United States Environmental Protection Agency

Office of Transportation and Air Quality
EPA-420-F-95-009b
June 1996

Emission Control Potential for Heavy-Duty Diesel Engines

Diesel engines are typically used to power trucks, buses and nonroad equipment (for farming, construction, mining, etc.) because of their fuel economy and durability advantages. However, visible exhaust ("smoke") from older diesel engines has raised public awareness of diesel engine emissions.

Diesel engines use compression instead of spark plugs to ignite the fuel. The high temperatures typical of diesel operation cause oxygen and nitrogen from the intake air to combine as oxides of nitrogen (NOx). NOx is an invisible, toxic gas that can form fine aerosol particles or salts which contribute to acidic precipitation (commonly known as "acid" rain, snow or fog). If engine temperature is decreased to reduce NOx, this tends to increase the amount of uncombusted fuel that may be emitted as particulate matter (PM) or gaseous hydrocarbons (HC). HC reacts with NOx and other pollutants to form ground-level ozone (smog). Ozone and PM are associated with many adverse health and welfare effects, including respiratory illness, environmental damage and visibility problems (haze).

Despite previous design improvements, diesel engines contribute a substantial portion of the NOx, PM, and, to a lesser extent, the HC emissions from mobile sources. Manufacturers have begun a comprehensive review of diesel engine design to move toward more effective controls for NOx, PM and HC. One strategy is to better manage the process of air and fuel delivery to the cylinder, reducing emissions production. Another strategy is to use "aftertreatment" (post-combustion) technologies to break down or capture emissions. Diesel engines of the future may use a combination of strategies, possibly incorporating fuel changes as well. The following is a brief description of several important diesel emission control options:

- **Fuel Delivery:** Designing electronic controls and improving fuel injectors to deliver fuel at the best combination of injection pressure, injection timing and spray location. This allows the engine to efficiently burn the fuel without causing the temperature spikes that increase NOx emissions.

- **Air Intake:** Redesigning turbochargers, aftercoolers and intake valving to provide optimum pressure, temperature and routing of the intake air. This is important for managing the physical and chemical processes needed to achieve good air-fuel combustion. Exhaust gas recirculation (mixing some exhaust gas with the intake air) is an established technology on cars that may be effective in heavy-duty diesel engines.

- **Aftertreatment Technologies:** Using catalysts or particulate traps to convert or capture engine-out emissions before they leave the exhaust pipe. Traps are used to remove and eventually burn particulate emissions. Catalysts for diesel engines are more complex than similar technologies used in cars, but hold promise for reducing NOx and particulate emissions by conversion to less-harmful compounds.

- **Diesel Fuel Parameters:** Employing fuel additives and improving fuel properties such as raising the cetane number, lowering the aromatics content or decreasing sulfur levels can contribute to reduced NOx and PM emissions and may also provide engine manufacturers with greater flexibility to use new emission control technologies.

EPA's Office of Mobile Sources is pursuing requirements for a greater degree of emission control from heavy-duty diesel engines by proposing new emission standards for engines from heavy-duty highway and nonroad applications.

The Office of Mobile sources is the national center for policy on air pollution from highway vehicles and nonroad equipment. You can write to us at:

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