TIER 4 INTERIM ENGINE

THE MYSTERY OF DPF REGENERATION

Tier 4 Interim engine technology may have the reputation of being finicky, even demanding. But in reality, it is quite straightforward when it comes to operation and maintenance. FOCUS magazine is looking at two aspects. The first, as detailed in the Third Issue, 2012, reviewed the need to filter and keep clean the Ultra Low Sulfur Diesel (ULSD), and also briefly discussed engine additives. In this issue, FOCUS will cover how a diesel particulate filter (DPF) works, and the need to keep an eye on the control panel so you know when it is time to get it serviced.

WHAT'S A DPF DO?

A DPF is often paired with a catalytic converter especially designed for diesel engines called a DOC (diesel oxidation catalyst). Their jobs are very different.

DOCs control carbon monoxide, hydro-carbons, smell, and the soluble organic fraction of particulate matter (PM). They have no moving parts and simply chemically oxidize the exhaust to harmless gases. Most engine manufacturers also use the DOC to chemically oxidize the fuel that is added to the exhaust through post injection during regeneration.

DPFs are used in most diesel engines designed and produced in the United States or Japan. Some manufacturers are using DEF (diesel exhaust fluid) to meet iT4a. The DPF approach reduces the PM to ash during regeneration. The DEF approach oxidizes nitrogen oxide (NOx) with the use of ammonia and a Selective Reduction Catalyst (SCR). The DEF approach requires continual refilling of a DEF tank. It appears most manufacturers will utilize both approaches to meet the Tier 4F regulations slated for 2015.

This article covers only the DPF approach as used in Kawasaki wheel-loader models.

While the main job of the DPF is to filter out, or remove PM/soot from the exhaust stream, it too chemically oxidizes passing exhaust to harmless gases.

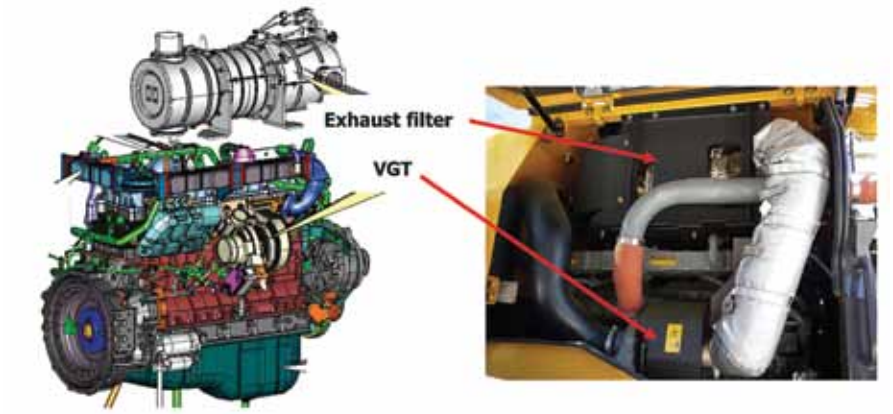
Wall-flow DPFs are what most owners and operators of Tier 4 Interim construction equipment will encounter, including Kawasaki IT4 owners. They use high-tech materials like ceramics, silicon carbide, and metals to trap PM. DPFs are highly efficient, capturing from 85 to 99 percent of the exhaust's PM.

The DPF becomes restricted as it filters PM out of the passing exhaust gases during operation. Hence the need for "regeneration" of the filter.

AUTO REGENERATION

There are two kinds of automatic regeneration — passive and active. Neither requires any activity on the part of the equipment operator. The computer and sensors make the call and initiate the appropriate response. The frequency of regeneration is determined by the amount of PM buildup, which results in an increase in exhaust backpressure.

If your wheel loader is actively working most of the time it is in operation, the high exhaust temperature produced by the engine will reduce most of the PM to ash before it accumulates. This is called passive regeneration.



The DPF/Exhaust Filter is a rugged component that filters particulate emissions from the exhaust very efficiently. It replaces the muffler. The DPF is very effective in trapping particulate emissions. Passive and Active Regeneration keeps the DPF element cleaned without any action required by the operator.

During active regeneration, the machine's computer jumps in and initiates a process that includes the injection of diesel fuel into the engine cylinders during expansion after the power stroke. This process is called post injection. The DOC oxidizes this fuel, which pumps up the heat significantly. This heat reduces the PM in the DPF to ash. The time required for this active regeneration takes 15 to 20 minutes to complete.

In most circumstances, the passive and/or active regeneration of the system keeps the DPF working at peak performance.

MANUAL REGENERATION

If for some reason the engine temperature simply has not been hot enough to allow either the passive or active regeneration, manual regeneration is required. And this does require operator participation.

A light comes on in the instrument panel asking the operator initiate manual regeneration. The operator must stop the machine and activate the regeneration process. The engine RPMs are raised, the machine hydraulics are automatically loaded, and diesel fuel is post injected into engine cylinders during expansion after the power stroke and reacts with the DOC to clean the DPF, just as in the active regeneration process. This takes up to 45 minutes.

This type of manual regeneration effort would not be required in most cases if the wheel loader is actively operated so the correct operating temperature is maintained. Low engine and machine loading and/or lots of idle time are about the only way manual regeneration is required.

If the operator refuses to actively operate the machine in a manner that keeps it running at the correct operating temperature, and refuses to heed the warning light on the instrument panel and the eventual audible alarm asking manual regeneration be initiated, at some point the engine will go into a "limp-home mode" where RPMs and power are greatly reduced to the point that production with the machine will not be possible.

There is a final regeneration process — Forced or Service Regeneration. To execute this procedure, a technician from your dealership must hook up to the machine with KCMA's Maintenance Pro Dr. In some cases the DPF will need to be removed and cleaned or replaced. This, of course takes time — easily a day or more of down time, depending on the procedure.

It's important to note that even with correct engine-temperature operation and automatic regenerations, removal of the DPF for cleaning will eventually be required in order to remove the ash accumulated from regenerations.

HOW LONG WILL THE DPF LAST?

The EPA has stipulated to DPF manufacturers that the filter must last at least 3,000 hours between forced cleanouts for engines 75-173 horsepower, and 4,500 hours for engines 174-750 horsepower. How many of these forced-cleanout service intervals can be made to the same filter is currently unknown because of the newness of the program.

Also, DPFs and DOCs can clog or fail prematurely. For example, using the high sulfur diesel fuel or non CJ-4 engine oil will create havoc by generating more PM, chemically deteriorating the DOC and plugging the DPF. The metallic ash additives found in non CJ-4 engine oil will adhere to the cells within the DPF and cannot be removed. Permanent damage will result.

Tech article provided by Equipment World, MECA.org, and Kawasaki Wheel Loaders.