Imminent Emissions Standards Push Vehicle Makers to Adopt NOx-Selective Catalytic Reduction Technologies

The vehicle emissions standards set to be implemented worldwide are driving the need to reduce nitrogen oxide (NOx) and carbon dioxide (CO2) emissions to a greater extent than ever before in diesel vehicles ranging from passenger to heavy duty trucks. One of the leading technologies for achieving these new emissions standards is selective catalytic reduction or SCR which, thermodynamically speaking, makes it possible for an engine to operate more efficiently while reducing NOx emissions. This is an important step for vehicle evolution as nitrogen oxides are a leading greenhouse gas emission and smog causing compound, making SCR technology a significant contributor in the fight against climate change.

Integrating SCR technology into existing vehicle platforms is being approached in many different ways by vehicle manufacturers, with tweaks in the fuel system covering nearly every component of the entire engine process. They all include adding a reductant (diesel exhaust fluid or DEF) to the tank and reservoir to covert NOx into nitrogen gas (N2) and oxygen, but then some boost efficiency by creating a highly tuned dosing system for the pump; using heated or insulated lines and pipes, or injectors to ensure optimal temperatures for NOx reduction; developing a stand-alone or integrated control system; adding flow optimizers such as mixers and inlet cones; using sensors for control and diagnosis; and of course modifying exhaust lines with the SCR catalyst.

Overview of the New EURO VI and US Tier 4 Emissions Regulations

First, let's quickly review the new emissions standards that are the impetus behind the development of SCR technology for reducing emission in diesel engines. In the US, the Environmental Protection Agency (EPA) has set final Tier 4 standards for diesel-powered vehicles. As part of these standards, manufacturers are required to cut particulate matter emissions by 90% and nitrogen oxides by 50%, making it the most challenging compared to preceding Tiers. The Tier 4 standards is applicable for any diesel engines greater than 75 horsepower, but is first applied to on-road vehicles such as semi trailers and other diesel powered trucks. It also applies to off-road equipment such as agricultural machines and construction equipment. These standards must be met by these engines and machines by January 1, 2013.

The new EURO VI emissions regulations will come into effect for new heavy commercial vehicles and buses registered from January 2, 2014 forward. These regulations require that NOx emissions be reduced by 80% compared to EURO V standards and that particulate matter be reduced by 66% compared to EURO V standards (ETC test cycle, equivalent emissions). Future regulations will require even further reductions in particulates to an estimated 95% below EURO V standards. The standards also impose a limit on ammonia emissions, and will represent a milestone in the development of world emissions standards with its first-ever World Harmonized Test Cycle requirement for engine certification.

Recent Manufacture Integrations of SCR Technology for Diesel Engines

Perhaps the most famous of all technological application of selective catalytic reduction is that of BlueTEC. DaimlerChrysler's Mercedes Benz group, together with Volkswagen and Audi, have heralded their BlueTEC technology as a way to reach the strictest emissions standards anywhere in the world. Using a set of different aftertreatment technologies to solve the basic problem of emissions reduction, BlueTEC is also used as a descriptor of the various solutions they employ to reduce oxides of nitrogen.

The BlueTEC system contains the same set of processes in various forms, regardless of the operating characteristics of the vehicle. The first is process reduces carbon monoxide and hydrocarbon emissions by using an oxidizing catalytic converter. The second reduces particulate matter with the use of a particulate filter (either stand-alone or integrated).

And finally, BlueTEC reduces NOx emissions, the most problematic emission for all manufacturers. They do this with one of two approaches, both involving an SCR technology. They either use their NOx absorber, which is a catalytic device that converts NOx to nitrogen. Alternatively, they employ their urea-based injection system, using AdBlue of course.

The most recent addition to the Mercedes-Benz line using the BlueTEC technology is the E 300 BlueTEC HYBRID, which is a luxury class diesel hybrid with a fuel economy of 4.2 L per 100 km (or 56 miles per gallon). The vehicle is equipped with a 2.2 liter, four-cylinder diesel engine with a compact electric motor. The electric motor assists the diesel engine during acceleration (giving the boost effect) and alternator mode. It is also needed for recuperation of braking energy.[i]

This engine has a 15% lower fuel consumption than the earlier E 250 CDI model, despite the fact that the E 300 is based on the E250 CDI. This vehicle is set to be released in the European market as a Saloon and Estate in Q3 of 2012.[ii]

Volkswagen Group has also introduced their Volkswagen CC BlueTDI that incorporates several emissions control technologies, including selective catalytic reduction in the heavier (larger than Golf class) models. Like most of their other models, each component is integrated in a modular construction format, with the resulting tailpipe emissions ready for the EURO VI standards as well as Tier 4 standards.[iii]

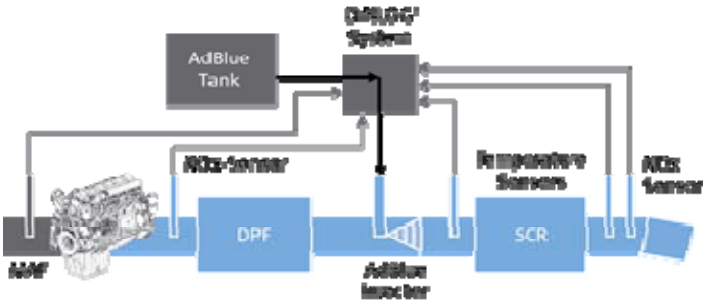
Porsche is also in the SCR game with their Cayenne Diesel using an AdBlue tank located in the car's spare-wheel well. The 3.0 liter V6 diesel engine also includes a heating component for the tank and lines to transport the AdBlue fluid to the exhaust gases. Additional components include an injection valve for the AdBlue fluid, as well as the selective catalytic reduction converter. Adding this vehicle to the luxury class of diesels with superior emissions control, the Cayenne Diesel with all of the updated components should be released later in 2012 at a price of $64,500.[iv]

Another interesting development in the area of selective catalytic reduction is the dispensing of DEP at the pump. Irving, for instance, now offers an ammonia-based

DEF solution that can be dispensed from their pumps in the same transaction as diesel fuel. It's another way to make the meeting of higher emissions standards easier for vehicle owners.

Combining SCR Technologies with DPF Technologies for Better Emissions Reductions

Another development in the race to develop exhaust systems that meet the new standards is a combined selective catalytic reduction system with a particulate matter reduction technology which provides superior emissions reductions. One such technology is the DiNox System offered by Dinex. This system provides emissions reductions in two stages. The first uses a ceramic filter DiSiC or DiPEX that removes up to 99% of particulates which are then collected and catalytically burned. During this stage, the system also ensures that residual hydrocarbons and carbon monoxide are burned.[v]



The Dinex DiNOx System including DPF and SCR technologies

In the second stage, the DiNOx system measures the levels of NOx in the exhaust gases, and then administers the exact amount of urea (AdBlue) in a selective catalytic converter system. As with other systems, the AdBlue reacts with the NOx to form nitrogen gas and water, thereby reducing NOx emissions by 80% or more. In all, the system is said to meet EURO VI and EEV-emissions levels for on-road vehicles. It will also meet Tier IV off-road standards.

Dinex touts their system as stand-alone, in that it can function independently of the engine, without requiring information from the engine to achieve high conversion rates of NOx. The entire system is composed of the DPF, exhaust pipelines, urea storage tank, urea injection and control system, sensors, SCR, and DiNLOG system for management of the entire process. The result is a system that can either be used to retrofit existing diesel engines, or inserted into new vehicles to shorten OEM engine development time.

Cummins has several similar systems that can either be combined for superior emissions reductions or used in a stand-alone fashion. Their hydrocarbon injection system, for instance, injects unburned fuel upstream of the diesel oxidation catalyst or diesel particulate filter to start the emissions reduction process. This system is especially applicable for common-rail fuel systems or those that require alternatives to in-cylinder dosing.

They also produce a DEF injection system for the introduction of urea into exhaust stream. These complement any SCR technology, and use proprietary electronic control technology to measure pre-aftertreatment nitrogen oxide levels. These readings are then fed to the control system where the urea doser injects the reductant into the exhaust system. They also produce electronic controls which can be integrated into the engine control module or used alone, as well as sensors for pressure, temperature, nitrogen oxide levels, and oxygen levels.[vi]

Additional Innovations Will Make This Year an Exciting One for SCR

Component manufacturers and vehicle makers alike are looking for further advancements that will remove even more NOx emissions in the commercial, agriculture, and passenger vehicle sectors. Technologies such as fine-tuned dosing of reductant using injector controls and SCR technologies that work without exhaust recirculation are all being developed. The coming months will be interesting as we see more of these technologies take shape.

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