Project Summary

Texas Department of Transportation

0-5955: Characterization of In-Use Emissions from Non-Road Equipment in the TxDOT Fleet

Background

The Texas Department of Transportation (TxDOT) operates the largest fleet of non-road equipment in Texas and one of the largest in the United States. TxDOT's non-road fleet consists of construction equipment such as cranes, excavators, loaders, etc., a vast majority of which run on diesel engines. The emissions impact from these units is considerable, but the emissions characteristics are not well understood. Emissions from the equipment—particularly oxides of nitrogen (NOx)—are an issue of concern, especially in non-attainment areas in Texas. The overall goal of this project was to characterize emissions from TxDOT's non-road diesel equipment fleet, assess the effectiveness of using various emissions reduction technologies, and propose appropriate strategies for TxDOT's non-road fleet based on the research findings.

What the Researchers Did

Researchers performed an extensive literature review and investigation to obtain information on emissions reduction technologies, non-road emissions reduction case studies, and non-road emissions resources. Based on results of these activities, researchers identified three emissions reduction technologies as promising candidates for reducing emissions in non-road equipment: hydrogen enrichment (HE), fuel additives (FA), and selective catalytic reduction (SCR).

Researchers analyzed the characteristics of TxDOT's non-road equipment fleet and identified three categories of equipment that contributed the most NOx emissions—graders, rubber-tire loaders, and excavators. The research team developed a protocol for testing non-road equipment emissions using portable emissions measurement systems (PEMS), including duty cycles that replicated the various operational modes of the equipment.

Tests on six graders assessed emissions characteristics before and after installation of the FA and HE technologies. The emissions testing used Texas Transportation Institute's (TTI's) SEMTECH-DS and Axion test units to collect results for NOx, carbon monoxide (CO), particulate matter (PM), hydrocarbons, and carbon dioxide (CO_2).

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An additional project task involved development of an optimization methodology to identify the best strategies for deployment of emissions reduction technologies on a fixed budget. This approach takes into account information regarding the available budget and the costs and emissions reduction observed for different technologies. The results of the methodology enable a deployment strategy that maximizes benefits in non-attainment and near non-attainment areas, where emissions reduction is of major importance.

What They Found

Researchers analyzed test results using both average modal emissions rate and fuel-based approaches to compare emissions of the tested graders before and after application of the emissions reduction technologies. Overall, there was a high variability in the measured emissions among the graders and between operational modes. Analysis of the test results showed that neither FA nor HE applications had a significant impact on NOx emissions or CO emissions. Both technologies provided moderate reduction in hydrocarbon and PM emissions. The levels of NOx emissions observed during the in-use testing using PEMS were lower than emissions calculated based on U.S. Environmental Protection Agency (EPA) guidance.

The optimization methodology was applied to demonstrate possible deployment strategies to distribute emissions control equipment among TxDOT's non-road fleet for various budget levels. This exercise demonstrated the flexibility and application of the optimization approach to maximize benefits from emissions reduction technologies.

What This Means

Due to the variability in the data and relatively few equipment units tested, results should be considered as indicative of the direction of changes achieved in emissions levels, not as conclusive evidence of the effectiveness of either FA or HE technologies.

Since NOx reductions were the primary focus of this study, researchers do not recommend that TxDOT deploy either FA or HE to reduce emissions of the non-road equipment fleet. However, SCR remains a promising option for NOx emissions reductions. While this project did not test with SCR, it is the subject of a separate, ongoing project with TTI and TxDOT under an EPA grant. The optimization methodology developed as a part of this project has future applicability if TxDOT finds suitable technologies (such as SCR) for deployment in the non-road fleet.

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