2011 Super Duty Diesel Truck with NO_x Aftertreatment

Diesel engine aftertreatment: Minimizing NO_x emissions with SCR.

Ford Motor Company

Ford's 2011 Super Duty diesel truck—which utilizes aftertreatment technology jointly developed by Ford and the U.S. Department of Energy (DOE)—delivered a multitude of firsts for the company. It was the first Ford diesel engine developed entirely in-house, the first to operate on B20 (a blend of 20% biofuel, 80% petroleum diesel), and the first to comply with stringent 2010 emissions standards that require a reduction in oxides of nitrogen (NO_x) by more than 80% compared to 2007 emissions levels.

To meet these new standards, Ford had to dramatically reduce the NO_x emissions of its diesel vehicles. Through cost-sharing, DOE supported Ford's development of an aftertreatment technology, which was not popularly favored. Lean NO_x control for diesels was seen as a large risk; in turn, the cost-share was set at 65% DOE and 35% Ford. Ford led the engineering effort with partners ExxonMobil and FEV. Under the code name "Ultra Clean Fuels," the project lasted from 2001 to 2005 and was considered a success.

The system—urea-based selective catalytic reduction (SCR)—is the most cost-effective technology available to remove enough NO_x from diesel exhaust to comply with the new emissions guidelines, and Ford was ready to take on the after-combustion investment. Although relatively new to the United States, SCR has gained popularity in Europe over the last five years. Within three years of its introduction to Europe, the SCR-equipped vehicles reduced fuel costs by the equivalent of nearly one half billion dollars, saved more than 74 million gallons of diesel, and spared the environment from more than 880,000 tons of carbon dioxide.

The Ford-patented diesel aftertreatment system is a three-stage process. The first step occurs when the exhaust stream enters the diesel oxidation catalyst. Hydrocarbons and carbon monoxide are converted to water and carbon dioxide. Second, the NO_x is minimized through SCR by dosing diesel exhaust fluid (DEF), an aqueous solution of urea that is transformed to ammonia within the exhaust. The ammonia enters the SCR module, which contains a non-precious metal catalyst, and NO_x is converted to harmless nitrogen and water. Finally, the diesel particulate filter traps any soot. Several system aspects, including catalyst types, urea injection concepts, and filter regeneration strategies, had origins in the Ford/DOE program.

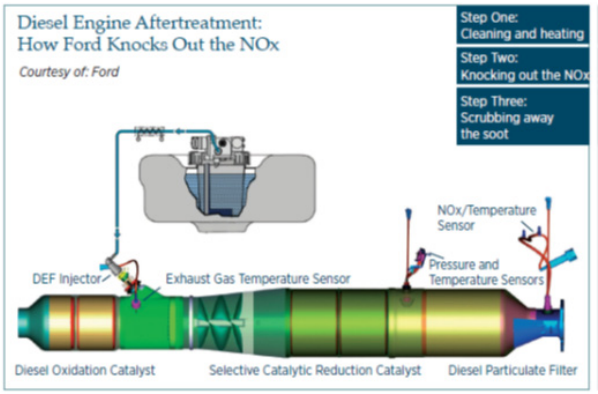

Figure 1. Three-stage diesel engine aftertreatment system