tailpipe-out NO_X emissions in the exhaust and aftertreatment system were predicted using a SwRI thermal model that computes the heat transfer from the exhaust gases to the exhaust piping and aftertreatment devices and from those walls to the outside world. The model includes the effect of vehicle speed on the cooling of the exhaust system, and includes natural convection heat losses in addition to forced convective heat transfer. It was also necessary to account for exothermic reactions at the oxidation catalyst, so engine-out hydrocarbon (HC), carbon monoxide (CO), and oxygen (O_2) concentrations, as well as the A/F ratio of the exhaust were considered by the model.

The aftertreatment system was assumed to include a diesel oxidation catalyst (DOC), a diesel particulate filter (DPF), and selective catalytic reduction (SCR) system. The SCR system was assumed to be a ceramic substrate coated with $V_2O_5/WO_3/TiO_2$ formulation.

Variables investigated in this analysis included a DPF followed by SCR, SCR followed by a DPF, insulation of the exhaust, effect of air velocity over catalyst, and effect of changes in mass of the oxidation catalyst.



Results

Results show that the exhaust temperatures are relatively low for this engine through much of the FTP-75 cycle, resulting in relatively poor NO_X conversion by the SCR system. These results also show that the exhaust and aftertreatment systems must be shielded or insulated to have a reasonable chance of working over the various cycles.

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