

## DPF - Diesel Particulate Filters

- Reduction on [Diesel engines](#) .

A diesel particulate filter (or DPF) is a device designed to remove diesel particulate matter or soot from the exhaust gas of a diesel engine. Wall-flow diesel particulate filters usually remove 85% or more of the soot, and under certain conditions can attain soot removal efficiencies of close to 100%.

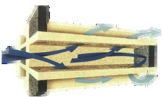
Partial flow filters (like the PM Cat) reduce in order of 45 % average. Some filters are single-use, intended for disposal and replacement once full of accumulated ash. Others are designed to burn off the accumulated particulate either passively through the use of a catalyst or by active means such as a fuel burner which heats the filter to soot combustion temperatures.

Modern electronic controlled engines are programmed to run when the filter is full in a manner that elevates exhaust temperature or produces high amounts of [NOx](#) to oxidize the accumulated ash, or through other methods. This is known as "filter regeneration".

Cleaning(service) is also required as part of periodic maintenance, and it must be done carefully to avoid damaging the filter. Failure of fuel injectors or turbochargers resulting in contamination of the filter with raw diesel or engine lube oil can also necessitate cleaning, sometimes this is not possible and change of the filter element is necessary.

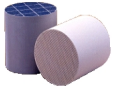
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### Wall-flow filters



In wall flow filters, particulate matter is removed from the exhaust by physical filtration using a honeycomb structure similar to an emissions catalyst substrate but with the channels blocked at

alternate ends. The exhaust gas is thus forced to flow through the walls between the channels and the particulate matter is deposited as a soot cake on the walls. Such filters are made of ceramic (cordierite, silicon carbide, sintered metals or aluminium titanate) honeycomb materials.



### **Wall-flow filters trap most ultra-fine exhaust particles**

Ceramic wall-flow filters remove almost completely the carbon particulates, including fine particulates of less than 100 nanometers (nm) diameter with an efficiency of >95% in mass and >99% in number of particles over a wide range of engine operating conditions. Since the continuous flow of soot into the filter would eventually block it, it is necessary to 'regenerate' the filtration properties of the filter by burning-off the collected particulate on a regular basis. Soot particulates burn-off forms water and CO<sub>2</sub> in small quantity since it is less than 0.05% of the CO<sub>2</sub> emitted by the engine. The most successful methods to achieve regeneration on retrofit applications include:

- Incorporating an oxidation catalyst upstream of the filter that, as well as operating as a conventional oxidation catalyst, also increases the ratio of NO<sub>2</sub> to NO in the exhaust. Trapped particulate burns off at lower exhaust temperatures using the powerful oxidative properties of NO<sub>2</sub> and oxygen.
- Incorporating a catalytic coating on the filter to lower the temperature at which particulate burns to normal exhaust temperatures.
- Using very small quantities of fuel-borne catalyst (FBC), such as iron or ceria additive compounds, added to the fuel thanks to an on board dosing system. The catalyst, when collected on the filter as an intimate mixture with the particulate, allows the particulate to burn at lower exhaust temperatures (around 350°C instead of 650°C) and increases the combustion kinetic (typically 2-3 minutes) while the solid residues of the catalyst are retained on the filter as ashes. Control over the combustion process is critically important in maintaining the long-term integrity of the filter. Its performances in terms of temperature and kinetic make the FBC technology particularly suitable for urban and stop-and-go cycle duty cycles with low fuel penalty.

- External heating of the trap either on or off the vehicle or machinery with electrical heaters. It applies only to industrial applications and is usually only used when the engine is off.
- Fuel injector or burner placed in the exhaust line upstream of the DPF.

**Typical Conversion Efficiencies:**

Filter Type

Particulate matter measured

by particle count\*

Particulate matter(PM10)

measured by mass\*\*

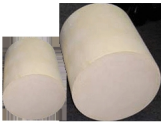
CO)	HC	NOx	
Coated (Pt)	>99%	> 85%	90%
Un coated or FBC***	>99%	> 85%	-

\* *ultra-fine and fine particles (diameter 10 - 500 nm)*

\*\* *Requires less than 15 ppm sulfur in fuel for best performance.*

\*\*\**Fuel Borne Catalysts*

## Variants of DPFs

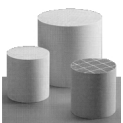


### **Cordierite wall flow filters**

The most common automotive filter is made of cordierite (a ceramic material that is also used as catalytic converter supports (cores)). Cordierite filters provide excellent filtration efficiency, are (relatively) inexpensive, and have thermal properties that make packaging them for installation in the vehicle simple. The major drawback is that cordierite has a relatively low melting point (about 1200 °C) and cordierite substrates have been known to melt down during filter regeneration. This is mostly an issue if the filter has become loaded more heavily than usual, and is more of an issue with passive systems than with active systems, unless there is a system break down.

Cordierite filter cores look like catalytic converter cores that have had alternate channels plugged - the plugs force the exhaust gas flow through the wall and the particulate collects on the inlet face.

The cordierite filter elements are very sensitive for vibrations, they will crack easily when heavily moved or hit on the casing.



### **Silicon carbide wall flow filters**

The second most popular filter material is silicon carbide, or SiC. It has a higher (2700 °C) melting point than cordierite, however it is not as stable thermally, making packaging an issue. Small SiC cores are made of single pieces, while larger cores are made in segments, which are separated by a special cement so that heat expansion of the core will be taken up by the cement, and not the package. SiC cores are usually more expensive than cordierite cores, however they are manufactured in similar sizes, and one can often be used to replace the other. Silicon carbide filter cores also look like catalytic converter cores that have had alternate channels plugged - again the plugs force the exhaust gas flow through the wall and the particulate collects on the inlet face.

The characteristics of the wall flow diesel Particulate filter substrate are as follows: Broad band filtration (the diameters of the filtered particles are 0.2-150  $\mu\text{m}$ ); High filtration efficiency (can be up to 95%); High refractory; High mechanical properties. High boiling point.

### Ceramic Fiber Filters



Fibrous ceramic filters are made from several different types of ceramic fibers that are mixed together to form a porous media. This media can be formed into almost any shape and can be customized to suit various applications. The porosity can be controlled in order to produce high flow, lower efficiency or high efficiency lower volume filtration. Fibrous filters have an advantage over wall flow design of producing lower back pressure. Ceramic wall-flow filters remove carbon particulates almost completely, including fine particulates less than 100 nanometers (nm) diameter with an efficiency of >95% in mass and >99% in number of particles over a wide range of engine operating conditions. Since the continuous flow of soot into the filter would eventually block it, it is necessary to 'regenerate' the filtration properties of the filter by burning-off the collected particulate on a regular basis. A major disadvantage is the risk of higher backpressure in this kind of Filter is gapping of the fibers( they open themselves because high pressure and don't close when the pressure is in normal range.

Soot particulates burn-off forms water and CO<sub>2</sub> in small quantity amounting to less than 0.05% of the CO<sub>2</sub> emitted by the engine.



### Metal fiber or sintered metal flow through filters

Some cores are made from metal fibers - generally the fibers are 'woven' into a monolith. Other have sintered "balls" which forms a monolith by folding the mats in to a air intake filter like model. Such cores have the advantage that an electrical current can be passed through the monolith to heat the core for regeneration purposes, allowing the filter to regenerate at low exhaust temperatures and/or low exhaust flow rates. Metal fiber cores tend to be more expensive than cordierite or silicon carbide cores, and generally not interchangeable with them because of the electrical requirement.

### Paper

Disposable paper cores are used in certain specialty applications, without a regeneration strategy. Coal mines are common users in these applications, the exhaust gas is usually first

passed through a water trap to cool it, and then through the filter.

Paper filters are also used when a diesel machine must be used indoors for short periods of time, such as on a forklift being used to install equipment inside a store.

- [Partial flow Soot filter](#)
- [DPF Animation](#)

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