New Filter Technology for Diesel Engines

Sintered Metal Filter SMF®

Deutscher UMWELTPREIS '03

Sootfree
SMF® — soot-free in future

The aggregate of the future

In the past few years, the diesel engine has been able to assert itself as a drive unit on account of its economic efficiency and hard-wearing properties. The statistics for newly registered vehicles in Western Europe are showing the unbroken popularity of diesel engines. In Germany more than 40% of all new passenger cars registered have diesel engines. Despite state-of-the-art engine technology in all diesel engines, this type of drive unit still comes in for criticism due to particulate emission. According to scientific research, diesel engines without a filter represent a health risk. The World Health Organisation (WHO) and the American environment authority EPA have found that soot from diesel engines can now be made responsible for five percent of all cancers of the upper respiratory system.

Market development

The diesel engine makes a vital contribution to the achievement of climate protection objectives. Thanks to its low fuel consumption it produces around 20% less carbon dioxide than a petrol engine. It has been recognised for a long time, however, the soot from diesel engines puts a strain on health and the environment. The EURO 4 standard prescribes a value of 0.025 g/km for particulate emission from diesel engines. It is expected that the EURO 5 standard will make the use of a diesel particulate filter mandatory, due to even lower values. Swiss legislation already prescribes a filter in all construction machinery.

Deutscher UMWE
Exhaust aftertreatment systems for diesel engines achieve new quality levels thanks to the use of the sintered metal filter SMP®. The SMP® has significant advantages in comparison with previous filter concepts thanks to its design and the material used. This filter technology has created the preconditions necessary for the use of filters in all diesel engines in passenger cars, trucks, buses, construction machinery and stationary units in future.

Federal German President Johannes Rau congratulates the HJS Development Team on being awarded the German Environment Prize 2003.

Advantages of the SMF® Jetfilter®

- Filter efficiency 99%
- Optimum gas flow
- Low exhaust gas back pressure
- High ash storage capacity
- Modular self supporting design
- Individual application for design volume
- Easy to clean
- Low cost canning
- Simple recycling

German Environment Prize 2003 for the innovative filter design of the SMP®.
SMF® for modular CRT® systems

The modular design of HJS CRT® systems already offers users major advantages. Maintenance and service are easy grace to individual component replacement.

HJS supplies an SMF® module in place of the ceramic filter module used up to now. The large ash storage capacity of the SMF® and the better flow behaviour within the filter offer users decisive advantages. Maintenance intervals are extended by using the SMF®, this ensuring further time and cost savings in company service operations.

The innovative filter design allows extremely simple and effective filter cleaning, which is only usually necessary after a very long period of operation, however.

SMF® modules for CRT® applications

<table>
<thead>
<tr>
<th>Area m²</th>
<th>Length mm</th>
<th>Ø mm</th>
<th>Wall-flow filter</th>
<th>Application examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8</td>
<td>250</td>
<td>160</td>
<td>7.5 x 6&quot;</td>
<td>Passenger cars/construction vehicles</td>
</tr>
<tr>
<td>2.5</td>
<td>250</td>
<td>190</td>
<td>7.5 x 8&quot;</td>
<td>Transporters</td>
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<tr>
<td>3.3</td>
<td>300</td>
<td>190</td>
<td>—</td>
<td>Construction vehicles</td>
</tr>
<tr>
<td>5.4</td>
<td>250</td>
<td>296</td>
<td>10.5 x 10&quot;</td>
<td>Construction vehicles</td>
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<tr>
<td>7.0</td>
<td>335</td>
<td>296</td>
<td>10.5 x 12&quot;</td>
<td>Buses, construction vehicles</td>
</tr>
<tr>
<td>8.1</td>
<td>385</td>
<td>296</td>
<td>11.25 x 14&quot;</td>
<td>Construction vehicles</td>
</tr>
</tbody>
</table>

Other geometries are available on request.
Material Properties

Specification for HJS sintered metal in diesel particulate filters

1. Material description

STMS3W

2. Composition

Base material: High-temperature chrome-nickel-steel
Metal powder: Extremely fine metal powder made of heat-resistant chrome-nickel-steel

3. Properties

Area weight: 1.600 g/m²
Thickness: 0.38 mm
Porosity: 45% incl. base structure
Pore size: 10 µm (MFP - Mean Flow Poresize)
Permeability: 100 m³/(m² • h) at 200 Pa
differential pressure to air
Filter efficiency: >95%, soot mass diesel engine
>99%, particulate number
Ultimate elongation: 40% (x-axis), 20% (y-axis)
Melt temperature: 1360°C
Thermal shock rate: >1.000 K/s
Permanent operating temperature: ≤850°C
Soot deposits: 20 - 25 g/m²

The material properties of sintered metal and the innovative filter design allow a wide range of different design shapes.

Sintered metal under the scanning electron microscope.
Deciding factors

The use of high-alloy corrosion-resistant metal powders combined with reinforcing base materials made of the same substance guarantees a long service life for our filter materials. Sintered metal technology allows a defined pore size to be set at high porosity. Filter effectiveness of more than 95% at low pressure loss and a great deal of design freedom for the filter medium are the result of our development. Good heat dissipation and metallic elasticity prevent thermal regeneration damage to the filter and allow high soot deposits at minimum pressure loss.

The self-supporting design of the Jetfilter® makes it possible to use the system without editional bearing systems. This allows optimum use of design space, reduces costs and makes installation easier. There is thus an emission of hazardous fibres from ceramic mats whatsoever. The high degree of freedom in material shaping makes it possible to design a filter system that provides optimum storage of both engine and additive ashes. The feed air resistance has also now been adapted to the conditions in the exhaust air stream. Flat feed air angles and large feed areas towards the engine side reduce backpressure to the minimum level technically possible. It is very easy to clean non-combustible residue from the filter but this is usually only necessary after an extremely long period of use.
Active thermoelectric regeneration

HJS has developed an active regeneration method developed for the HJS diesel particulate filter made of sintered metal (SMP®) and its different design variants. This SMP® system with active regeneration is made up of the HJS diesel particulate filter with sensors for filter monitoring and determining the soot deposit level, a fully automatic additive dosage system, the heating elements for filter regeneration and the control unit.

Since it can store 2.5 times more ash than the wall-flow filter, the increased ash formation due to the use of an additive is insignificant. A distinction is made with the regeneration of particulate filters between continual CRT® systems and filters coated with catalysts and systems that do not work continually (active regeneration). In the case of active regeneration, soot is stored in the filter until the point where the amount of soot optimum for regeneration has been deposited on the filter material. It is only then that the soot burning process is triggered. With the HJS system, the soot is ignited by heat radiated from heating elements. Three elements 10 mm apart encircle the whole filter and ensure large-area homogenous heating up of the filter material. The extremely low mass of the heating elements (which are only 2 mm in diameter) results in a very quick increase in temperature which makes ignition of the soot layer possible after a heating period of only 60 seconds no matter how difficult the conditions. Heat rays are applied to around 10% of the sooty filter surface, triggering soot combustion over the whole filter surface.

Glowing heating elements ensure the soot layer ignites. Temperature profile (of the outflow area) of the SMP® during active regeneration.
HJS Fahrzeugtechnik GmbH & Co KG is a successful medium-sized enterprise, which together with its staff of 360 employees, designs, produces and sells exhaust aftertreatment systems as well as exhaust systems for cars and commercial vehicle retrofit systems at two business locations. With innovative technology, excellent quality and a high degree of customer orientation HJS makes an important contribution towards pollution control. Development potential, mature production processes, certified quality management and active marketing guarantee HJS a high level of acceptance on the market.

**HJS exhaust systems:**

- Catalytic Converter
- Silencer
- Mounting Kits
- Diesel Particulate Filter
- CRT® System
- Sintered Metal Filter SMF® System