



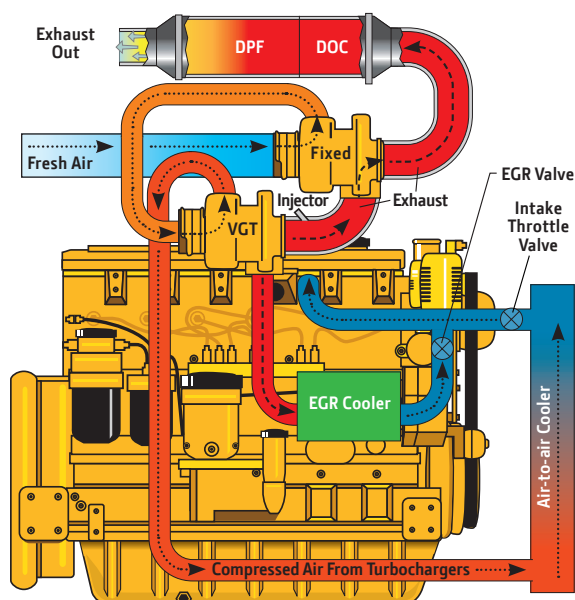
Technology to Reduce Emissions in Large Engines

There are two ways to reduce particulate matter (PM) and nitrogen oxides (NOx) emissions in large engines. The first is with cooled exhaust gas recirculation (EGR) paired with an exhaust filter. Cooled EGR lowers NOx while the exhaust filter reduces PM.

The second way to reduce these emissions is with selective catalytic reduction (SCR) and a diesel oxidation catalyst (DOC). The SCR system lowers NOx while the DOC reduces the remaining PM. Machines also can use a combination of cooled EGR, an exhaust filter, and SCR to reach the extremely low levels required by Final Tier 4 regulations.

How does cooled EGR with an exhaust filter work?

Cooled EGR cools and mixes measured amounts of exhaust gas with incoming fresh air to lower the



The John Deere PowerTech™ PSX 9.0 L Engine utilized cooled EGR and an exhaust filter to meet Interim Tier 4 regulations.

The John Deere Solution

The John Deere Integrated Emissions Control (IEC) system uses an aftertreatment solution that's paired with our performance-enhanced, fuel-efficient Interim Tier 4 (IT4) engine platform featuring proven cooled exhaust gas recirculation (EGR). For FT4, our IEC system will typically consist of cooled EGR, a diesel oxidation catalyst (DOC), diesel particulate filter (DPF), and a selective catalytic reduction (SCR) system specifically designed to meet the rigorous demands of agricultural applications.

These aftertreatment components will be monitored and controlled by proprietary electronics within our enhanced engine control unit (ECU). This completely integrated approach of using a combination of cooled EGR, exhaust filter, and SCR technologies will allow John Deere machines to use less diesel exhaust fluid (DEF) than other IT4 SCR solutions, and to provide outstanding total fluid efficiency without sacrificing overall performance.

engine's peak combustion temperature, thereby reducing NOx to an acceptable level. Because of the lower combustion temperatures used to reduce NOx, there is an increase in PM.

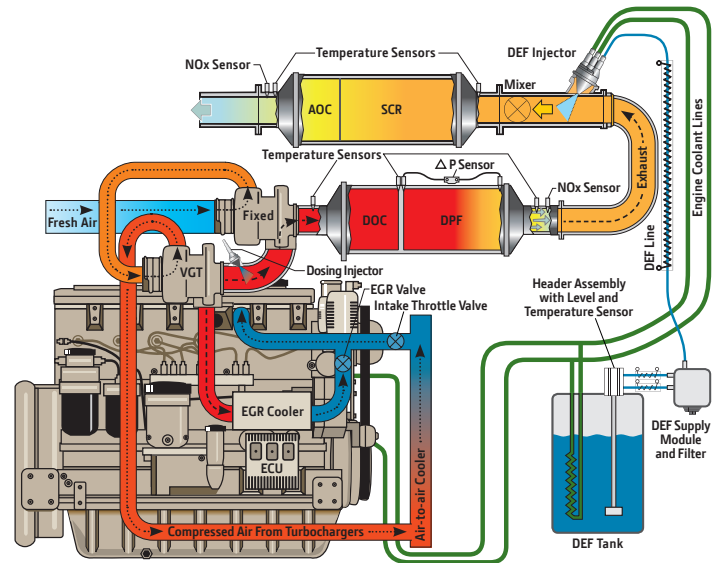
PM can be reduced to acceptable levels by using an exhaust filter. The exhaust filter contains a diesel oxidation catalyst (DOC) and a diesel particulate filter (DPF). A catalyst in the DOC reacts with exhaust gases to

reduce some PM as well as carbon monoxide and hydrocarbons. The exhaust gas is then routed to the DPF, which forces the gases to flow through porous channel walls, trapping and holding the remaining PM.

The DPF uses exhaust heat created under normal operating conditions to oxidize the trapped PM into nitrogen gas and carbon dioxide, which is then expelled through the exhaust pipe. This process is called filter cleaning. Some engines can be programmed to temporarily increase the exhaust temperature to clean the filter when necessary.

How does SCR work? Engines that utilize SCR to lower NOx operate at a higher combustion temperature with delayed timing, allowing for a more complete burn of diesel fuel. This reduces PM in the exhaust. Any further reduction of PM is accomplished by a chemical reaction in the DOC. However, because of the higher combustion temperatures, the engine creates more NOx.

To reduce NOx, a diesel exhaust fluid (DEF, or urea), is injected into the exhaust stream. When the exhaust gases combine with the DEF in the SCR catalyst, NOx is broken down into nitrogen gas and water vapor and expelled through the exhaust pipe.



For Final Tier 4 (FT4), the John Deere Integrated Emissions Control system on some power categories consists of cooled exhaust gas recirculation (EGR), an exhaust filter with a diesel oxidation catalyst (DOC) and diesel particulate filter (DPF), and a dual-catalyst selective catalytic reduction (SCR) canister with an SCR catalyst and an ammonia oxidation catalyst.