



Mid-South

BASICS OF AFTERTREATMENT

EMMANUEL OKHIURE

DEFINITION OF AFTERTREATMENT

In a simpler definition it is the method of interaction with exhaust gas in order to reduce the levels of pollutants emitted.

WHAT IS A DOC?

- PM reduction product

Flow-through substrate

- Made of cordierite or metal
- No maintenance necessary

Substrate is coated with precious metals

- Platinum (Pt) and Palladium (Pd) as catalyst
- Enables conversion at a lower temperature
- In general, increasing Pt increases conversion efficiency

Compatible with ULSD and 15 PPM & 500 PPM sulfur diesel fuels

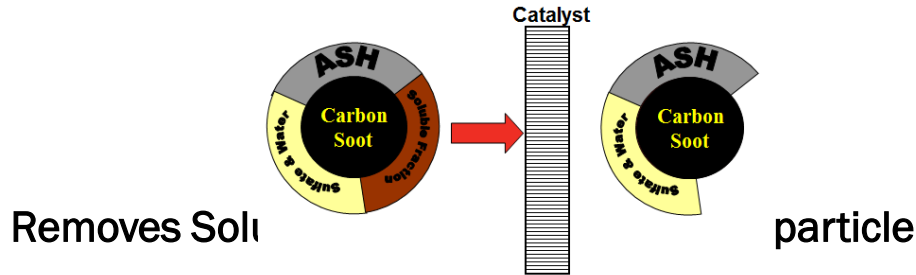


Light seen through substrate paths

WHAT DOES A DOC DO?

Provides >90% reduction of CO, HC

Provides 25 – 50% reduction of PM



Promotes passive regen of DPF by creating NO₂

Enhances combustion of diesel fuel in the exhaust stream to generate heat for active regen of DPF

Enhances performance of SCR catalyst with creation of NO₂

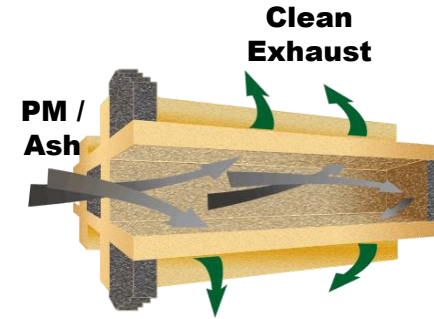
DIESEL PARTICULATE FILTER (DPF)



WHAT DOES A DPF DO?

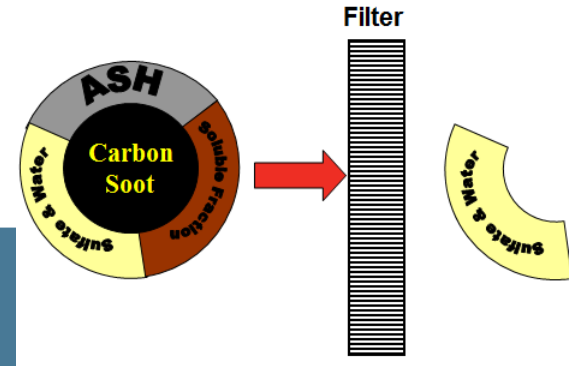
Porous ceramic walls capture soot and ash from exhaust

- Soot is removed by periodic regeneration (active / passive)
- Ash accumulates, requiring DPF removal and maintenance



Provides >90% PM reduction

Traps Carbon Soot, Ash and Soluble Organic Fraction of particle



CONTINUE...

Soot is a PM and it gets oxidized or burned out $>500^{\circ}\text{C}$.

Ash is incombustible and so a regen will not clean it out but a periodical maintenance service of the DPF to get rid of the ash.

TYPES OF REGENERATION

1) Passive Regen: enabled by DOC

- Requires 18:1 NO₂:Soot minimum and Temperature >250° C
- Conditions occur naturally during normal engine operation

2) Active Regen: Requires temperature >500° C

- Temp achieved by engine management, dosing diesel fuel into exhaust stream or alternative heat source, e.g. burner

3) Stationary Regen: Requires temp > 500° C and the engine must be stopped and a regen initiated using an INSITE or a switch. This basically a human interaction.

DRIVERS INTERACTIVE AND TIPS



GENERAL ENGINE INDICATOR LAMPS



Check Engine Lamp Or Amber Warning Lamp

The Check Engine Lamp (which may also be referred to as the Amber Warning Lamp) illuminates to remind the driver of scheduled maintenance due. It will flash for 30 seconds after the engine ignition event and remain illuminated, indicating that the engine needs service at the first available opportunity.



Stop Engine Lamp

The red Stop Engine Lamp indicates, when illuminated, that the vehicle needs to be stopped as soon as it is safe to do so.

ON – BOARD DIAGNOSTICS

Every 2013 and newer engine includes On-Board Diagnostics as a part of the emissions regulation requirement. On-Board Diagnostics monitors all emissions-related engine systems during operation. If the system detects any emissions-related malfunctions, it will alert the operator to the detected malfunction through a dash lamp known as the Malfunction Indicator Lamp (MIL).



Malfunction Indicator Lamp (MIL)

The MIL illuminates when the On-Board Diagnostics system detects a malfunction related to the emissions control system. The illuminated MIL indicates that the engine and aftertreatment system should be diagnosed and serviced at your next available opportunity. The MIL can be illuminated along with any of the engine indicator lamps.

ON-BOARD DIAGNOSTICS CONT..



If the MIL is illuminated with the red Stop Engine Lamp, the vehicle should be stopped as soon as it is safe to do so. It should then be taken to an authorized Cummins location for repair.

*Lamps shown are for illustrative purposes only. Be sure to reference your vehicle manufacturer's Owners Manual for specific lamps and details.

DIESEL PARTICULATE FILTER (DPF).

The DPF is an integral component of the aftertreatment systems on every 2007 and newer vehicle. It captures Particulate Matter in a wall-flow ceramic filter. The exhaust system periodically undergoes regeneration raising temperatures to oxidize captured PM and clean the system. Lamps alert the driver when the regeneration is needed.

High Exhaust System Temperature (HEST) Lamp

The HEST lamp illuminates to indicate that exhaust temperatures may exist due to aftertreatment regeneration. This is normal and does not signify the need for any vehicle or engine service. When this lamp comes on, ensure that the exhaust tail pipe outlet is not directed at any combustible surface or material. Reference Cummins Owners manual for complete instructions.



OEM A

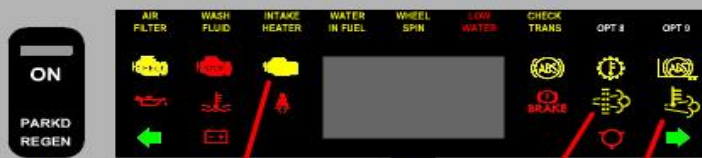


This light will stop blinking and eventually turn OFF during the Stationary (Parked) Regeneration indicating a cleaned exhaust filter.

This light will turn ON during a Stationary (Parked) Regeneration or during Active Regeneration indicating High Exhaust Temperature (HEST lamp).

NOTE - Extended Operation with the Permit Switch in the OFF or STOP position can cause permanent damage to the DPF assembly!!

OEM B



Check Engine Light

DPF Light

HEST Light

Optional Switch

OEM C



CONTINUES.....



Aftertreatment Diesel particulate Filter (DPF) Lamp.

Illuminated

The aftertreatment DPF Lamp indicates, when illuminated or flashing, that the aftertreatment DPF requires regeneration. This is accompanied by the following:

1. If the vehicle is equipped with a Regeneration inhibit switch, ensure that that the switch is not in the inhibit position.
2. Perform a DPF regeneration by one of the following methods:
 - a. change to more challenging duty cycle-such as highway driving for at least 20minutes to increase exhaust temperatures.

OR

- b. Perform a parked regeneration (Stationary)

FLASHING

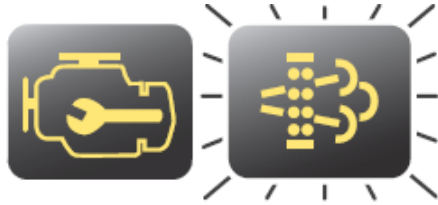


**IF A REGENERATION IS NOT PERFORMED
IN A TIMELY MANNER AFTER THE DPF LAMP ILLUMINATED. THE DPF LAMP WILL BEGIN TO
FLASH. THIS INDICATES A HIGH LEVEL OF PM IN THE DPF. HOWEVER, ENGINE POWER WILL
REDUCE AUTOMATICALLY.**

CONTINUES.....

Flashing With Check Engine Lamp/Amber Warning Lamp

A flashing DPF Lamp combined with an illuminated Check Engine Lamp/Amber Warning Lamp indicates that the aftertreatment DPF needs regeneration immediately. Engine power will be reduced automatically. A parked regeneration is required.



Stop Engine Lamp

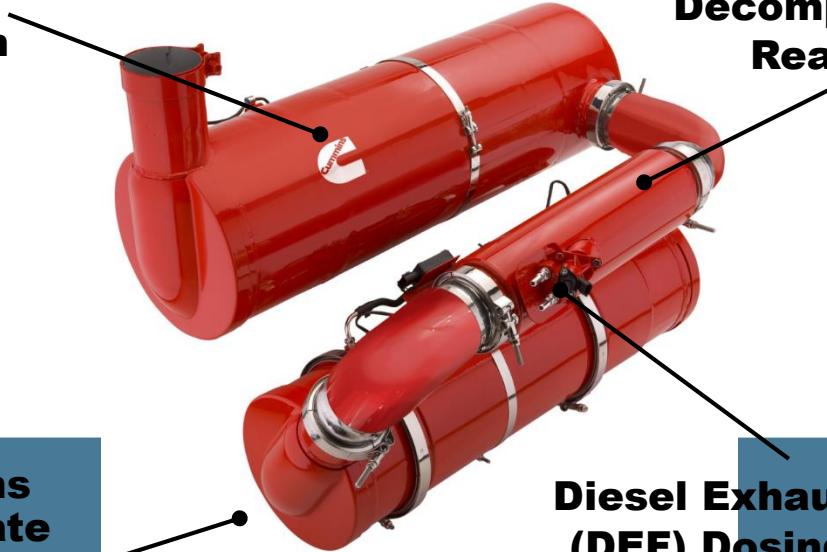
If a parked regeneration is not performed, the red Stop Engine Lamp will illuminate. As soon as it is safe to do so, the vehicle should be stopped. It should then be taken to an authorized Cummins location for repair. **Regeneration Inhibit Switch** The purpose of this switch is to prevent or disable aftertreatment DPF regeneration. Reference the vehicle Owners Manual for complete operation and use of this switch. Unnecessary or excessive use of the Regeneration Inhibit Switch will result in a loss of fuel economy, or an increased need for parked regeneration.



CUMMINS SCR AFTERTREATMENT SYSTEM

**Selective
Catalytic
Reduction
(SCR)
Catalyst**

**Decomposition
Reactor**



**Cummins
Particulate
Filter**

**Diesel Exhaust Fluid
(DEF) Dosing Valve**

DIESEL EXHAUST FLUID(DEF) FOR SELECTIVE CATALYTIC REDUCTION(SCR) AFTERTREATMENT

Every 2010 and newer vehicle has an on-frame storage tank for DEF and a dash lamp that indicates low DEF levels. Refilling this tank with DEF is critical in order for your vehicle to comply with U.S. Environmental Protection Agency (EPA) emissions regulations.

Diesel Exhaust Fluid (DEF) Lamp



Illuminated

An illuminated DEF Lamp is an indication that the DEF level is low. This can be corrected by refilling the DEF tank with Diesel Exhaust Fluid.

Flashing

A Flashing DEF Lamp indicates that the DEF level has fallen below a critical level. This can be corrected by refilling the tank.



CONTINUES.....

Flashing DEF lamp with check Engine lamp/Amber warning lamp



A Flashing DEF lamp combined with an illuminated check engine lamp/Amber warning Lamp indicates that the DEF level is critically low and the unit will experience loss of power. Normal engine power will be restored after refilling the DEF Tank.

Flashing DEF lamp With check Engine Lamp/Amber warning Lamp And Stop Engine Lamp

when the DEF gauge reads zero and the engine has been shut down, has idled for one hour after the DEF tank has been run dry, or if the vehicle's diesel fuel tank is refilled without refilling the DEF tank, the stop engine lamp will also be illuminated, along with the flashing DEF lamp/Amber Warning amp.



ITEMS DRIVER WILL NOTICE.

Under certain conditions (cold or very dry), condensation in the form of water vapor can be seen coming from the vehicle tailpipe. This is normal. It will clear within a few minutes of normal vehicle operation.

If the engine is left at idle for significant periods of time without reaching the minimum exhaust operating temperatures, the engine will automatically increase the engine idle speed for several minutes to maintain the condition of the particulate filter. This can be interrupted by pressing either the service brake or the clutch.

After prolonged idle, you may notice momentary white vapor and an odor. This is normal.

When the HEST Lamp is illuminated, you may notice an odor. This is normal.

If the odor is excessive and you also notice white vapor, have the exhaust system inspected for leaks.

Tips For Efficient Driving.

1. Lower drive speeds – At interstate speeds, each 1.0 mph (1.6 kph) increase

CONT.....

equals a 0.1 mpg (0.04 km/L) decrease. For example, driving at 65 mph instead of 70 mph can save 0.5 mpg (0.21 km/L) and create roughly a 7 percent improvement in fuel economy.

2. Run in top gear more than 90 percent of the time – Every 10 percent drop in time in top gear equals approximately a 3 percent to 5 percent decrease in fuel economy.
3. Decrease idle rpm and idling time – Using the lowest idle speed possible helps reduce fuel use by up to 0.5 gal/hr (1.89 L/hr). Every hour of idle time that you eliminate can increase your vehicle's fuel economy by as much as 1 percent.
4. Follow proper driving habits – Sudden braking, rapid acceleration, early downshifting and other poor driving habits can negatively impact fuel economy by as much as 30 percent.
5. DEF consumption is expected to be approximately 2% of fuel consumption depending on vehicle operation, duty cycle, geography and load rating etc.
6. DEF at 32.5% solution it will begin crystallization and freeze at 11deg F or -11 deg C but it will not inhibit the driver from starting the vehicle because the DEF thaws quickly once you start the vehicle.

DIESEL EXHAUST FLUID.(DEF)

This is a reactant necessary for the functionality of the SCTR system. It is carefully blended aqueous Urea solution of 32.5% high synthetic and 67.5% deionized water.

Urea is a compound of nitrogen that turns to ammonia when heated. It is used in a variety of industries including as fertilizer for agriculture. A DEF should have a specification of German Institute of standardization DIN70700 ISO 22241-1, and meet AUS-32 specs. All this ensure the proper concentration at 32.5%.

DEF is none toxic, nonpolluting and nonflammable solution. It is stable, colourless and odorless. The concentration of 32.5% of Urea is critical in solution because it provides the lowest freeze point, also SCR systems are calibrated to 32.5% ,so that optimum Nox will be reduced during operation.DEF at the correct concentration will begin to crystallize at 11 deg F or -11 deg C, both Urea and water will freeze at same rate, ensuring that the fluid does not become diluted or over concentrated. This will not inhabit the operator from starting the vehicle because DEF thaws quickly once you start the vehicle.

SOME AFTERTREATMENT ACRONYMS

DPF:- Diesel Particulate Filter

DEF:- Diesel Exhaust Filter

SCR:- Selective Catalyst Reduction

DOC:- Diesel Oxidation catalyst

EGR: Exhaust Gas Recirculation

VGT:- Variable Geometry Turbo

PID:- Parameter Identifier

MID: Message Identifier

PM:- Particulate Matter.