

Using Ceramics in Exhaust Systems to Purify Emissions



Governing bodies around the world are introducing increasingly stringent emission regulations. This has led to a push to develop ever more efficient filters, especially for diesel exhaust systems.

Ceramics in exhaust systems offer a highly effective way to purify vehicle emissions, improving air quality and making urban environments cleaner places to live. Ceramic Diesel Particulate Filters (DPF) are particularly effective, with some removing nearly 100% of soot from the exhaust emissions.

Today, DPF systems are being fitted as standard on many diesel vehicles, especially large trucks, coaches and heavy machinery. To work on the road, they are designed to be highly durable and easy to maintain.

Types of Ceramic Used in Diesel Exhaust Systems

Ceramic isn't the only material used in exhaust filters. Paper and metal fibres can also be used to filter diesel particles. However, ceramic filters keep costs low, are easy to mass produce, are extremely durable, and provide fine filtration of particles. The following types of ceramic have become commonplace in DPF systems:

Cordierite

Cordierite is the most common ceramic used in wall-flow filters. Wall-flow filters force gas to flow directly through the filter, unlike flow-through filters such as catalytic converters.

Cordierite is an ideal material for DPFs as it filters out a very high percentage of particles and is fairly cheap.

The only downside of using cordierite ceramic is that it can melt if the filter is being regenerated – a maintenance process that involves burning off filtrate material to clean it. The risk of damaging the ceramic is especially high if there has been a large accumulation of soot and particles. Therefore cordierite filters often need a catalyst to lower the regeneration temperature.

The structure of the filter is similar to the honeycomb core of a catalytic converter, but the DPF has

plugged channels, meaning the gas is forced through the wall and the filtrate is collected on the inlet face.

Silicon Carbide

Silicon carbide is a ceramic that is also used in wall-flow filters. Silicon carbide filters aren't as popular as cordierite ones, for the simple reason that they are more expensive. The reason for the added cost is that they are not thermally stable, so cement has to separate the filter cores to protect them from heat expansion.

Silicon carbide DPFs work on the same principle as the cordierite filters. The efficiency of these types of filter can be as high as 95%. Silicon carbide also has a high melting point of 2700oC.

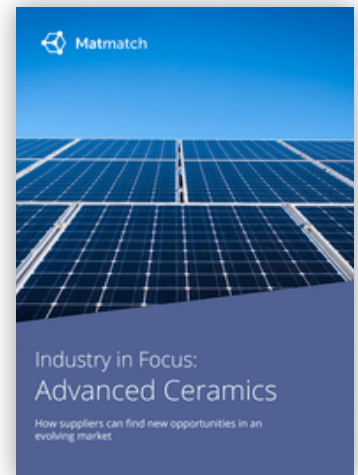
In this white paper, we look at some interesting opportunities for advanced ceramics suppliers, including new markets and applications for piezoelectric devices, smart factories of the future and current industry trends. Download now.

Ceramic Fibres

Ceramic fibre filters contain different types of fibrous ceramic that are entwined, creating a porous material. The fibrous material is easily shaped and can be used in DPFs of various shapes and sizes.

Depending on the density of the ceramic fibres, the porosity can vary, which affects the efficiency of the filter. The main benefit of ceramic fibre filters is that they have a reduced back pressure compared to other wall-flow filters.

Ceramic wall-flow filters remove most carbon particles and other fine particulates that have diameters smaller than 100nm (nanometres).



Benefits of Using Ceramics in Diesel Particulate Filters

The main benefits of using ceramics are:

Efficient particle removal

Ceramic wall-flow filters remove most carbon particles and other fine particulates that have diameters smaller than 100nm (nanometres).



Low cost

Ceramics are relatively inexpensive compared to other filter materials such as metal fibres.

Easy maintenance

They are easily maintained through regeneration, thus giving them a longer lifecycle. A study carried out by The Engineering Society For Advancing Mobility – Land, Sea, Air, and Space cited easy maintenance as the main advantage of using ceramic filters.

Minimal back-pressure

Compared to other materials, ceramics such cordierite and silicon carbide create less of a pressure drop.

Regeneration of Diesel Particulate Filters

Ceramic filters need cleaning regularly to remove the build-up of soot. There are two ways to regenerate the filter:

- **Passive regeneration** – the exhaust system is warm enough to burn off the particles, or a catalyst is added to aid the removal.
- **Active regeneration** – very high temperatures are created in the exhaust system to burn off the filtrate.

These days, most diesel vehicles have a built-in filter management system that may use one or more of several regeneration techniques, including:

- Delayed fuel injection to increase the temperature of the exhaust system
- A catalyst that lowers the temperature at which the soot combusts
- An oxidiser catalyst that increases the temperature

- Microwave technology to raise the temperature of the filtrate
- Heater coils that raise the temperature

Summary

Ceramics are widely used in exhaust systems to filter out pollutants, especially in diesel particulate filters. Ceramic filters are low cost, easily manufactured, robust and long-lasting, making them ideal for use in road vehicles and plant machinery alike.

With recent developments in regeneration technology, ceramic filters are even easier to maintain and last longer than ever before.