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Automotive trends: Cabin air filter demands

Dr.-Ing. Heinz Reinhardt,
Freudenberg Filtration Technologies KG, Weinheim

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Introduction

To understand the market demands for cabin air filters requires more than a product-related approach alone. A successful company must also understand the market and its needs, together with its own position in the marketplace. Freudenberg Filtration Technologies' Dr. Heinz Reinhardt examines the OEM, OES and IAM cabin air filter segments, and introduces olfactometric testing, which could give car buyers useful information about the effectiveness of cabin air filters.

Technically oriented people often talk of market demands in terms of the required technical performance of products, as well as the need to reach certain goals defined in specifications and standards etc. Marketing people on the other hand think of customer needs, markets (segmentation and growth), behaviour of market participants as well as distribution, communication and – last but not least – pricing.

As the combined input of both groups is necessary to benefit customers, the analyses and actions of both groups must be taken into account to perform successfully in the marketplace.

Thinking about the market

An appropriate market definition is crucial for success as it determines the customer and his demands, as well as the needs of the supplier. In the case of cabin air filters, the passengers' demands inside the car must also be covered, which makes the cabin air filter different from other products in the automotive industry.

Another characteristic feature is that the product itself has to be changed regularly, independently of its technical performance.

In this environment Freudenberg defines itself as a "supplier of cabin air filter elements", providing all the necessary products and services worldwide, and defines the market segments it wants to cover as OEM (Original Equipment Manufacturers) and Aftermarket, with the two segments OES (Original Equipment Service) and IAM (Independent Aftermarket).

Trends in the OEM marketplace

The OEM market consists of the vehicle manufacturers installing cabin air filters into their air handling systems, and thus creating the 'market'.

Additionally, as cabin air filters are frequently installed in HVAC systems, these system manufacturers also play an important role as the product influences the performance of its HVAC systems.

The installation of cabin air filters is at a different stage of its lifecycle in the major car producing regions of the world. In the Americas and Asia the installation rate will increase in the future, and growth is assumed. This is not the case in Europe, where an installation rate of cabin air filters for cars of greater than 90 % has been reached.

The assumption of future growth in the OEM market outside Europe is based on socio-cultural trends, such as increased health awareness and comfort demands, together with the continuing growth of allergy-related health complaints.

Demand in this segment is created independently of the product by the major trends in the automotive industry. These are currently:

- Consolidation of vehicle manufacturers and first tier suppliers – today there are only six major HVAC manufacturers worldwide;
- The strategy of the most important vehicle manufacturers to think globally and react to local market demands at the same time, together with a platform strategy that enables them to do this – for example, the largest platform equipped with cabin air filters is Volkswagen (VW)'s PQ35/PQ46 platform. It comprises VW, Audi, Seat and Skoda cars. It started in 2003 with a need for 0.5 million filters per year. This number is scheduled to rise to 2.5 million filters per year in Europe by 2007, when all platform cars will be built. There was tremendous price pressure on this project; the vehicle manufacturers and the first tier suppliers used their purchase power to put pressure on the filter manufacturers;
- The need for "local content", enhanced by the platform-strategy for reasons of security of supply, and because of political issues – for example it is advantageous if filters are produced in the countries where the platform cars are manufactured;
- The shortening of development cycles leading to shortened reaction times;
- The demand for continuous improvement in supply chain management;

All of these demands have to be taken in context with the tools available to the purchase departments – such as "global sourcing" and "reverse auctions".

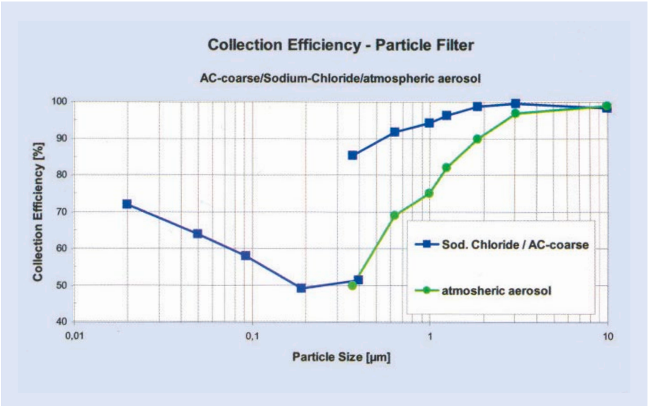

Figure 1: Particle collection efficiency results with different test aerosols

In research carried out, which asked OEMs what they most demanded of suppliers, the emphasis was on product quality, response times, and the adherence to delivery dates.

The importance of "product innovation" only becomes more important when talking to staff in development and marketing roles.

The aftermarket

In Europe about 14 million cars per year are equipped with a cabin air filter, and indeed since 1989 about 115 million cars have been equipped.

In a mature filtration market such as that of engine filters, more than 80 % – 90 % of the whole market volume comes from the aftermarket. These amounts have not yet been reached for the installation of cabin air filters, but with the increasing average age of cars in Europe (e.g. in Germany – from 6.3 years in 1992 to 7.6 years in 2004) more cars on the road for longer potentially gives more opportunities for aftermarket suppliers of equipment.

However, this is countered by the fact that the service intervals for cars are also constantly increasing. For example, at the beginning of the 1990s, the aim was to exchange cabin air filters every 15,000 km. Today this has risen to 30,000 – 40,000 km, and suppliers are faced with demands of up to 60,000 km.

This demand is understandable from the overall strategic viewpoint of the OEMs, but could lead to cabin air filter lifetimes of more than three – four years. In contrast, a VDI (Verein Deutscher Ingenieure) working group recommended that for reasons of hygiene, a service time of two years should not be exceeded*.

The aftermarket consists of all the distribution channels, which are used to supply the service parts to the end users – the car drivers themselves. It includes service centres belonging to vehicle manufacturers (OES) as well as the distribution channels acting independently of the vehicle manufactures (IAM). Distribution via the internet does not play a major role at the moment.

Whereas OES organisations market the service parts of their respective OEM – and thus are closely linked to the organisation – IAMs market a defined product range of several OEMs, partly under its own label.

Like OEM/OES, IAM is undergoing a period of consolidation Europe-wide. The main driver of this consolidation is the centralisation of marketing and sales functions, in order to strengthen market- and purchasing power.

The IAM in Europe is determined by its regional diversification in attitude and structure. Specific national and local characteristics must be taken into account. Filter manufacturers of engine filters with well established distribution networks play an important role in this market segment.

With the revised EU Block Exemption Rules* aiming at the deregulation of the automotive market, the competition between OES and IAM segments has intensified. The vehicle manufacturers now have extended warranty periods, improved service (through better training of personnel), better equipment, they have introduced logistical systems to bind dealers, and they have improved bonus systems. In addition, the increased use of electronics in cars with the decreased serviceability required (without the need for special equipment) is seen as a powerful additional means to retain and grow market share.

According to the same research mentioned earlier, the most important performance criteria that suppliers have to fulfil for the OES segment are price-performance ratio, product quality and the adherence to delivery dates. With OES, other criteria (such as order processing, technical service etc) do not play such an important role as the same survey aimed at the OEM segment found. In OES, product innovations are important for two out of three respondents questioned.

There may be an option for the installation of specifically designed filters for specific groups, like allergy sufferers who may be keen to be in vehicles that have filters with increased particle filtration efficiency – at the cost of decreased adsorption efficiency and filter lifetime – compared to the "standard filter" installed by the OEM.

Performance setting and control

The performance of a cabin air filter is defined individually by every vehicle manufacturer, in specifications for filter media and the filter element for a defined project. There is no "legal prescription" whatsoever for the requested performance of a cabin air filter, as it is not a security item. The test standards for assessing the particle filter performance and the adsorption performance specify a test method but not a performance needed. That is why we can find filters – especially in the IAM – with very poor filtration efficiency.

Existing standards around the world are not identical. In Europe, for example, cabin air filters are tested in most cases according to DIN 71460 parts 1* and 2* respectively; in the USA according to ISO/TX 11 155*; and in Japan with test aerosols according to JIS Z 8901* for particle filters, and DIN 71460 part 2 for combination filters. A test rig according to DIN 71460 parts 1 and 2 is currently being built up at a test centre in Korea, which will act as a reliability centre for cabin air filters.

All these test methods are suitable for the standardised comparison of filter performance only. They can be regarded as a first means with which to differentiate between the qualities of different filters under standardised laboratory conditions. They have to be performed, but they do not reflect the filter's performance under realistic conditions i. e. they are not suitable for testing the filter's ability to improve comfort and wellbeing in the passenger cabin. That is why additional tests need to be carried out, to evaluate the filter under real-life conditions.

Real-life conditions

In Europe the total concentration of man-made particles in the air expressed by the PM10 value has diminished. On the other hand the number of fine particles in the air (expressed by the PM 2.5 value) has increased, though dust removal in industry has been greatly improved over the years and the EEC directives for engines has resulted in less emission per car. The naturally occurring particles – i. e. pollen, microorganisms, dusts from soil etc. – can be regarded as unchanged.

In the field of gaseous components a decrease in VOCs and SO_2 emissions has been reported, with increases in NOx and periodical increases in ozone.

Developments in filter testing

Filter testing of cabin air filters must be developed with the aim of giving more assistance to development engineers, marketing people, not to mention the end user who ultimately chooses a filter.

On the particle filter side, dusts with particle sizes relevant for health should be used for testing. Standardised tests methods should still be applied to analyse and optimise the adsorption of any particular gaseous component like NOx, VOC and others. Additionally, gaseous substances should be tested in "real-life" environments – such as concentration in the low ppm or ppb range – as this is necessary to answer questions of "breakthrough" and desorption behaviour, as well as give realistic measures as to the lifetime of cabin filters.

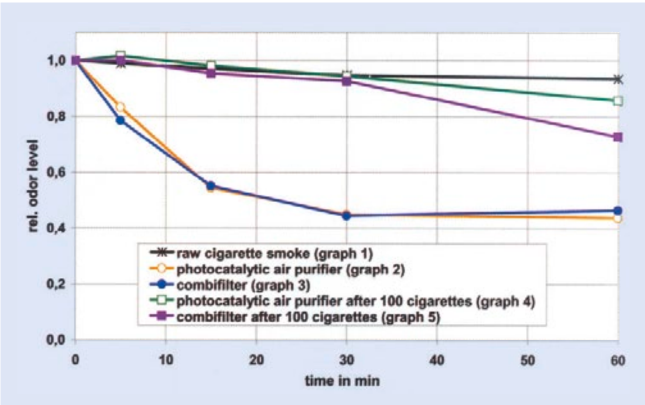

Figure 2: Initial and long-time odour removal efficiency of different equipment

Case study: Olfactometric testing in the field

A new tool for testing cabin air filters is the use of olfactometric measurements following DIN 13725* and VDI 3882, part 1*. Using these methods, an objective picture of odour perception can be achieved. It gives additional end-user related information and can be regarded as a means to get objective results on the comfort and wellbeing of a passenger in a car. It can be combined with the evaluation of samples from the laboratory and the field, and can be applied to many real-life problems such as:

- Odour removal efficiency for different odours and odour mixtures;
- Desorption of odours
- Evaluation of different adsorbents and equipment against odours

Particle collection efficiency results with different test aerosols

Figure 1 shows the fractional collection efficiency with different test aerosols, measured with the same filter element under comparable conditions. It can clearly be seen that a large difference exists depending on the test aerosols used. This result provides important information, as a proportion of these particles stay in the lungs for longer, and can even enter the blood circulation. As a consequence, carcinogenic and inflammatory reactions such as asthma may arise. It is therefore necessary to use filters with a high fractional efficiency in this particle range.

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Olfactometric results of odour removal efficiency measurements

There are air purifiers on the market using active air treatment processes such as UV irradiation – or UV photocatalysis – for reducing odours.

In two olfactometric measurement series', the initial efficiency and the long-time efficiency of a commercially available photocatalytic air purifier (consisting of a HEPA filter and UV irradiation plus a TiO_2 catalyst) was tested and compared to a standard micronAir® combifilter

The test was performed in a 1 m^3 test chamber with cigarette smoke as the test aerosol. The results are shown in figure 2. In order to evaluate the initial performance, one cigarette the initial performance, one cigarette was burnt; samples of the air were taken afterwards at certain intervals and given to an olfactometric test panel, consisting of four people. They determined the odour perceived at every sample taken. The results for this "raw cigarette smoke" measurement are plotted in graph 1 in figure 6, expressed as "relative odour level".

The relative odour level compares the odour perceived at the beginning of the test, to the odour perceived at the time the sample was taken. A decrease to 40 % (80 %) means a decline of odour achieved by the element under test to 12 % (30 %) of the odour perceived, when compared with the scenario without the odour-reducing element.

The odour perception of the "raw cigarette smoke" stayed almost constant for all samples taken during the full 60 minutes of the test. Nearly the same odour reduction in magnitude and decline could be fond for the photocatalytic air purifier (graph 2) and the combination filter (graph 3). Both reached a relative odour level of 0.41 – 0.43, for samples taken 60 minutes after the cigarette was burned down.

In order to evaluate the long-time efficiency of both options, 100 cigarettes were initially burnt down in the test chamber. The chamber initially contained the combifilter alone, then the photocatalytic unit was added, and air was sucked through the system. Then the chamber was cleaned and another cigarette was burnt down, and the measurement procedure repeated as previously.

The results are shown as graphs 4 and 5, figure 2. With the samples taken after 30 minutes and earlier, only a minor odour reduction could be detected, whereas after 60 minutes better values were obtained for the odour reduction of the combination filter, compared to the photocatalytic unit. Additionally, the long-time efficiency diminished when compared with the initial efficiency in both cases.

The initial efficiency of a second module that was tested in the same way is shown in figure 3. This module was a less sophisticated prototype containing only UV irradiation and les efficient filter elements. It can be seen that UV irradiation alone, and also when installed with the particle filter, could not efficiently reduce the cigarette smoke odour. A fair efficiency is achieved with the combination filter plus UV irradiation.

If we analyse and compare the results of figures 2 and 3, while taking into account the results of other measurements performed*, it can be said that olfactometry is a valuable tool to demonstrate differences in the odour reduction of different equipment available on the evaluation of the performance of air handling equipment against odours.

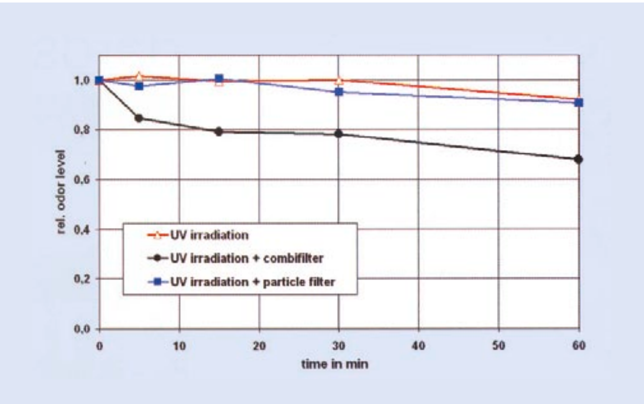

Figure 3: Odour removal efficiency of an air purifier for re-circulated air

■ Conclusion

In cabin air filtration, the car passenger is ultimately the customer. He must be given realistic information that can be used and understood. The benefit expected from the installation of a cabin air filter in a car needs to be communicated via development engineers and marketing people in the OEM and aftermarket organisations.

Today, standardised test methods are used to evaluate cabin air filters. Additionally, methods providing information – that is easy to understand for the passenger and easy to communicate to the marketing staff – must be introduced.

Results of olfactometric tests are a useful tool to create such information. The benefit for the passenger can be proven, and this benefit can also be experienced. This tool should therefore be used systematically for the evaluation of the performance of cabin air filters.

*For references please contact the editor.

[Note: The figures given in the graphs are mean values with tolerances entailed by the customary production fluctuations. The explicit written confirmation of Freudenberg Filtration Technologies is always required for the correctness and applicability of the information involved in any particular case.
This paper was first given at Filtrex 2004 (organised by EDANA.)]

■ About the Author

Dr.-Ing. Heinz Reinhardt is currently Head of Application Engineering Automotive Filters at Freudenberg Filtration Technologies. He was worked at the company since 1980, after completing a study and thesis on Air Purification at the Technical University of Karlsruhe.
heinz.reinhardt@freudenberg-filter.com

Freudenberg Filtration Technologies KG
69465 Weinheim (Germany)
Phone +49 (0) 6201 80-6106 | Fax +49 (0) 6201 88-6106
info@freudenberg-filter.com | www.freudenberg-filter.com