Automotive Emission Controls R&D: From Catalyst Research to System Controls Development

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ABSTRACT

An overview of the automotive emission control R&D in US from catalyst materials research to aftertreatment system controls development will be presented. In addition, the recent developments regarding the US federal regulations, engine and emission control technologies will be discussed.

I. INTRODUCTION

Automakers will have to develop and produce various high content propulsion technologies to meet the upcoming high fuel economy standards and more stringent emission standards. One of the challenges for the industry is to develop effective, inexpensive and reliable aftertreatment system solutions to meet the tailpipe emission standards for nitrogen oxides (NOx), hydrocarbons (HC), carbon monoxide (CO) and particulate matters (PM) produced from internal combustion engines.

II. DISCUSSION

A. Regulatory Development

Currently, all light-duty passenger vehicles sold in US have to meet the US EPA Tier 2 or California LEV II emission standards. Both EPA and CARB plan to roll out more stringent Tier 3 and LEV III standards in the near future**.** Heavy-duty on-road vehicles are now required to control NOx emissions, while off-road equipments will be required to control NOx by 2014.

B. Catalyst Technologies

Various catalyst technologies will be used in combinations to meet the emission standards. Three-way catalysts (TWC) are used for gasoline and gas-electric hybrid vehicles, and a lean NOx reduction catalyst will be added for lean gasoline engines. HC adsorber and electrically-heated catalyst technologies are also being considered for more stringent emission standards and high voltage becoming available due to the vehicle electrification.

For diesel engines, a combination of an oxidation catalyst, a catalyzed filter and a lean NOx catalyst are used. A few technologies that can simultaneous control NOx and PM emissions are under development for reduced system volume and cost.

B. Aftertreatment System Modeling

Numerous converter models have been developed to reduce the technology development time and cost. System-level models have been developed to quickly assess the performance of different system architectures and control strategies. Recently, there are efforts in linking aftertreatment system models with more refined engine models or vehicle system models.

D. Model-based Controls Development

Currently, sophisticated kinetic model-based control strategies are being developed to maximize the system performance over a wide range of conditions. Model-based SCR control strategy will be discussed as an example.

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