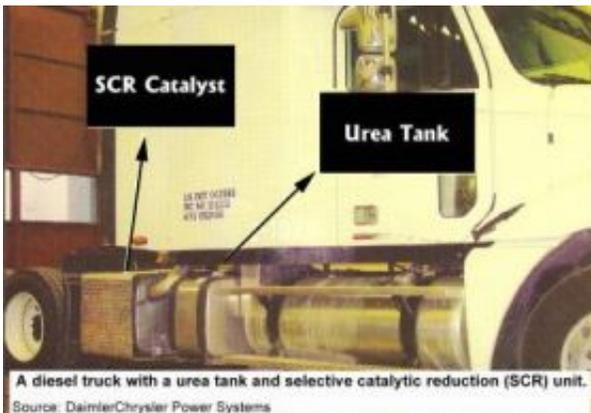


Urea tanks on diesel trucks—that's the law in the United States starting in 2010

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A prototype diesel truck with a urea tank and SCR unit. Credit: DaimlerChrysler Power Systems

Urea tanks will be standard equipment for most new diesel trucks, buses, cars, and sport utility vehicles (SUVs) manufactured in the United States after Jan. 1, 2010. An automotive grade of urea will be injected into the vehicles' exhaust stream to "scrub" nitrogen oxide (NO_x) from the diesel exhaust.

NO_x, a major air pollutant, contributes to smog, which causes asthma and respiratory and heart diseases.

The system, urea SCR or "urea-based selective catalytic reduction," is the only technology available that can remove enough NO_x from diesel

exhaust to comply with strict new limits imposed by the U.S. Environmental Protection Agency (EPA), says Glenn Kedzie, Environmental Counsel for the American Trucking Associations.

The automotive urea, called "diesel exhaust fluid" (DEF) in the United States and AdBlue, a trademarked name in Europe, reduces NO_x by as much as 90% alone, and can take NO_x to near-zero levels when used in combination with diesel particulate filter technology, says Kim Doran, spokesperson of the newly formed North American SCR Stakeholders Group and editor of FactsAboutSCR.com, a Web site dedicated to SCR news.

DEF and AdBlue are an aqueous urea solution 32 (AUS 32), a clear 32.5% nitrogen solution of high-purity urea in demineralized water. The urea solutions are safe to handle, manufacturers claim. AdBlue can be bought in bulk in Europe or by the liter at some service stations.

The advent of DEF and AdBlue is creating a new demand for urea, the world's most widely used nitrogen fertilizer. Some are concerned that the new use will drive fertilizer prices higher. Others think it will be an incentive for manufacturers to increase production and thus, lower prices.

"We know about diversion of traditional food crops such as corn or sugarcane to biofuels like ethanol—but now urea, a basic input for food production, is also going into fuel," says Dr. Amit Roy, President and CEO of the International Center for Soil Fertility and Agricultural Development (IFDC).

"Ironically, cleaning our environment is a key reason for both technologies."

Manufacturers Adopting Urea SCR Technology

More than half a million diesel trucks in Europe now use urea SCR and the fleet is growing by about 25,000 trucks per month, according to Integer Research, a London-based market analysis firm specializing in urea SCR.

Doran says that SCR technology is being adopted by passenger car and light truck manufacturers serving the United States including Audi, BMW, Hyundai, Jeep, Kia, MiniCooper, and Volkswagen. Mercedes-Benz is introducing three new diesel-powered SUVs that use urea SCR technology into the United States in late 2008. Urea SCR is also used in Japan and Singapore and will soon be used in China.

Manufacturers in the commercial trucking industry adopting SCR include Freightliner, Kenworth, Mack, Peterbilt, and Volvo. Leading engine manufacturers using SCR include Cummins and Detroit Diesel Corp.

Future Demand

Consumption of the urea solution is about 3% of the diesel consumption. Diesel trucks average 6.5 miles per gallon (2.8 km/liter). An average diesel truck will need to refill its 20-gallon tank of DEF every 4,000 to 6,000 miles (76 liters every 6,400 to 9,600 km).

Urea to reduce NO_x emissions now consumes 0.3 to 0.4 million metric tons (mt) of urea in Western Europe, says Stephen Zwart, Licensing Manager of Netherlands-based Stamicarbon, the world's largest licensor of urea plant technology. In 10 years the current truck fleet in Western Europe will have been replaced, and urea use will be 3 to 4 million mt.

Future urea demands generated by SCR technology in the United States have been calculated by Dr. Carlos Baanante, IFDC Agricultural Economist.

In 2003, 213 billion liters of diesel fuel were used for transportation in Europe and 146 billion liters in the United States, according to EarthTrends, an initiative of the World Resources Institute (<http://earthtrends.wri.org/index.php>).

Baanante assumes that only 7% of the diesel trucks in the United States will use urea SCR in 2010—the new trucks purchased that year.

"U.S. urea consumption for transportation will probably be the urea fertilizer equivalent of about 210,000 tons in 2010—but will be at least double that amount in 2011 and will increase rapidly afterward as older trucks are replaced with newer models that carry urea tanks," Baanante says.

The estimates assume that a liter of the solution weighs about 1 kg and the urea fertilizer contains 46% N, Baanante explains. Thus, 1 kg of urea solution would consume the N needed to produce 0.7065 kg of urea fertilizer. A conversion factor of 0.7065 is used to calculate urea solution consumption in terms of mt of urea-fertilizer equivalent.

"More than 90% of the world's urea production is for fertilizers—but new demands for urea SCR may change that," Baanante says. Urea is also used in animal feed, plastic and glue manufacture, highway de-icing, cloud seeding to induce rain, and tooth-whitening products.

Stringent New EPA Exhaust Emission Rules

Kedzie says that diesel-powered vehicles manufactured in the United

States in 2010 can emit no more than 0.2 grams of NO_x per brake horsepower hour—90% less than current emissions. The new EPA regulations will not apply to vehicles manufactured before 2010.

Tractors, bulldozers, and other non-road vehicles must meet the new EPA standards by 2015. The U.S. timetable for ships and locomotive engines has not yet been set.

"Some trucking agencies are now buying new trucks that were scheduled for replacement after 2010 to avoid the expenses of urea tanks and buying and transporting urea," Kedzie says.

But Thom Albrecht, a transportation equity analyst with Stephens Inc. in Virginia, United States, thinks that most corporate carriers—the main buyers of heavy-duty trucks—will continue normal buying cycles as the next EPA emissions deadline looms in 2010. Albrecht reached that conclusion after surveying 88 carriers about their future buying plans.

New Demands Could Affect World Fertilizer Market

Keith Stokes, proprietor of Stokes Engineering and IFDC consultant on urea production, says, "Urea for NO_x reduction will create a new demand that could drive up fertilizer prices—just as ethanol production did."

But Doran of SCR Stakeholders says, "Demand for this automotive-grade urea is not expected to exceed 5% of the world's production. The new use of urea to control vehicle emissions could lead to increased investment and expand world capacity for urea production."

How Urea SCR Systems Work

Urea SCR cleans the exhaust after combustion. The urea solution is held in a separate storage tank and injected as a fine mist into the hot exhaust gases. The heat breaks the urea down into ammonia—the actual NO_x-reducing agent. Through a catalytic converter, the ammonia breaks the NO_x down to harmless nitrogen (N) gas and water vapor. The exhaust is no longer a pollutant; the atmosphere is about 80% nitrogen gas.

Bill Herz, Vice President of Scientific Programs for The Fertilizer Institute, based in Washington, D.C., says, "You hear a lot about harmful effects of fertilizer on ecosystems—but little about the positive role of urea in stripping away pollutants."

Doran says, "Because SCR technologies reduce NO_x exhaust to almost zero, engines can be tuned to maximize fuel efficiency." The result is as much as a 3%

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