

CleanAIR PERMIT™ FBC Filter System

For Diesel Engines

The PERMIT™ FBC Filter System Advantage:

- Works with All Diesel Engines
- No Increase in NO₂ Emissions
- Dual-Action Passive Regeneration
- Low-Temperature Regeneration
- Reduces Diesel Particulate Matter by Greater than 85%
- Reduces Carbon Monoxide (CO) and Hydrocarbons (HC)
- Wall-Flow Ceramic Filter Design
- Available as Standard Filter, Filter/Muffler, or Filter/Silencer Design
- Available with V-Clamp or Welded Design

Applications:

- Mining Equipment
- Generator Sets
- Pumps
- Construction Equipment
- Buses
- Trucks
- Fork Lifts
- Retrofit

The CleanAIR™ Difference:

- MSHA Tested for Use in Mines
- Custom Engineering and Design
- Integrated Manufacturing
- Product Optimization for Space Availability
- 304L Stainless-Steel Housing
- Durable Product Manufacturing for Operation Under Extreme Conditions

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**CleanAIR
SYSTEMS**

The CleanAIR PERMIT™ FBC Filter System – Catalyzed Particulate Filter with Fuel Born Catalyst for Diesel Engines

The PERMIT™ FBC Filter System for diesel engines is designed to reduce [diesel particulate matter \(PM\)](#), [carbon monoxide \(CO\)](#) and [hydrocarbons \(HC\)](#), without increasing [nitrogen dioxide \(NO₂\)](#) emissions. Applications for the PERMIT™ FBC Filter System include on-road and off-road equipment such as mining vehicles, construction equipment, and stationary engines.

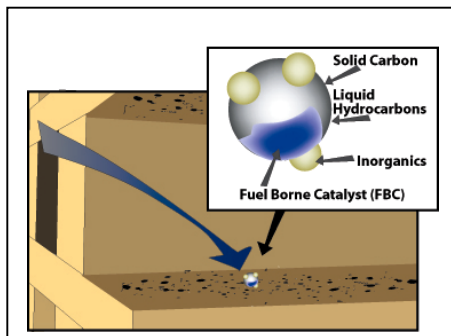
This system contains three components:

1. a passive, regenerating (self-cleaning), wall-flow filter coated with a unique catalyst.
2. a fuel borne catalyst (FBC) to aid regeneration
3. a [HiBACK USB™](#) data logger/alarm unit to measure exhaust back-pressure and temperature

The PERMIT™ FBC Filter is available in standard designs, muffler combination, and filter/silencer configurations. The PERMIT™ FBC Filter System has also been tested by the [Mine Safety and Health Administration \(MSHA\)](#) and shown not to increase NO₂ and to be safe for use in mining operations. The CleanAIR PERMIT™ FBC Filter is packaged in a 304L stainless steel shell and finished by bead blasting to give a highly corrosion-resistant product that will last for years.



PERMIT™ FBC Filter
Standard Design with End Cones



Diesel particulate with FBC inside, being oxidized by catalyst-coated ceramic filter and fuel borne catalyst.

How the PERMIT™ FBC Filter Works

The wall-flow design of the CleanAIR PERMIT™ FBC Filter captures diesel PM as soon as the engine is started and continues through operation, dramatically [reducing PM and visible black smoke](#). The filter is coated with CleanAIR's unique catalyst to reduce [carbon monoxide](#) and [hydrocarbon emissions](#), while at the same time working with the FBC to passively regenerate the filter. Regeneration takes place when the captured PM is oxidized to CO₂ by both the catalyst and the FBC during engine operation. This provides "dual-action" regeneration that begins working as low as 325°C (617°F) for diesel engines operating on 500 ppm sulfur fuel. The combination of CleanAIR's catalyst with the FBC yields the lowest exhaust temperature requirements for regeneration.

PERMIT™ Filter + FBC = Dual-Action Regeneration

Diesel PM is oxidized two different ways

1. Within the particulate by the FBC
2. From the outside by the special catalyst coating on the ceramic filter

Emissions Reduction Summary

Control Technology	Fuel	CO	HC	PM
PERMIT™ FBC Filter (No increase in NO ₂)	ULSD (< 15 ppm S)	Up to 90%	Up to 80%	Over 85%
	LSD (< 500 ppm S)	Up to 90%	Up to 80%	Over 85%
	HSD (> 500 ppm S)	Up to 90%	Up to 80%	Varies with fuel and engine
	Biodiesel	Up to 90%	Up to 80%	Over 85%

Results are fuel dependent and may vary with application.

PERMIT™ FBC Filter Package Designs

The packaged filter can be incorporated into many different configurations depending upon the application requirements, such as a standard PERMIT™ FBC Filter with changeable end cones, a filter/muffler combination, or a filter/silencer configuration. The standard design is a packaged filter with cones on both inlet and outlet ends. Typical sound attenuation for this design is 12 dBA. Replacement muffler designs are used for applications where space is too tight to add the filter separate from the existing muffler. Special inlet or outlet configurations and brackets can be used on the PERMIT™ Filter/Muffler combination that will allow the filter to replace an existing muffler. Typical sound attenuation for this design is 15-20 dBA.



The PERMIT™ FBC Filter as a Filter/Muffler Design

A silencer replacement design is available for applications that require higher levels of sound attenuation or for large engines that require multiple PERMIT™ Filters. The silencer shell has a removable panel allowing full access to the filters mounted inside. The PERMIT™ Filter/Silencer is available in industrial, critical or super-critical grade sound attenuation levels.



Inside view of Filter/Silencer Design using PERMIT™ FBC Filters

How Sulfur in Fuel Affects the PERMIT™ FBC Filter System Performance

The PERMIT™ FBC Filter System is designed to operate on [fuel sulfur content](#) as high as 8000 ppm. Unlike passive systems where the catalyst coating is greatly affected by sulfur, the PERMIT™ FBC has a high tolerance for sulfur in the fuel. See chart below for regeneration requirements versus sulfur content.

Sulfur Content by Weight	Regeneration Temp.	% Run Time Required
< 15 ppm	300° C (572° F)	>30%
< 500 ppm	325° C (617° F)	>30%
> 500 ppm	360° C (680° F)	>30%

About the Fuel Borne Catalyst

The fuel borne catalyst (FBC) is dissolved in diesel fuel and supplied as a concentrated mixture. A small portion of the mixture is introduced into the tank or bulk fuel supply of diesel powered vehicles. The typical ratio of concentrated mixture to normal diesel fuel is 1 part to 1500 parts.

The FBC passes through the fuel system without causing any wear or plugging because it is dissolved in the fuel. The extreme heat of the combustion process causes the FBC to precipitate out of the solution. The “free” catalyst now becomes incorporated inside the diesel particulate. Typical diesel particulate consists of solid carbon, liquid hydrocarbons and inorganic components. With the particulate imbedded with the catalyst, it is readily oxidized into carbon dioxide and water vapor. Since the FBC is dispersed with the particulate inside the filter, regeneration begins at very low temperature and is much less dependent upon fuel sulfur levels compared to other filter systems. Also, the FBC allows regeneration at normal exhaust temperatures without increasing NO₂ emissions.

The FBC is registered with the EPA and has undergone extensive testing for both durability and emissions. Engine wear did not increase as a result of using the FBC at double the recommended dosage over a 1000-hour test. Emissions were also checked for 200 chemical species, including dioxins and nitro-PAHs to determine if any toxic compounds were created by the FBC. Results showed no toxic compounds created and no increase in typical emissions.

HiBACK USB™

Data Logging and Alarm System

The [HiBACK USB™](#) is a microprocessor-based data logger and alarm system used in conjunction with the CleanAIR PERMIT™ Filter System as both an alarm and a data logger to record time, backpressure and temperature data. The [HiBACK USB™](#) unit can warn the operator of possible problems with excessive backpressure, can track the duty cycle of the engine and allow analysis for operation time, exhaust temperature and backpressure profiles. Data collected by the [HiBACK USB™](#) can be downloaded to a computer for detailed analysis using optional software. *(Optional software sold separately. The HiBACK USB™ is required for warranty of the PERMIT™ Filter.)*

