Publication Series Viledon

An optimum filter concept for paint-spray cabins: essential for maximized paintwork quality

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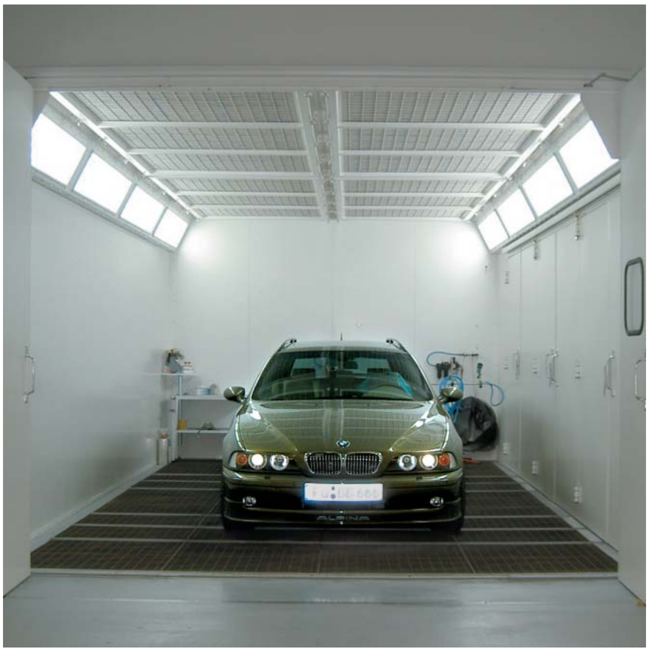
Introduction

A long-standing and unfortunately still topical problem in automotive paint-spray operations is surface imperfections caused by dust inclusions. They are primarily a visual nuisance, but may also constitute starting points for corrosion damage. Since eliminating these defects is time-consuming, and concomitantly expensive, everything should be done in order to avoid dust inclusions right from the outset.

Besides other factors, filtration of the intake air plays a crucial role. The incoming fresh air contains dust particles, which by reason of their size may cause damage to the final paintwork.



Air pollution

Filter system design is closely dependent on technical parameters, like dust concentration and grain size distribution. When the contents of the atmospheric air are analyzed in terms of their composition and particle sizes, then typically two different fractions are found:

- The range with particles of below 5 µm in size
  The dusts in this grain size range originate primarily from combustion operations and other industrial processes. The main constituents found are carbon (soot) and sulfur (e.g. in the form of sulfates).

- The range with particles of above 5 µm in size
  These dusts predominantly originate from erosion processes on the Earth's crust. So frequently encountered elements include silicon, calcium, aluminum and iron.

The proportion of each individual dust fraction in the total dust will vary from place to place. In rural areas, the dust's composition will not be the same as in industrialized conurbations. What's more, it's also subject to seasonal and meteorological influences.

An analysis of the data published in specialist periodicals on the immission loading in Germany reveals significant fluctuations in airborne particle concentrations over the course of a year.

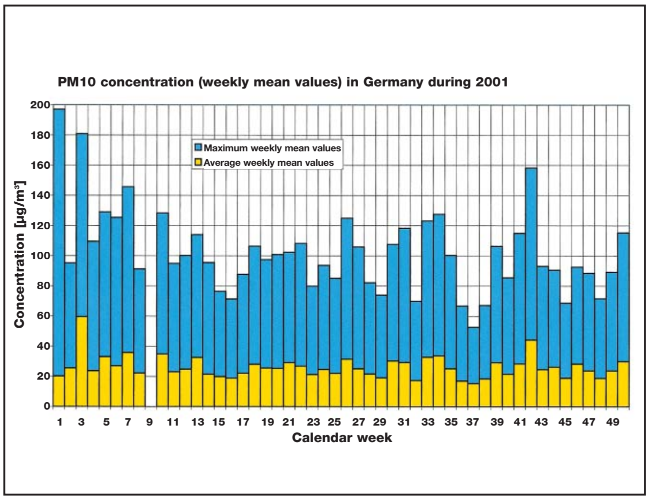


Fig. 1 Airborne particle concentration in Germany during 2001

Seasonal influences are particularly manifest, for example, in the incidence of Sahara dust and high pollen counts. The sand dust, which is carried to us in the upper layers of the atmosphere over thousands of kilometers, consists mainly of the elements silicon, aluminum, potassium, calcium and iron. Its grain size spectrum covers the range from about 50 µm to less than 1 µm, with the main proportion lying between 20 and 5 µm.

Pollens, too, can be encountered in such high concentrations that they form a clearly visible yellow coating on all surfaces exposed to the surrounding air. The rounded or elongated-oval pollen grains are between 10 and 100 µm in size, depending on their origins. The surface configuration is in most cases specific to the species concerned (bulges, cones, spines, etc.).

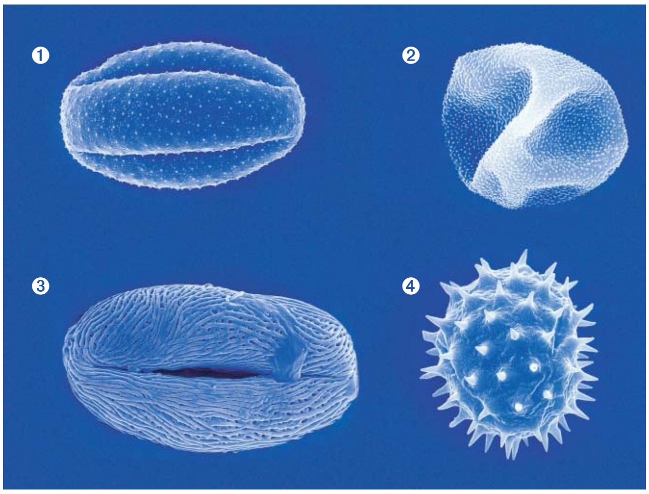


Fig. 2 SEM-pictures of pollens
(1) Ribwort, (2) Stinging nettle, (3) Thistle, (4) Sunflower

Besides these mostly supraregional instances of air pollution factors, the dust situation directly at a paint-spray cabin's location is likewise of major significance. Dust emitters in the direct vicinity may, if the wind direction is conducive, increase the air pollution many times over.

In view of all these multifaceted influencing variables, it's understandable that only a meticulously planned filter concept is able to ensure that even in critical dust situations paint-spraying can proceed with flawless results.

Requirements for intake air filtration

In order to reliably prevent dust and fiber particles penetrating through the air path as far as the paint-spray zone and causing paintwork defects, the intake air has to be filtered in at least two stages (prefiltration, ceiling filtration), both out of cost-efficiency considerations and for safety reasons.

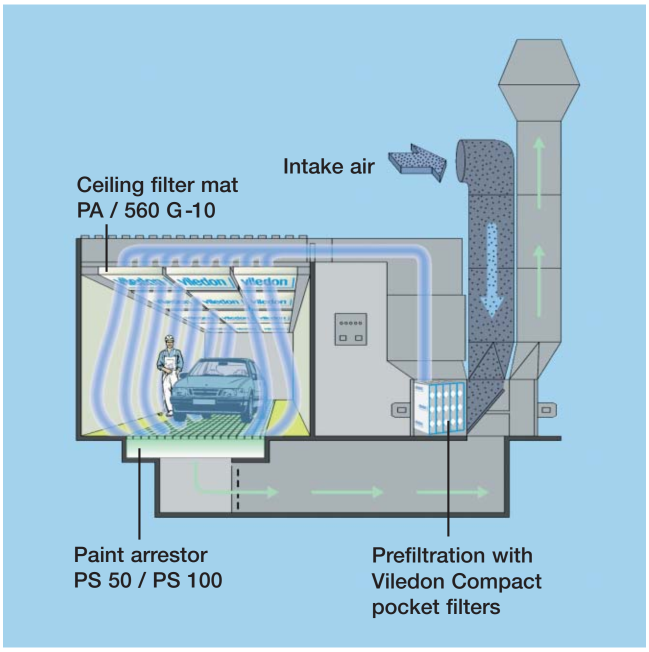


Fig. 3 Schematic depiction of a repair cabin

Prefiltration

The job of the prefilter stage is to arrest the main proportion of the dust. The air ducts are thus almost totally protected against soiling and the useful lifetime of the ceiling filter installed in the cabin (fine filter) is extended.

Cut-to-size filter mats are frequently used for prefiltration: they are inserted in a mounting frame, which is mostly constructed in a corrugated or zigzag configuration, thus increasing the filtering area while at the same time ensuring conveniently compact dimensions. This design has proved a commendably cost-effective solution when using Viledon filter mats of Filter Class G3, e.g. PSB/275 S or G4, e.g. P15/500 S. The Viledon filter mats are made of synthetic-organic, progressively structured, high-performance nonwovens.

Progressive structure means that layers of fibers are arranged one behind the other so as to create a uniform decrease in porosity towards the clean-gas side, thus achieving maximized arrestance of deleterious particles together with a favorable pressure drop characteristic and a high dust storage capacity.

In newly designed paint-spray cabins, pocket filters are increasingly preferred in the prefilter stage. Compared to the filter mats, the pocket filters possess a significantly greater filtering area, with a correspondingly higher dust storage capacity and thus an extended operational lifetime. So the use of pocket filters may significantly prolong the replacement intervals, with concomitantly favorable effects on maintenance and filter replacement costs. For prefiltration, pocket filters of Filter Class G3, e.g. Viledon Compact G 35 S or G4, e.g. Viledon Compact F 45 S, are recommended.

The Viledon pocket filters are made of synthetic-organic, high-performance, progressively structured nonwovens. The pockets are welded in a leakproof configuration, and foam-sealed into a plastic frame. The inherent stability of the filter pockets prevents the pockets from kinking when exposed to alternating loads, which would permit dust particles already arrested to break through. Downstream units are thus effectively protected against soiling.

All filter mats or pocket filters used in the prefiltration stage should have been type-tested to EN 779. This means that the filter manufacturer undertakes to produce and supply the air filter products in a consistent quality conforming to the test certificate concerned.

Fig. 4 Viledon filter mat P 15/500 S and Viledon Compact pocket filter F 45 S

Ceiling filtration

By reason of its direct proximity to the object being paint-sprayed, the ceiling filter in the cabin is of crucial importance for an optimum filtration process. Basically, it has two jobs to do:

- Fine filtration of the intake air already precleaned in the prefilters. This means dependable arrestance and permanent retention of dust particles that have passed through the prefilter and that by reason of their size and structure might cause damage to the paintwork.

- Uniform air distribution and air routing inside the paint-spray cabin. This means assuring maximally turbulence-free ventilation with the aim of achieving a smooth flow of filtered air around the object being paint-sprayed.

In paint-spray cabins, Viledon ceiling filters of Filter Class F5, e.g. PA/500-10, PA/560 G-10 or Filter Class F6, e.g. PA-5 micron have become the state of the art, by virtue of their reliability and cost-efficiency. They are made of synthetic-organic fibers, and are progressively structured in order to optimize their dust storage capacity and collection efficiency.

Fig. 5 Viledon ceiling filter PA–5 micron

The permanent retention of dust particles already arrested over the entire operating period necessitates a special finish for the ceiling filter. It is not sufficient merely to spray the outer surface of a ceiling filter with an adhesive substance. Due to the low penetration depth achieved by the spray process, these fiber layers possess merely a slight dust bonding capacity. After only a relatively short time, this will already be saturated with dust particles and pourable coarse dust will be able to make its way through the filter medium unimpeded.

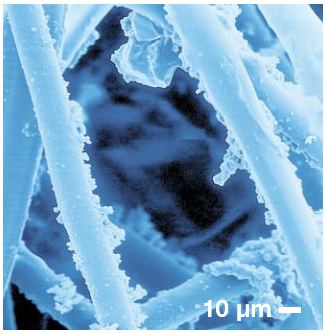


Fig. 6 Fibers with an actively adhesive finish, showing the retained particles

The most effective, though also more elaborate finishing method utilizes an impregnation process. This ensures that each individual fiber receives an actively adhesive finish, thus achieving maximized dust bonding capacity, which ensures the high level of dependability so essential for the paint-spray process.

For dependable and cost-efficient design of the ceiling filtration system, a limit particle size has to be defined. This is the particle size as from which visible surface defects and the necessity for reworking have to be anticipated. From long years of mutual feedback with users, paint suppliers and paint-spray cabin manufacturers, plus analysis of numerous paint sample sheets, it is known that in dependence on the paint-spray system being used particles above a size of 10 or 5 µm lead to visible paintwork inclusions.

For this reason, the filters installed in the ceiling of a paint-spray cabin have to ensure practically 100-per-cent arrestance of these particle sizes. While the two Viledon ceiling filters PA/500-10 and PA/560 G-10 (F5) assure this for the 10-µm particles, practically 100 % of the particles 5 µm in size are arrested by the Viledon PA -5 micron (F6). The Viledon migration test has been developed specifically to enable the filter's performance to be verified.

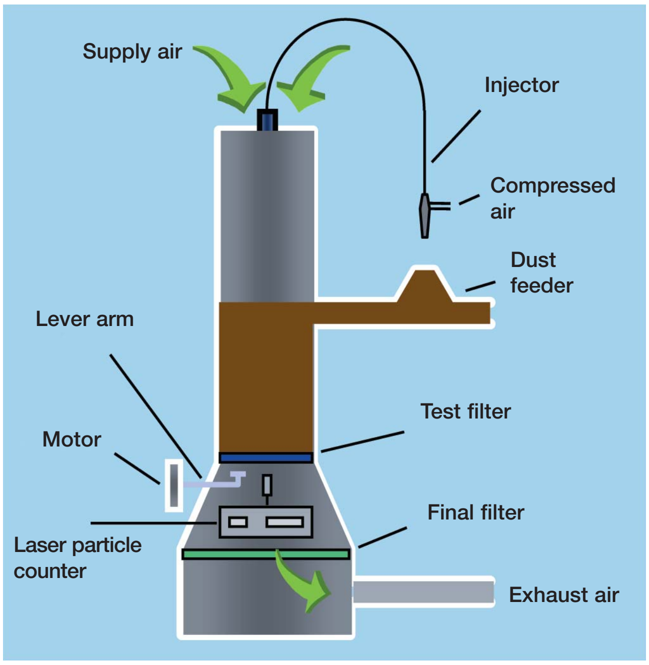


Fig. 7 Filter test rig for the migration test

The Viledon migration test

In paint-spray cabins, the ceiling filters are continually subjected to alternating loads caused by the continuous vibration of the system involved, which tends to encourage detachment of the arrested dust from the filter.

The test conducted in conformity with EN 779 does not permit the filter medium to be assessed in terms of its specific suitability as a ceiling filter in a paint-spray cabin. This is primarily due to the fact that the synthetic test dust specified in the above standard constitutes an extremely adhesive variety of dust, by reason of its soot content (23 %). This means that transmigration of dust particles can be practically ruled out from the start.

For the laboratory test, it is therefore essential to use a test dust that is not only non-adhesive but also lies within the relevant grain size range. One particularly suitable choice is a standardized dust consisting of aluminum oxide and used for manufacturing abrasive materials. Depending on the type involved (coarse, fine), the grain size range lies between 10 and 35 µm or 2 and 13 µm.

In the actual filter test rig, the filter under test is installed horizontally, as in normal operation, and exposed to the dust. The dust concentration lies at approx. 18 mg/m^3 and thus by a factor of about 500 to 1,000 above the values actually encountered in practice. This ensures that a sufficient number of particles are present on the raw-gas side to enable the filter medium concerned to be reliably assessed in terms of its collection efficiency. Mechanical vibrations affecting the filter medium, like those acting on the filter ceiling in actual operation, for example, are simulated by a motor-driven lever arm mounted on the bottom of the filter under test. The number of particles penetrating through the filter medium is determined by means of a particle counter.

In order to obtain optimum paintwork results, the filter material to be installed in the ceiling of a paint-spray cabin has to achieve the Migration Test Class of SO; this means that in

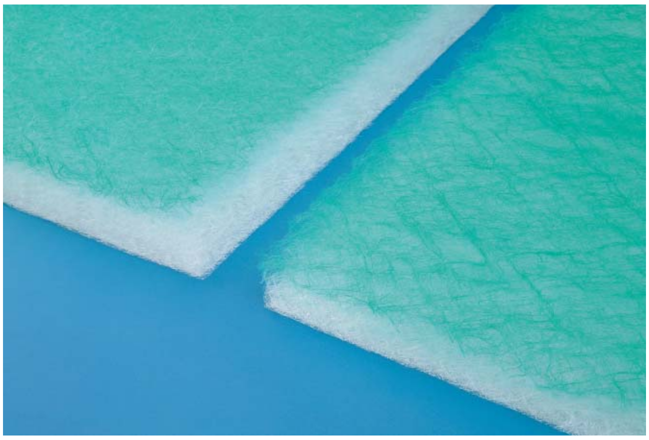


Fig. 8 Viledon paint mist arrestor PS 50 / PS 100

the migration test not more than 10 particles per m^3 of air with a particle diameter of > 10 µm may be found under the PA/560 G-10 filter. In the case of the PA–5 micron model, this limit value applies for particles of > 5 µm in size.

Exhaust air filtration

Top-quality filtration of the exhaust air from paint-spray cabins is handled by paint mist arrestors of the PS 50 and PS 100 types. The PS 100 model is particularly suitable for use in installations with heat recovery systems.

The paint mist arrestors consist of a flexibly elastic progressively structured glass-fiber medium, i.e. with an openly structured face side (green) and increasing fiber density towards the clean-air side (white).

The filters are non-flammable in conformity with DIN 4102.

To protect the units located downstream of the paint mist arrestor, we recommend installing an additional filter stage with pocket filters of Filter Class G3 or G4.

Viledon product overview

Prefiltration	Filter mat Filter mat Pocket filter Filter mat Filter mat Pocket filter	PSB/275 S P15/350 S G 35 S PSB/290 S P15/500 S F 45 S	G3 G3 G3 G4 G4 G4
Ceiling filtration	Filter mat Filter mat Filter mat	PA/500-10 PA/560 G-10 PA-5 micron	F5 F5 F6
Exhaust air filtration	Paint mist arrestor	PS 50, PS 100	

Further technological requirements for the filters

Besides its technical suitability, the filter system has to meet other requirements as well, in order to assure trouble-free operating characteristics and defect-free paintwork.

Temperature stability:
Up to a temperature of 100°C, the effect of the actively adhesive finish must not be impaired (temperature peaks of up to max. 120°C).

Storage stability:
Even after several years of storage, unrestricted usability must be assured.

Resistance to solvents:
High concentrations of solvents (recirculated air mode in the drying process) must not adversely affect the arrestance characteristics.

Absolutely siliconefree filter material (no craters)
Utilization or paint-job approval at automakers provides a guideline (even if different paint-spray systems are used in the repair zone).

Complete integration of the individual fibers in the fiber matrix of the filter material (no release of fibers).

Exclusive use of non-breaking, synthetic-organic fibers (no fiber breakage).

Technical hygiene-related requirements in conformity with VDI 6022
Under the requirements laid down in VDI 6022 part 3, the filters used must not act as nutrient mediums for microorganisms. In the guideline's sectorally specific requirements, filters of Filter Class G3 or G4 are recommended for repair cabins in the prefilter stage, and F 5 or F6 as ceiling filters.

Viledon filters for paint-spray cabins meet all these requirements and thus constitute an optimum filter concept for maximized paintwork quality.

Our explicit written confirmation is always required for the correctness and applicability of the information involved in any particular case. Issued: November 2004

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