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SELECTIVE CATALYTIC REDUCTION FOR DIESEL ENGINES IN STATIONARY POWER AND TRANSPORTATION APPLICATIONS

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Selective catalytic reduction using ammonia is a widely utilized option in Europe for NO_x control of stationary diesel powerplants, and also has been applied to marine diesels to meet international and local regulations. Over the past five years there has been increasing interest in SCR applications in the heavy-duty transportation sector (buses and trucks), where the supporting infrastructure for the reduction agent such as urea is an important practical issue. Whether the transportation industry adopts SCR depends in part on the relative cost effectiveness of other competing technologies for NOx control. The effectiveness of SCR catalysts when exposed to diesel soot and particulate for extended periods is also an issue. In addition, there is a limited amount of test data on SCR when used with diesel engines fueled by coal derived fuels and slurries. In this paper we will provide an overview of some selected applications of SCR to diesel engines in the transportation and stationary sectors.

Three types of NO_x control are being pursued most vigorously in transportation, urea-SCR, hydrocarbon-SCR and NO_x storage and reduction (also called Lean NO_x Traps). While it is too early to pick the “winner”, it is very likely that the ultimate choice will be the technology that melds most easily with the other emission control technologies that will have to be installed on future vehicles. Indeed, there have already been preliminary demonstrations of “4-way” converters (hydrocarbons, CO, soot and NO_x). Other technologies, e.g., plasma-assisted decomposition of NO_x, are also still being pursued and may find application in niches in which fuel economy can be traded for compactness, generality or ease of control.

Urea-SCR exploits the hydrolysis of conveniently carried, aqueous solutions of urea to generate ammonia in the exhaust manifold. The ammonia then reacts with NO_x over the same types of catalysts as are employed in stationary NO_x abatement. This system offers excellent NO_x conversion over most of the conditions found in the exhaust of a Diesel engine as well as resistance to sulfur poisoning. At the lowest exhaust temperatures found

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in the driving cycles of heavy duty vehicles and in certain, commonly occurring transient conditions, urea-SCR does not offer sufficient performance. Moreover, the widespread deployment of urea-SCR will require the coordination of engine manufacturers, reagent suppliers, exhaust system suppliers and service stations to establish an infrastructure for producing and delivering solutions of urea. In our analyses, the economics of this technology depend sensitively on that coordination.

Hydrocarbon-SCR, either direct or with the aid of a fuel processor, obviates the need to develop a urea infrastructure. Recent laboratory work suggests that HC-SCR catalysts can be made quite active and tolerant of considerable quantities of sulfur oxides. If so, then this sort of technology may also find use for stationary applications as well.

The chief benefit of NO_x storage and reduction is fuel economy compared with HC-SCR, since the regeneration of the sorbent can, in principle, be done off-line by switching the sorber out of the exhaust stream. Recent improvements in desulfation protocols promise to extend the utility of this technology to engines that are fueled with less than pristine fuels.

The many tradeoffs required to satisfy the opposing demands of legislators, suppliers, customers and shareholders and the relatively short period until the technology will be fielded speak to the need for sophisticated modeling tools to shorten development cycles and provide a minimally over-engineered system. The DOE has sponsored an initiative to develop such simulation tools, which are just now becoming available.