SCR: PREFERRED TECHNOLOGY FOR EPA 2010 ENGINES

For 2010, the U.S. Environmental Protection Agency requires that diesel truck emissions contain a drastically reduced percentage of NOx, or oxides of nitrogen. (NOx is an environmental pollutant that contributes to smog and acid rain). As the diesel engine industry has worked to meet the new requirements, two NOx reduction technologies have emerged: SCR—Selective Catalytic Reduction, and MEGR—Massive Exhaust Gas Recirculation. While Volvo Trucks and most other manufacturers have embraced SCR as the preferred solution, it's important to understand the basics of both systems.

SELECTIVE CATALYTIC REDUCTION

Selective Catalytic Reduction (SCR) is an exhaust aftertreatment system that injects a small amount of Diesel Exhaust Fluid (DEF)—a water-based solution of urea—into the exhaust.

Mixing DEF with exhaust in the presence of a catalyst turns NOx into harmless nitrogen and water vapor. This is a highly effective way to reduce harmful emissions to the extremely low standards set by the EPA. Best of all, it allows the engine to be restored to a more efficient state of operation for better fuel economy.

Diesel Exhaust Fluid

The urea used in DEF is a nitrogen compound—commonly found in fertilizer—that is not hazardous but can corrode aluminum. DEF will be carried on EPA 2010 trucks in a tank that must be refilled during fueling. On Volvo trucks, the 18-gallon tank will have its own level gauge, and will deliver 4,000 miles or more.

DEF freezes at 12°F, but the tank is heated and there is no delay in driving even if the tank freezes.

Higher Injection Pressure

With EPA 2010 standards, diesel exhaust pollution—which includes carbon monoxide, hydrocarbons, particulate matter (soot) and NOx—will be reduced by 99%. To achieve these low levels while maintaining fuel economy, durability and power, we've also made improvements in our fuel injection and combustion processes.

For 2010, Volvo Truck engines will incorporate our Ultra High Fuel Injection pressure system, which reaches injection pressures of 35,000 psi—the highest in the industry. The higher the pressure, the finer the atomization and the better the fuel economy. Producing such high fuel injection pressure required certain engine modifications, such as adding a damper on the camshaft and moving the drive gears to the back of the engine to reduce torsional vibrations.

SCR VS. EGR

EXHAUST GAS RECIRCULATION

In Exhaust Gas Recirculation, or EGR, engine exhaust is recycled back through the engine to dilute the oxygen, which reduces NOx formation.

Industry Definition	EGR Flow
Light EGR	10-20%
Heavy EGR	20-35%
Massive EGR	35-50%+

Virtually all engine manufacturers today use a form of EGR. Volvo Trucks used "Light EGR" for EPA '02 and "Heavy EGR" for EPA '07 engines. For 2010 we will continue to use a modest amount of EGR, since it takes both EGR and SCR to achieve near-zero NOx.

EGR definitely helps reduce NOx. But it also has some drawbacks:
- EGR lowers power density
- EGR increases heat rejection
- EGR reduces fuel economy.

	Massive EGR	EGR + SCR
Power Density	LESS	MORE
Heat Rejection	MORE	LESS
Fuel Efficiency	LESS	MORE

Power Density

Power density—expressed in terms of horsepower per liter displacement—is affected by the amount of EGR being used. Increasing the EGR rate dilutes the percentage of oxygen available for combustion, so it's necessary to push more air into the engine.

On the other hand, decreasing the amount of EGR allows higher power output. This will allow Volvo's 13 liter engine to have a maximum power output of 500 horsepower and 1750 lb-ft of torque.

Heat Rejection

EGR engines have an EGR cooling system that transfers heat from the exhaust to the coolant. This requires a bigger radiator, plus a larger fan that must run more often, thus consuming more fuel.

Soot Regeneration

EPA '07 regulations reduced allowable exhaust soot to the point that a filter was needed. All diesel engine manufacturers added an aftertreatment that captures soot in a DPF filter for regeneration. "Passive" regeneration employs a chemical process utilizing NOx in a continuous low-temperature process. If there isn't enough NOx, "active" regeneration must be used, periodically injecting fuel into the exhaust stream to raise the temperature high enough to burn up the soot.

When a Massive EGR engine increases the amount of recycled exhaust, it reduces the amount of available oxygen and creates more soot, increasing regeneration. Because the NOx is reduced inside the engine, there is insufficient NOx for any passive regeneration. All regeneration will be active, using fuel. But the SCR system reduces the amount of EGR, increasing the amount of oxygen and reducing the need for regeneration, which helps to increase fuel economy.

No Active Regeneration

For 2010, Volvo has gone the extra mile and developed the ultimate regeneration technology. By rebalancing the NOx-to-soot ratio, Volvo has increased passive regeneration to the levels necessary to totally eliminate active regeneration, in normal on-highway operation. This not only saves fuel, but reduces driver training and driver management issues. We **really** take the burden off the driver.

Fuel Economy

Increased fuel economy is the primary reason why Volvo Trucks selected SCR for our EPA 2010 engines. For every dollar you invest in DEF, you will get two dollars back in reduced diesel fuel costs. Even when the cost of DEF is taken onto account, Volvo Truck engines for EPA '10 will reduce fuel costs.

THE BEST SOLUTION FOR TRUCK AND FLEET OWNERS

While Volvo Trucks EPA '07 engines use EGR, meeting the tough EPA '10 NOx standards while improving fuel economy was a challenge. By using SCR aftertreatment, less EGR, and eliminating active regeneration, Volvo Trucks has been able to achieve the 99% NOx reduction required by the standard, while improving fuel economy and performance and reducing driver involvement at the same time.

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