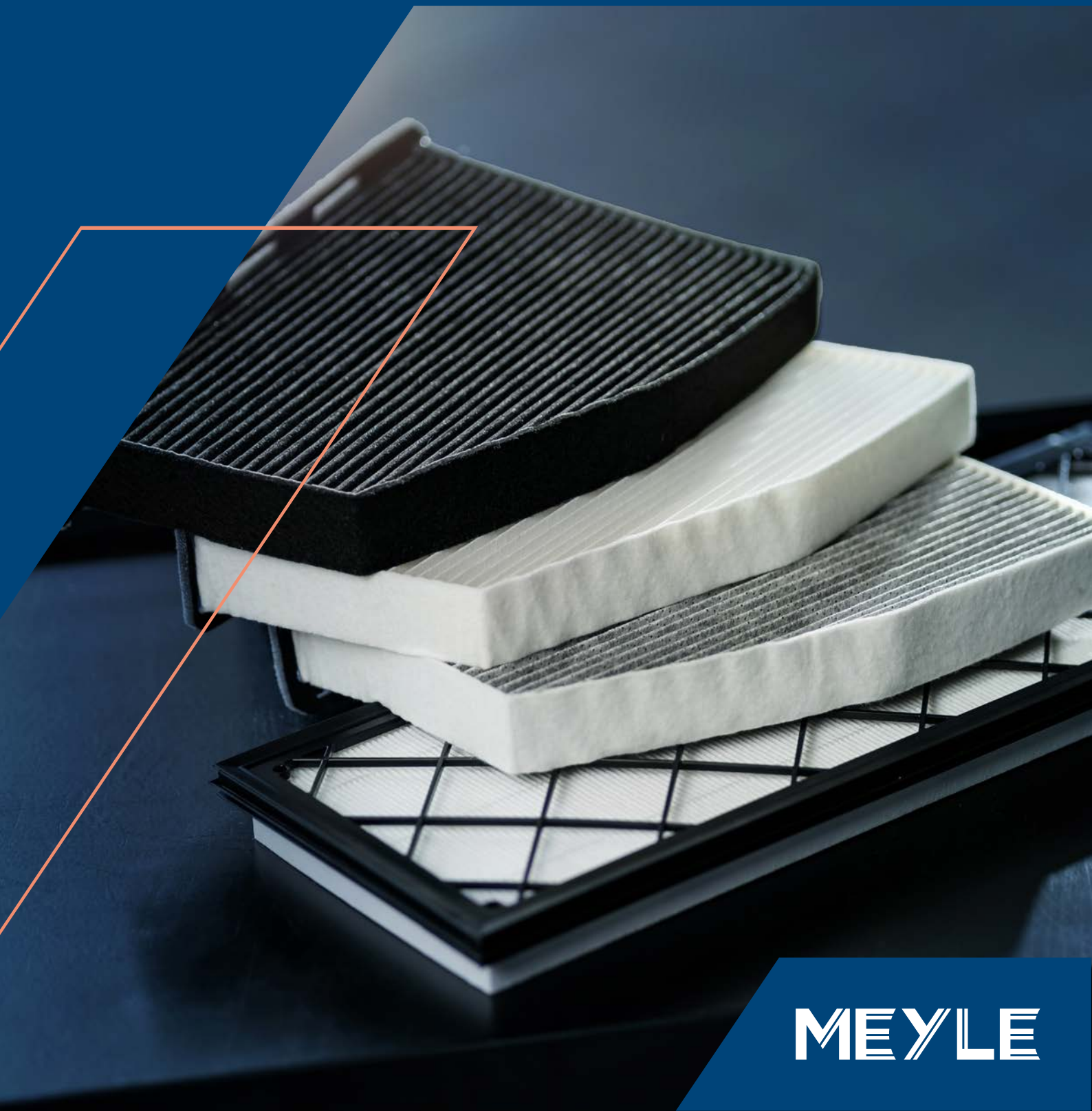
CABIN AIR FILTERS FOR CLEANER AIR IN PASSENGER CARS

PRINCIPLES, EXPERT KNOWLEDGE, PRACTICAL TIPS



MEYLE

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CHAPTER 1: INTRODUCTION

DEMAND FOR CLEAN AIR IS GROWING – EXPERT KNOWLEDGE ABOUT CABIN AIR FILTERS AND THEIR USE.

WHY IS THE DEMAND FOR HIGH-QUALITY VEHICLE CABIN FILTERS ON THE RISE, AND HOW CAN YOU BENEFIT FROM THIS DEMAND?

The focus turns to health and well-being:

More and more people are committed to making their daily lives healthier – in line with the motto 'Do something good for yourself!' Whether it's unprocessed foods, specific forms of exercise or a more sustainable approach to consumption, there's a growing focus on a healthy lifestyle. Even the quality of the air we breathe receives more attention these days. With increasing attention being paid to the quality of the air inside the car („the air inside the car tends to be much more polluted than outside"), the issue of cabin air filters is more important than ever. After all, every European spends an average of four years and one month of their life in their vehicle.

Everything you need to know – in an objective and practical form:

The aim of this white paper is to provide you with objective expert knowledge about cabin air filters. In addition to the sources, types and effects of air pollutants, here you will also find relevant information about the history, design and function of air filters.

Do something good and boost workshop success:

In-depth knowledge and skills associated with cabin air filters can provide passenger car workshops with the opportunity to expand their business, acquire new customers and improve their reputation as a well-informed expert in passenger cars. As you will learn in this white paper, the market offers a large, occasionally confusing variety of cabin air filters. We've put together selection criteria for you in a straightforward and easy-to-understand format, ensuring you can always find a suitable filter for your customers and process orders quickly and efficiently.

CHAPTER 2: AIR POLLUTANTS
CHAPTER 2.1: AIR POLLUTANTS – PRINCIPLES

FOR CLEAN AIR ACROSS THE BOARD – CABIN AIR FILTERS FOR PASSENGER CARS.

WHY HAVE CARS BEEN A PLACE WITH POOR AIR QUALITY UP UNTIL NOW, AND HOW CAN THIS BE EASILY CHANGED?

Clean air for well-being and health:

A pollutant-reduced air supply promotes attention and the ability to concentrate, whilst polluted air inside the vehicle can lead to fatigue, irritation and coughing. But clean air is no longer a given in many areas. Even spa towns prized for their clean, fresh air can be polluted with exhaust, fine dust and pollen. Many scientific studies now reveal how harmful frequent exposure to polluted air can be for your health. Even pollutant concentrations below the legal limits can lead to severe respiratory diseases and allergies – and in exceptional cases may even reduce life expectancy.

Safe at home – and in the car?

Those who value clean, pollutant-free breathing air for themselves and their loved ones may use a controlled ventilation system with pollutant filter and a vacuum that also purifies the air at home or a mobile air purifier at the workplace. But if there's no ventilation system with an effective cabin air filter in use on the drive to work, the shops or holiday destinations, you have to breathe in whatever's floating around, whether it's exhaust, fine dust or other pollutants. Without a suitable cabin air filter, the air inside the car is anything but clean. The Association of German Engineers (VDI) and Zentralverband Deutsches Kraftfahrzeuggewerbe (ZDK) have come to recognise the importance of this issue – much like users and vehicle manufacturers – and therefore defined hygiene guidelines for vehicle cabins in the VDI/ZDK 6032 standard in 2024.

More than four years of polluted air:

Every European spends an average of four years and one month of their life in the car – and therefore in an environment with highly polluted breathing air. (Source 11) That's because roads have very high pollutant concentrations these days due to the exhaust of internal combustion engines, brake and tyre abrasion, and other sources. There's also the fact that unfiltered air in the vehicle's passenger cabin has a much higher concentration of pollutants (Source 12) than the intake air from the immediate surroundings as a result of physical accumulation effects.

The car as an oasis of clean air:

Whether you're dealing with rush hour, traffic in the tunnel, a fine dust alert or simply pollen on a drive through the countryside, a high-quality cabin air filter is well worthwhile. Depending on the design and quality, the filter can effectively and safely remove just about any of the harmful substances described further below, regardless of how polluted the intake air is, and thus ensure optimal well-being for passengers.

CHAPTER 2.2: AIR POLLUTANTS – OVERVIEW

AIR POLLUTANTS DO NOT DISSIPATE.

WHERE DO POLLUTANTS LIKE FINE DUST AND NITROGEN OXIDES COME FROM, AND HOW HARMFUL ARE THEY?

Air pollutants can also come from natural sources:

There are two different sources of air pollutants: man-made (anthropogenic) and natural.

Man-made air pollution is largely the result of combustion processes in industrial systems, power plants and transportation, as well as agriculture. Fine dust, nitrogen dioxide, carbon monoxide, sulphur and chlorofluorocarbons (CFCs) are the most common of these undesirable pollutants.

Air pollution caused by nature has a variety of sources such as stirred-up desert dust, pollen, volcanic eruptions and forest and bush fires. If the released substances rise high enough into the atmosphere, they can cover greater distances and pollute the air, quite literally, on the other side of the world. For example, measuring stations run by the states and the German Environment Agency (UBA) often detect fine dust from the Sahara, far-off forest fires and volcanic ash even inside Germany (Source 1). Because people are not responsible for the air pollution resulting from natural events, it is not taken into account when established limits are exceeded, as prescribed by the European Union in Directive 2008/50/EC on ambient air quality (Source 2).

What that means: Whilst political measures can reduce anthropogenic pollutants, natural emissions can rarely be controlled and have a continuous impact on air quality. Despite all the air purity plans and other political efforts to reduce man-made air pollution, nature will continue to release pollutants unabated. It's therefore up to each individual to ensure their own protection and, for example, use air filters in their most important personal spaces – home, workplace and car.

CHAPTER 2.3: AIR POLLUTANTS – OFFICIAL 'AIR POLLUTERS'

LAWS DEFINE WHAT CONSTITUTES AIR POLLUTION.

WHAT SUBSTANCES POLLUTE THE AIR THE MOST, AND HOW HARMFUL ARE THEY TO OUR HEALTH?

The following substances are officially labelled 'air pollutants':

Fine dust (in particular, soot) comes from many different sources, including stirred-up desert dust, forest fires and volcanic eruptions, as well as agriculture, domestic fuel, internal combustion engines and brake and tyre abrasion. In urban areas, traffic is the largest source of fine dust. Depending on particle size and concentration, fine dust can be harmful to human health.

Carbon monoxide (CO) can be released through incomplete combustion – for example, in internal combustion engines, industrial systems and ovens powered by domestic fuel. The gas is toxic and has a suffocating effect on people and animals.

Nitrogen oxides (NOx) form during combustion processes, especially under high temperatures, and are a precursor to fine dust, which means the risk to health is immediate. Nitrogen oxide is also considered to be an indicator of other impurities. If it's detected, there's a high degree of probability that other typical air pollutants are present. That's why levels of NOx pollution in the air are measured in many areas, including in the national air quality monitoring network, with which government agencies continuously document air quality.

Volatile organic compounds and hydrocarbons often come from petrol, which evaporates in small amounts at petrol stations or leaks from poorly tuned car engines. Additional sources include solvents like paint. Exposed to sunlight, hydrocarbons and nitrogen oxides form photochemical smog, the main component of which forms harmful ozone.

Sulphur dioxide is produced in large quantities with the combustion of hard coal and lignite and in smaller amounts with the combustion of petroleum products. Unlike in the past, when most of the gas was simply released into the atmosphere, high-emission power plants and industrial facilities now filter out a majority of it.

Ammonia is toxic and primarily produced by livestock. Livestock excrement contains urea and protein, which together form ammonia.

Did you know?

Livestock farming is the largest source of the pungent-smelling gas in the Netherlands.

CHAPTER 2.4: AIR POLLUTANTS – RISKS TO HEALTH AND WELL-BEING

AIR POLLUTION CAN CAUSE ILLNESS.

WHAT EFFECT DOES POLLUTED BREATHING AIR HAVE ON PEOPLE, AND WHAT ARE SOME OF THE POTENTIAL CONSEQUENCES?

Fine dust: a health risk

Air pollution is considered to be one of the biggest health risks worldwide. According to WHO estimations, around seven million people die prematurely as a result of polluted air every year (10). Poor air quality not only compromises subjective well-being but can also have a negative impact on health and significantly reduce life expectancy. Children, the elderly and people with respiratory or heart conditions, in particular, are at risk. Air pollution comprises a mix of substances, which is why it's not always clear which substance is responsible for damaging health. But scientific studies do prove that fine dust, including soot particles, is the most toxic air pollutant (Source 17).

Limits do not protect against health risks:

Even if limits are not exceeded, it has been proven that children who are exposed to traffic-related air pollution develop lung function more slowly (Source3). Negative effects on infants were also proven in 2013 (Source 5). But air pollution can also impair the lung function of healthy adults – even in rural areas and with pollutant concentrations below the European standard (4). Simply put, European air quality directives do not ensure full protection from all the potential health effects of polluted air. In a study with mice, researchers were able to prove a direct link between relatively low fine dust pollution and arteriosclerosis (Source 13).

Short-term effects:

Exposure to highly polluted air can lead to coughing, wheezing, shortness of breath and eye irritation a short time later. If the air pollution dissipates, the symptoms will subside. But exposure to highly polluted air over a longer period of time could result in death. Those particularly at risk are the elderly and people who are already weakened due to heart or respiratory conditions. They die several days and even months earlier than they would if they had been exposed to clean air, which is also backed by statistics. The death rate can increase during or shortly after a period of heavy air pollution (Sources 14 and 15). On the other hand, healthy people are unlikely to succumb to the short-term effects of air pollution.

Long-term effects:

Those who are exposed to polluted air over a period of many years are at risk of long-term effects such as worsening asthma, chronic bronchitis and cardiovascular diseases. Over the long term, air pollution can also lead to vasoconstriction, blood clotting disorders, and cardiac arrhythmias.

CHAPTER 3: CABIN AIR FILTERS
CHAPTER 3.1: CABIN AIR FILTERS – DEFINITION AND HISTORY

DEVELOPED TO PROTECT BREATHING.

HOW LONG HAVE AIR FILTERS FOR THE VEHICLE CABIN BEEN AROUND, AND WHY WERE THEY DEVELOPED?

Once unheard of, now a standard:

Cabin air filters are a component of the ventilation and climate control system of modern vehicles. Also known as pollen filters, they can free intake air of particles, pollutants and odours – provided they're installed correctly and replaced as required. Developed by Saab in the 1970s, the first models were primarily used in the Saab 900 Turbo series.

Poor air quality as a good reason:

In 2001, a Danish study (Ssource 8) found that the concentration of pollutants inside the passenger space is four times higher than in the area surrounding the vehicle, which is one of the factors that contributed to the demand for filters. The physical explanation is that the air drawn into the vehicle cabin circulates, increasing the pollutant concentration over the duration of the drive. Nevertheless, cabin air filters only hit the scene in the 1990s – more than a hundred years after the invention of the automobile – and are now a standard feature in just about every modern vehicle.

CHAPTER 3.2: TYPES OF CABIN AIR FILTERS – DESIGN AND FUNCTION

A GOOD THING CONTINUES TO IMPROVE TO THIS DAY.

HOW ARE CABIN AIR FILTERS DESIGNED, HOW DO THEY WORK, AND HOW DO THEY DIFFER?

Since they were first invented, cabin air filters have continued to develop and improve. The first models could only remove particles (fine dust) using the coffee filter principle. Thanks to technological progress, more and more functions have been added over time, making it possible to filter additional pollutants from the air. But one thing has remained the same. The design of conventional cabin air filters follows the principle of simple, single-stage particle filters. In contrast, modern filters have additional filter stages.

Particle filter – the base for fine dust:

For particle filters, a plastic or textile frame with a pleated fleece serves as the filter medium. The fleece generally comprises a special polymer featuring a structure that allows it to capture dust and soot particles from the air flowing through. The level of quality is dependent on the density of the fibres. The finer the openings are, the more effective the filter is, as more particles can stick to the fleece. However, every filter slows the airflow produced by the fan, resulting in a loss of pressure, which is why the fleece can only be so fine.

AN OVERVIEW OF PARTICLE FILTERS:

- Function: filters pollen, dirt, particles, dust, fine dust and soot
- Filtration performance: > 10 µm
- Features: robust, durable and economical

Activated carbon filters/combination filters – also eliminate harmful gases:

Simple particle filters began developing into combination filters in the 1990s. This type of filter features an additional layer of activated carbon applied to the filter fleece and can therefore capture particles as well as odours and harmful gases. What makes this possible is the highly porous structure with interconnected pores of activated carbon, which resemble the structure of a sponge. At approximately 2,000 square metres per gram of activated carbon, the inner surface is enormous in relationship to the total volume. As a result, the inner surface of four grams roughly corresponds to the surface of a football pitch. The layer of activated carbon is positioned on the side of the filter facing the vehicle cabin. The pre-filter layer removes the relatively large dust and soot particles from the intake air, allowing the fine pores of the activated-carbon layer to capture odours and harmful gases in particular. In this way, the layer of activated carbon serves as an adsorbent material, binding carbon monoxide (CO), nitrogen oxides (NOx), ozone, unpleasant odours and more. The activated carbon will also capture any especially small particles of fine dust that pass through the fleece. It's also worth mentioning that there are significant differences in the types of activated carbon, which have an impact on filter quality. The surface structure of activated carbon is dependent on its origin. Coconut fibre carbon, for example, has a larger surface structure than hard coal, lignite and charcoal – and can absorb a high volume of iodine and thus more organic compounds. This premium carbon is therefore also used in high-quality activated carbon filters.

AN OVERVIEW OF ACTIVATED CARBON FILTERS:

- Function: filters pollen, dirt, particles, dust, fine dust and soot, binds gases like ozone, nitrogen and sulphur dioxide, and reduces odours
- Filtration performance: > 2.5 µm
- Features: robust and durable, with coverage of a wide range of pollutants

Activated carbon filter with coating (biofunctional activated carbon filter) – also protects against bacteria, fungal spores and allergens:

Activated carbon filters with antibacterial effect feature an additional layer of filter impregnated with an antibacterial substance, ensuring that bacteria, mould and allergens cannot collect or form on the filter surface. The impregnation usually comprises natural active substances such as silver ions and polyphenols (a chemical compound that forms in plants).

AN OVERVIEW OF BIOFUNCTIONAL CARBON FILTERS WITH COATING:

- Function: filters pollen, dirt, particles, dust, fine dust and soot, binds gases like ozone, nitrogen and sulphur dioxide, reduces odours and protects against microorganisms and the development of bacteria, fungi and mould
- Filtration performance: > 0.1 µm
- Features: robust, with coverage of a wide range of pollutants as well as biogenic pollutants

Activated carbon filter with NOx adsorption effect (MEYLE PD activated carbon filter) – permanently binds nitrogen oxides:

Activated carbon can adsorb (trap) harmful nitrogen oxides (NOx). However, there is a catch. Conventional cabin air filters featuring activated carbon release the captured NOx the moment clean air flows through the filter. If the car passes through an area polluted with nitrogen oxides, the pollutant is effectively filtered from the cabin air. But once the vehicle reaches an area largely free of NOx, the nitrogen oxides are released again and enter the vehicle cabin unchecked. The solution for this undesirable phenomenon is activated carbon filters with a special coating by MEYLE. Unlike simple cabin air filters with activated carbon, they bind NOx as a chemical salt compound. Even if the filter is disposed of in a waste incineration plant, the salt breaks down into harmless base substances – the harmful NOx is not released again and is permanently removed from the air. Incidentally, there's just one cabin air filter with this important feature: the MEYLE PD cabin air filter.

AN OVERVIEW OF MEYLE PD CABIN AIR FILTERS WITH NOX ADSORPTION EFFECT:

- Function: filters pollen, dirt, particles, dust, fine dust and soot, binds gases like ozone, nitrogen and sulphur dioxide, reduces odours and protects against microorganisms and the development of bacteria, fungi and mould. It also improves removal of fine dust and adsorption and offers chemical binding of NOx
- Filtration performance: > 2.5 µm
- Features: robust, with coverage of a wide range of pollutants, permanently captures NOx

TIPS AND ARGUMENTS FOR WORKSHOPS:

- High-quality filters even absorb microparticles less than 0.1 µm in size. For comparison, a human hair is around 70 µm thick.
- Explain to your customers that cabin air filters come in different quality and price levels: basic, medium and premium filters.
- Installation costs are much the same for all the filters. In other words, it doesn't cost 'a whole lot more' to install a premium filter.
- High-quality filters are simple to install, as the edges of the fleece don't bend, for example.
- Use the convenient MEYLE cabin air filter poster in your customer consultations.
- During the consultation, mention local air pollution ('Diesel lorries pollute the air on our urban motorway all day').

CHAPTER 4: MAINTENANCE AND REPLACEMENT GUIDELINES
CHAPTER 4.1: MAINTENANCE INTERVALS SHOULD BE OBSERVED

BETTER EARLY THAN TOO LATE.

HOW OFTEN SHOULD CABIN AIR FILTERS BE REPLACED, AND WHY IS IT IMPORTANT TO REPLACE THEM ON TIME?

New filters are better at purifying the air:

Modern vehicles direct around 500,000 litres of outside air into the cabin per hour. Cabin air filters remove dirt particles, pollutants and germs from this air and store them inside. But because absorption capacity is limited, filters should be replaced when they're 'full' at the latest. Otherwise, they can no longer fulfil their duty, which is to purify the air, and thus prevent the supply of fresh air.

Like seasonal tyre changes, twice a year:

Cabin air filters should always be replaced at the intervals defined by the manufacturer. But automotive experts also recommend replacing filters at least once a year or every 15,000 km. Replacing the cabin air filters twice a year is a good idea and will ensure pollutant-free breathing air at all times. Conveniently, this can be done when switching between summer and winter tyres. If the vehicle is frequently used in areas with especially high air pollution, it may be a good idea to replace filters more often. If in doubt, you can always ask an automotive specialist to check whether the filter is already saturated or safe for continued use. The manufacturer's replacement intervals should never be exceeded.

TIPS AND ARGUMENTS FOR WORKSHOPS:

- Cabin air filters should be replaced at least once a year or every 15,000 km.
- It would be even better to replace the filter when switching between summer and winter tyres (spring and autumn).
- Offer to replace the filter when doing any other maintenance work or repairs for your customers.
- Inform your customers of the benefits of high-quality combination filters ('Unlike simple fine dust filters, they also remove odours, toxic gases and even some bacteria').

CHAPTER 4.2: FILTER REPLACEMENT – PRACTICAL TIPS

IF DONE PROPERLY, IT JUST WORKS.

WHAT DESIGN-RELATED PITFALLS COULD YOU ENCOUNTER WHEN REPLACING THE FILTER, AND WHAT DO YOU NEED TO CONSIDER GENERALLY SPEAKING?

The cabin air filter can be installed at different locations:

The location of the cabin air filter is different for every type of vehicle and can be the engine compartment near the windscreen wiper, under the glove box or in the footwell behind the centre tunnel. Depending on the vehicle, more or fewer components will need to be removed for filter replacement, meaning the degree of difficulty can vary. The designers of the Ford Focus and Mondeo chose an especially clever location for installation. To change the filter, the accelerator has to be removed. Consult the manufacturer's documents or do some research online to determine where exactly the filter is located inside the vehicle.

The easiest rule is the most important:

The airflow of every multistage filter is 'from course to fine'. A coarse-stage paper filter first removes the largest particles like dust and pollen from the intake air, whilst additional stages refine filtration, capturing spores and bacteria. This universal filter principle means that every air filter has two sides that have to correspond to the flow of air once installed and must not be switched. If the filter were installed facing the wrong way, it would quickly clog and no longer be able to fulfil its purpose. But experience shows that around one in three cabin air filters is installed the wrong way round.

It all comes down to proper installation:

When installed, the new filter needs to be inserted precisely and securely into the mount and sit properly, as improper installation could result in the air bypassing the filter and entering the vehicle unfiltered. High-quality filters feature special edges made of fleece rather than cardboard and therefore function much like a reliable seal.

Cleaning the evaporator:

An important detail of proper filter replacement is often overlooked: cleaning and disinfecting the climate control system evaporator, which is located behind the cabin air filter and therefore on the 'clean side' of the air duct. Mould and bacterial films can develop on the evaporator due to the formation of condensation on the surface, releasing germs into the already filtered air and thus inhibiting the filtration effect. To eliminate this source of pollution, it's important to disinfect the evaporator and the connected air duct when replacing the filter. Specialist shops offer many easy-to-use solutions such as active foam, rinses and aerosols.

TIPS AND ARGUMENTS FOR WORKSHOPS:

- One in three cabin air filters is installed the wrong way round. Inform your technicians of proper installation.
- 'An improperly installed filter can quickly lead to failure and result in unnecessary costs.'

CHAPTER 5: CONCLUSIONS

WHAT FUTURE PROSPECTS DO CABIN AIR FILTERS HAVE, AND WHO CAN BENEFIT FROM THEM?

Unsurpassed purity:

The trend of clean breathing air will continue into the future – around the world. And even as more and more sources of emissions such as coal-fired power plants and old diesel engines are eliminated over the long term, the demand for high-performance cabin air filters for vehicles of all kinds will continue to grow. After all, there will always be air pollution. The latest filter technologies currently offered by premium manufacturers will be difficult to surpass.

The vehicle as an oasis of clean air:

Health awareness with the aim of increasing life expectancy and the associated legal regulations will make powerful air filters for vehicle cabins the norm, which means it's in the workshop's interest to keep abreast of this automotive technology too. After all, good air also means good business.

CHAPTER 6: FREQUENTLY ASKED QUESTIONS (FAQ) RELATED TO CABIN AIR FILTERS

WHAT QUESTIONS ABOUT CABIN AIR FILTERS SHOULD AN AUTOMOTIVE EXPERT BE ABLE TO ANSWER?

Why are cabin air filters so important?

Cabin air filters are key to improving air quality inside the vehicle cabin. They filter pollutants such as fine dust, pollen and exhaust from the air that enters the vehicle and thus contribute to passenger health and well-being.

What kind of cabin air filters are there?

There are different types of cabin air filter, including particle filters, activated carbon filters and biofunctional activated carbon filters. Particle filters primarily remove dust and pollen, whilst activated carbon filters also bind harmful gases and odours. In addition, biofunctional activated carbon filters offer protection from bacteria and fungal spores.

How often should cabin air filters be replaced?

The manufacturer's specifications should be observed. Maintenance intervals for cabin air filters vary depending on the vehicle and usage. But it's generally recommended that you replace filters at least once a year or every 15,000 to 30,000 kilometres to ensure optimal performance.

What are the benefits of high-quality cabin air filters?

High-quality cabin air filters offer better filtration performance and can remove a wider range of pollutants. Due to its flexibility, this high-quality materials prevents the formation of bypasses during installation, which would otherwise compromise filter performance. They help improve the quality of the air in the vehicle cabin, which in turn promotes passenger health and well-being and extends the service life of the climate control and ventilation systems.

Are there any legal requirements for cabin air filters?

There are guidelines that regulate the quality and performance of cabin air filters. In Germany, for example, the VDI/ZDK 6032 standard defines hygiene guidelines for the air inside the vehicle cabin.

What kind of air pollutants are there?

There are both man-made and natural air pollutants. Man-made pollutants include fine dust, nitrogen oxides, carbon monoxide and volatile organic compounds, which are primarily the result of combustion processes. Natural pollutants include pollen, desert dust and volcanic ash.

What effect do air pollutants have on health?

Air pollution can lead to a variety of health issues such as respiratory and cardiovascular diseases and reduce life expectancy. Children, the elderly and people with pre-existing health conditions are most at risk.

How do the different types of cabin air filter differ?

Activated carbon filters offer a wide range of filtration options. In addition to removing particles like dust and pollen, they can also bind harmful gases like ozone, nitrogen dioxide and sulphur dioxide as well as unpleasant odours, significantly improving the quality of the air inside the vehicle cabin.

How do biofunctional activated carbon filters work?

A biofunctional activated carbon filter features an additional layer of filter impregnated with an antibacterial substance. This layer prevents the collection and development of bacteria, mould and allergens on the filter surface, which offers additional protection from microorganisms and biogenic pollutants.

What is the MEYLE PD activated carbon filter, and how does it work?

The MEYLE PD activated carbon filter is a special cabin air filter that can permanently bind nitrogen oxides (NOx). Unlike conventional activated carbon filters, which can release NOx back into the air, the PD activated carbon filter binds NOx as a chemical salt compound that will never be released again, even when the filter is disposed of.

LIST OF SOURCES

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