

MAHLE n e w s

A F T E R M A R K E T

MAGAZINE FOR TRADE, WORKSHOP, AND ENGINE REPAIR

www.mahle-aftermarket.com

This edition of **MAHLE Aftermarket news** is packed with solutions. Solutions to the challenges of the future—and to current problems in the repair shop. As regards day-to-day business, we grilled the MAHLE engineers on the subject of pitting corrosion, and several others, for our “Theory & practice” section. When it came to the topic of cabin air filters, we took a deep breath—and were won over by the unmatched performance of activated carbon. And we learnt what not to adjust when exchanging a turbocharger. Because we also wanted to know what will influence trade and repair shops

tomorrow and beyond, we questioned experts about the future of the automotive market. And asked our developers to tell us what they have up their sleeves that will allow them to competently serve this market. The trend here is clearly moving from products towards complete solutions. With regard to service, MAHLE Aftermarket has started its own initiative: MAHLE Service Solutions. This complete repair solution involves much more than just having the right equipment. But more about this later—on page 6. We hope you'll find this edition an interesting read.

1/2015

What does the future of **SERVICE** **LOOK LIKE?**

You will find insights and perspectives into the service world of tomorrow on pages 2, 3, 6, 7, 10, and elsewhere in this edition.

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Head of MAHLE Aftermarket
Europe (EMEA)

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BEHR®

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KNECHT
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ORIGINAL

Dear readers,

The automotive aftermarket is rapidly changing. A development that is by no means new, but constantly creates new tasks for automobile manufacturers and suppliers. One of the most important for us is to keep on asking: what challenges are you confronted with on a daily basis in trade and the repair shop? What challenges will you face tomorrow? And how can we help you to overcome these quickly, competently, and on a sustainable basis?



Nicolas de Gaudemont, born in 1967, holds a Master of Science in Business Administration and knows the automotive industry inside out, from original equipment right through to after-sales support. Since 1992, he has held senior positions in leading companies in the automotive aftermarket. He is convinced that trade and repair shops today need much more than "just" good products.

Ours is not the only industry currently being influenced by a new kind of buying behaviour. We are observing this development along the entire value chain—in trade, in the repair shop, and with motorists. Offerings are becoming more transparent and thus more comparable, and buying decisions allegedly more rational. However, when it gets difficult to discern between the abundance of offers and detailed information available, one factor of long-lost importance comes into play: the brand. It provides orientation and stands for reliability—that is: quality, availability, and service.

The original equipment quality of our brand products has long been known, their availability is secured on an international level, and their service guaranteed in the original sense of the word. But will what we regard as good service now also be the service of the future? Or do we need to define this term further

—to incorporate a comprehensive overall performance that grows with the needs of our customers as well as making us an indispensable partner to trade and repair shops?

For MAHLE Aftermarket, good service is far more than having sound product information or an excellent delivery service. For us, good service means: a complete repair solution. MAHLE Service Solutions provides you with the equipment and expertise you need in order to meet the service expectations of your customers. In this context, we are particularly thinking in terms of service units—for HVAC systems, automatic transmissions, and tyres, for example—supported by a comprehensive package of services ranging from certified training on product and vehicle systems to technical information and special tools.

“ FOR US, GOOD SERVICE MEANS A COMPLETE SOLUTION FOR YOUR REPAIR. ”

However, we also interpret service as providing access to a comprehensive range of products and services that grows with the requirements of the market—from spare parts to the overall system. For example, when you order the MAHLE Original turbocharger, you also receive the necessary spare parts, installation kits, and oil lines—and the appropriate training as well as a repair shop hotline.

We ensure that trade and repair shops are optimally supported above and beyond our core areas of competence, powertrain and thermal management. We will soon be expanding our portfolio in connection with the further electrification of the drive, to include starters, alternators, and generators. In short, MAHLE Aftermarket provides you with genuine overall service performance.

Above all, service for us means: customer proximity, in the literal sense of the word. Because wherever you are, we are there. By constantly expanding our global sales and logistics network, we are creating the best conditions for continuing to successfully serve this challenging and exciting market together with you.

Sincerely,

Nicolas de Gaudemont
Head of MAHLE Aftermarket Europe (EMEA)

MAHLE
Service
Solutions

Where are we HEADED?

GLOBAL MEGATRENDS AND FUTURE MARKET SCENARIOS IN THE AUTOMOTIVE SECTOR.

The automotive market is being shaped by five megatrends: a scarcity of resources, global population growth, increased environmental awareness, the changing focus on markets in South America and Asia, and general urbanisation. The requirements placed on the automobile and its use are therefore changing accordingly.

Global energy consumption in the transport sector is on the increase. Experts predict that the demand for fuel for passenger car traffic will increase by up to 40% by 2030—although consumption per 100 km will decrease considerably. Fossil fuels will continue to make up the largest share by far, although biofuels are gaining in importance.

Automobile manufacturers and their development partners are addressing the topic of fuel consumption with innovative vehicle technology solutions, using lighter materials, further optimising aerodynamics, reducing rolling and frictional resistance, and increasingly turning to more environmentally friendly fuels such as biodiesel, ethanol, or CNG.

In the area of engines and drives, which is MAHLE's core business, topics such as downsizing—i.e. smaller and more fuel-efficient engines—, engine turbocharging, optimisation of injection systems, and electrification are relevant trends.

STRICT EU REQUIREMENTS, MORE BIOFUELS, WEIGHT BONUSES FOR HEAVY VEHICLES

Policymakers are creating low-emission zones, issuing licence restrictions, promoting intelligent traffic management systems—and calling for energy-saving measures. The EU requires fleet consumption to be reduced to 95 g/km CO₂ by 2020. Exceeding this figure will result in a penalty—with a fine of EUR 95 per gram of CO₂ and car sold. Today, the average level of CO₂ emissions lies at 137 g/km. Concrete savings are possible through technical optimisation of HVAC systems (7 g/km) and a higher percentage of biofuel (10 g/km). In order to achieve the targeted maximum of 95 g/km, it is absolutely necessary to address the engine environment.

This objective is complicated by the increasing demand for heavier vehicles. Although these vehicles receive a weight bonus,

this is not enough to offset their additional CO₂ emissions. The aim is to limit CO₂ emissions to no more than 68–78 g/km by 2030. How this objective is to be realised is not yet clear—especially since test methods are simultaneously becoming more difficult.

MORE VEHICLES AND SMALLER ENGINES, BUT DESPITE ALL THAT: MORE PISTONS

According to forecasts, global vehicle production will increase by around 27% between 2014 and 2023—that is, from around 89 million vehicles to 112.8 million. In Europe, growth will average 2.4% per annum. The number of diesel vehicles will grow by a total of approx. 18% and that of petrol-driven vehicles by around 22%. However, there will be fewer engines with five or six cylinders, and more with two or three. Nevertheless, the total number of cylinders (and, of course, pistons) will continue to rise globally—by 23% between 2012 and 2019 alone. The market for engine components is still continuing to grow.

THE POTENTIAL OF THE INTERNAL COMBUSTION ENGINE FOR REDUCING CO₂—AND MAHLE'S CONTRIBUTION

The internal combustion engine still plays a central role in international mobility—it just needs to be more economical. This is why, today, the MAHLE engineers are already working on the products of the future: filters will have even higher separation levels, thermostats will become even more intelligent (to keep certain areas of the drive at an optimal temperature, for example), engine components will become increasingly light and smooth-running, and turbochargers will become more efficient. Stop-start systems and variable valve train systems will also remain on the advance.

Overall, mechatronics and electrification will become increasingly important—partly in light of the ever-growing proportion of vehicles that are completely or partially driven by electrical energy. MAHLE is well placed to address all of these challenges: through its continuous research and development and the ongoing strategic expansion of its product portfolio, which has recently been expanded with the acquisition of Letrika to include electric motors, starters, and alternators, as well as electric drive systems.



The latest generations of turbochargers offer impressive advantages, with reduced consumption, CO₂ savings, and compliance with future exhaust gas limits. In addition, they provide greater driving enjoyment—by increasing torque in the lower engine speed range.



The higher the degree of turbocharging, the more important the cooling of the compressed air becomes. The solution comes from MAHLE Behr: the indirect cascaded intercooling, which is integrated in the intake pipe, almost achieves the temperature level of the coolant thanks to its two-stage cooling process.



The many different tasks of engine cooling can only be achieved by intelligently controlling the incoming energy flows. Thermostats that operate within the map provide significant impetus in this area.



SERVICE

for your service

MAHLE SERVICE SOLUTIONS: MAHLE AFTERMARKET IS EXPANDING ITS RANGE TO INCLUDE SERVICE UNITS AND SERVICES RELATING TO MAINTENANCE AND SERVICE, AND IS THUS TAKING ANOTHER STEP TOWARDS BECOMING A FULL-SERVICE PROVIDER TO THE REPAIR SHOP.

Whether their purpose is to increase comfort, safety, or efficiency, vehicle technologies are becoming increasingly complex. At the same time, the demands being placed on service and maintenance are growing. In order to perform the work both professionally and safely, repair shops need to have the right service units—and the corresponding knowledge required to use them. To support its partners in this growing segment, too, MAHLE Aftermarket established the new MAHLE Service Solutions division: with practice-oriented repair shop equipment and a comprehensive package of services. By continuously expanding its range of services for the repair and maintenance processes of repair shops, the company is making progress on the path to becoming a full-service provider.

BROUGHT TOGETHER: EXPERTISE FOR THE AFTERMARKET

MAHLE Service Solutions combines the expertise from many business areas, be it from MAHLE as a development partner and supplier of original equipment for vehicle air conditioning, from MAHLE Powertrain as a driver of innovation and supplier of testing and diagnostic systems to the automotive industry, from MAHLE Behr Service with more than 25 years of experience in A/C service units, or from the U.S. company RTI Technologies Inc., which has been integrated into the MAHLE Group and is specialised in A/C service units and systems for exchanging fluids.

ADDED VALUE: THE PACKAGE OF SERVICES

MAHLE Aftermarket offers more than high-quality products in its new Service Solutions division, such as a comprehensive package of diverse services and information tailored to the needs of the repair shop.

Train the trainer: in training conducted either on site or at MAHLE, MAHLE Aftermarket experts pass on their comprehensive expertise to trading partners so they can professionally advise and support their repair shop customers.

Service hotline: a direct line to MAHLE Aftermarket product specialists in the area of repair shop service equipment. Trading partners receive immediate answers to queries about product functionality, maintenance, and troubleshooting, or to complex questions asked by their repair shop customers.

Technical documentation: MAHLE Aftermarket offers a wide range of expertise tools for trade and repair shops: informative brochures and catalogues, damage brochures, Technical Messengers with helpful tips gained from practical experience for practical application, and—not least—the customer magazine MAHLE Aftermarket news, which appears three times a year and delivers practice-oriented technical knowledge, industry news, and much more.

Technical after-sales support: a well-developed service network ensures quick and professional support with all maintenance and repair-related issues.

Special tools: MAHLE Aftermarket offers the right tools and equipment to professionally repair and maintain MAHLE products and vehicle systems.

CONCRETE APPLICATIONS: THE NEW PRODUCT LINES

ArcticPRO

Nowadays, vehicle HVAC systems almost always come as standard. They are becoming increasingly complex and their professional maintenance more demanding—particularly because the systems operate with different refrigerants, each of which requires special handling. The ArcticPRO product line encompasses suitable service units for both refrigerants used today, R134a and HFO1234yf—and for relevant alternatives in the future.

**A/C SERVICE FOR R134A:
ArcticPRO ACX 180**

- User-friendly keypad, easy-to-read 3.5-inch colour display
- Convenient, intuitive menu navigation in 33 languages
- Automatic and manual mode selectable
- Individually extendable vehicle database
- Integrated flushing function
- Stable housing and smooth-running wheels for easy handling
- Extremely easy to maintain thanks to easy access through service doors and maintenance openings for filter-driers and oil changes
- High filter-drier capacity (150 kg)
- For passenger cars, trucks, and hybrid vehicles
- Complies with SAE J2788 and J2099 guidelines

A/C SERVICE FOR HFO1234YF:**ArcticPRO ACX 280 with integrated refrigerant analysis
ArcticPRO ACX 270 without refrigerant analysis, external refrigerant analysis unit optionally available**

- User-friendly keypad, easy-to-read 3.5-inch colour display
- Convenient, intuitive menu navigation in 33 languages
- Automatic and manual mode selectable
- Individually extendable vehicle database
- Integrated flushing function
- Stable housing and light running wheels for easy handling
- Extremely easy to maintain thanks to easy access through service doors and maintenance openings for filter-driers and oil changes
- High filter-drier capacity (150 kg)
- For passenger cars, trucks, and hybrid vehicles
- Complies with SAE J2843 and J2099 guidelines

FluidPRO

The increasing comfort requirements of customers and legislative CO₂ reduction targets have led, on the one hand, to an increasing number of vehicles being equipped with automatic transmissions or automated manual transmissions and, on the other hand, to increasingly technically sophisticated transmissions. Vehicle manufacturers are specifying maintenance intervals accordingly. MAHLE supports the service process with the automatic transmission flushing unit ATX 180, which is distinguished by its ease of use and automated flushing process.

**PROFESSIONAL TRANSMISSION OIL CHANGE:
FluidPRO ATX 180**

- Very high accuracy thanks to double weighing principle
- Fresh and used oil tanks, both 25 L
- Use of flushing and cleaning additives possible
- Automatic process, no manual switching or regulation necessary
- Boost function (accelerates the oil circuit for a better cleaning effect)
- Adapter set for almost every vehicle application available

**NitroPRO**

In this present era of fuel consumption reduction and tyre pressure monitoring systems, keeping the tyre pressure constantly at the correct level is taking on greater importance. An optimally inflated tyre reduces rolling resistance and thus the braking distance, contributes to saving fuel, and prevents increased flexing work and, consequently, premature tyre wear. The constancy of the tyre pressure can be increased by inflating the tyre with nitrogen. In addition, the gas can reduce the risk of fire, which is why nitrogen has been used for quite some time in heavily stressed tyres in particular, such as those for trucks or racing cars. With its NitroPRO product line, the new MAHLE Service Solutions division also provides repair shop customers with professional nitrogen tyre inflation systems. The revolutionary membrane technology in the units makes it possible to generate nitrogen in-house using normal ambient air—with a purity of 98%.

**NITROGEN TYRE INFLATION:
NitroPRO NTF 180**

- Generate nitrogen independently from existing compressed air from the repair shop
- Set-up option for either 95% or 98% nitrogen purity
- Innovative membrane technology
- Integrated maintenance unit for cleaning and treating compressed air
- Automatic flushing and filling mode for up to six tyres simultaneously
- Purity tester to check the nitrogen quality on the vehicle and in the unit





ON THE ROAD TO VICTORY

THE SUCCESSES ACHIEVED IN MOTORSPORT CAN ALSO BE APPLIED TO DRIVING ON THE ROADS. MAHLE IS ACTIVE IN ALL RACING CLASSES—PARTICULARLY IN THE HEART OF THE ENGINE.

Wherever motorsport races are being held in the world, MAHLE is on board—and almost always backing the winner. At Le Mans, for example. Since the 70s, most of the victories in the legendary 24-hour race have been achieved using MAHLE pistons, including the last 20 years in a row. Each class represents a particular challenge for the engineers. However, whether used in Formula 1 or a rally, the piston is and will remain the most important mechanical component by far. One unique requirement of a racing diesel engine for Le Mans is the extreme bank angle of 120 degrees, which places great stress on the piston and housing. For this purpose, MAHLE developed a stable solution for cylinder crankcases using NIKASIL® coating.

While steel pistons are already being used at Le Mans, up to now this has only been investigated for Formula 1. Nevertheless, in each new season there are technical innovations in the regulations that also affect MAHLE. The latest challenge for the developers was the conversion of 2.4-litre V8 engines to the new 1.6-litre V6 turbo engines. These are significantly smaller, but deliver considerably more output load, which also places more stress on the pistons. This is why MAHLE Motorsports focused intensively on developing the materials—using optimised aluminium alloys, also in a powder metal form, and new coatings on the piston crown and the ring groove walls. Conversion to the Energy Recovery System (ERS) also needs to be taken into account in the piston design, since the high external torque induced via the crankshaft into the engine by the electric motor provides additional tension. Seeing as only five engines, instead of eight, are currently permitted per season and

driver in Formula 1, it goes without saying that all components are generally subjected to additional stresses.

But while this premium class may be fascinating and appealing to the general public, MAHLE engineers have to work just as meticulously for the other races, too. This is, of course, evident in truck racing, where machines with an output of 846 kW (1150 hp) are used, achieving an electronically limited 160 km/h with a torque of over 5,500 Nm—speeds of over 200 km/h would also be possible for the race trucks. Another example: the FIA World Rally Championship, which places completely different demands on vehicles and engines. Because of the constant switching between gravel, snow, and asphalt tracks, the components need to be designed both for long distances with low loads and for driving continuously at full throttle. MAHLE is also involved in several other international racing series: for example, the American NASCAR or the German Touring Car Masters (DTM) where, as an official partner of BMW Motorsport, MAHLE is supporting the required transition from the V8 engine to the four-cylinder engines that will be used in the future. MAHLE is just as successful on two wheels. For instance, in MotoGP, the highest class in motorcycle racing, components have to withstand up to 18,000 revolutions per minute. Here, a special nano coating on the piston skirt helps.

These are extreme conditions indeed, but are often also the driving force behind new developments for large-scale production. Ultimately, anything that has proven itself in racing will also do a good job in day-to-day driving...

Friction on PISTONS

THE BEST CONNECTION IS ONE THAT IS AS STRONG AS THE MATERIAL ITSELF. THIS IS WHY THE TWO HALVES OF THE NEW TOPWELD® PISTON FROM MAHLE ARE CONNECTED BY MEANS OF A SPECIAL PROCESS: FRICTION WELDING. WHAT THIS BOILS DOWN TO IS THAT THE PISTON CROWN AND SHAFT ARE RUBBED TOGETHER UNDER ENORMOUS PRESSURE UNTIL THEY BECOME INSEPARABLY JOINED. QUITE SIMPLE REALLY—IF YOU HAVE THE RIGHT EQUIPMENT TO PRODUCE THE NECESSARY FORCES.

The higher the temperature in the combustion chamber of an internal combustion engine, the more important heat dissipation is. With a piston, this means that the cooling passage geometry is just as important as a high temperature-resistant material. However, if the piston is forged from a single block, considerable work is required to incorporate the cooling passage between the piston crown and shaft. So why not forge the piston in two parts, bore the cooling passage in both directions from the eventual middle—and then combine the two piston halves? This clever idea, however, harboured a great challenge: the stability and strength of the joint.

Friction welding is one of the few joining technologies that can produce joints whose properties are identical to, or even more

stable than, the base material. However, a complex device is required to put this into practice: a friction welding machine with one stationary and one rotating workpiece holder—and a high-performance power supply. This is because, in order to achieve a friction-welded connection from rubbing the piston parts together, the machine needs to have a driving force of 750 kW. (For comparison: this is normally the power output of the engine of an underground train!)

MAHLE has been using friction welding for decades in valve manufacturing to reliably connect the valve disc and shaft—and also applies this experience to produce the new friction-welded TopWeld® pistons, which are currently being installed in original equipment by leading commercial vehicle manufacturers.

THE EVOLUTION OF COOLING PASSAGES



FERROTHERM®—the articulated piston with a crown made of forged steel. Its cooling passage must be turned from solid metal. This requires a delicate, curved turning tool that needs to be custom-made. The hardness and toughness of the steel generate very high cutting forces, and the manufacturing of the cooling passage is equally complex.



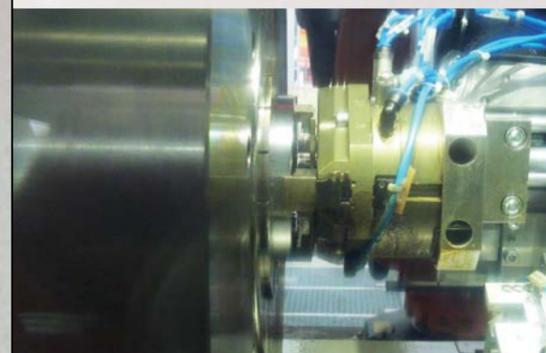
MONOTHERM® piston: the cooling passage is manufactured using an intricately manufactured, curved turning tool that must be delicate and stable at the same time. The cooling passage is subsequently sealed with two stamped sheet steel parts.



TopWeld®—the friction-welded piston: manufacturing the cooling passage for this piston is considerably easier and faster with a conventional (and therefore more stable) turning tool. A half groove is turned in both the skirt and crown of the piston. Friction welding is used to create the complete, closed cooling passage.



HOW TWO HALVES BECOME ONE.



Friction. One part of the piston is stationary; the other part is rotated.



Beading. Under the influence of the rotation and contact pressure of the two parts, the material begins to get hot and viscous at the joining surface—and the typical friction welding bead is formed.



Stop! Finally, the rotating part is abruptly stopped and the connected piston parts held in position under force until the material cools and thereby becomes solid.

NEW PRODUCTS FROM MAHLE SERVICE SOLUTIONS



MAHLE ARCTICPRO ACX 180
A/C service unit for vehicles with R134a refrigerant
Service for hybrid vehicles possible; designed according to SAE requirements

MAHLE ARCTICPRO ACX 270/280
A/C service unit for vehicles with HF01234yf refrigerant
Available in two variants: ACX 280 with internal refrigerant analysis, ACX 270 with external refrigerant analysis option (service without analysis unit possible)



MAHLE FLUIDPRO ATX 180
Automatic transmission flushing unit
Boost function for the best possible transmission cleaning; use of additives for flushing and cleaning possible

MAHLE NITROPRO NTF 180
Nitrogen tyre inflation unit
In-house production of nitrogen by means of revolutionary membrane technology; automatic service for up to six tyres possible

RING SET

For commercial vehicles	DAF XF-105, CF-85; 12.9 L, 6 cylinders, 300–375 kW (engines: MX300/340/375)
Characteristic features	PVD coating
Part no.	213 RS 10010 ONO (MAHLE Original)

MAHLE ORIGINAL

TURBOCHARGER

For commercial vehicles	DAF XF95 380 XF95 430; 12.6 L, 6 cylinders, 315 kW (engines: XF315M, XE280C, XF315C)
Part no.	213TC17336000 (MAHLE Original)

MAHLE ORIGINAL

FUEL FILTER

For trucks	Mercedes-Benz Actros MP4; 12.8 L, 6 cylinders, 310–375 kW (engine: OM 471)
Characteristic features	Main filter (patented) and prefilter
Part no.	KX276/6 KIT (MAHLE Original and Knecht)

MAHLE ORIGINAL

AIR FILTER

For passenger cars	BMW 1, 2, 3, 4 Series; 2.0/3.0 L, 4–6 cylinders, 170–250 kW (engine: N55 B30 A)
Part no.	LX 2076/1 (MAHLE Original)

MAHLE ORIGINAL

YOU CAN FIND DETAILED INFORMATION ABOUT THE NEW PRODUCTS IN THE REGULARLY UPDATED ONLINE CATALOGUES UNDER WWW.MAHLE-AFTERMARKET.COM

ASSEMBLY

For different engines Volvo Penta; 16.1 L, 6 cylinders, 430–485 kW (engines: TAD 1641 GE, TAD 1642 GE)
Characteristic features Ring carrier, cooling passage
Part no. 037 AY 00108 090 (MAHLE Original)



INTEGRAL THERMOSTAT

For passenger cars Ford Focus, Mazda 3, 5, MX5; 1.8/2.0 L, 4 cylinders, 81–184 kW (engines: R9DA, LF17, LF5H/W, L823, L828)
Part no. TI 202 82 (both MAHLE Original and Behr)

TURBOCHARGER

For passenger cars VW T4 Transporter; 2.5 L, 4 cylinders, 65–75 kW (engines: AJT, AYY, ACV, AUF, AYC)
Part no. 030TC14217000 (MAHLE Original)



MAP-CONTROLLED THERMOSTAT

For passenger cars BMW 2, 3, 5 Series, X1, Z4; 2.0 L, 4 cylinders, 120–180 kW (engine: N20)
Part no. TM 25 108 (both MAHLE Original and Behr)



TURBOCHARGER

For passenger cars Peugeot 307 2.0 HDi; 2 L, 4 cylinders, 136 kW (engine: DW10BTD4)
Part no. 039TC17732000 (MAHLE Original)



Decay

ON THE CYLINDER LINER?

CAVITATION—HOW IT ARISES, HOW TO PREVENT IT.

MAHLE ENGINEERS ARE REGULARLY ASKED BY REPAIR SHOPS AND ENGINE RECONDITIONERS FOR HELP WITH DIAGNOSING DAMAGE—AND IN THE PROCESS ARE CONFRONTED WITH SMALL HOLES THAT SOMETIMES OCCUR ON THE CYLINDER LINERS.

These holes exclusively affect “wet” liners (type WN), i.e. those that have been directly flushed with coolant, and are always in the area around the water jacket—particularly at the top and bottom dead centre of the piston. They are solely found on the major or minor thrust side and get bigger towards the inside.

Are these casting defects? Or did blowholes get trapped in the grey cast iron? Neither is the case. MAHLE uses the centrifugal casting method to produce cylinder liners. During the casting process, the high centrifugal forces in the cast completely and reliably prevent the formation of bubbles and blowholes. So these are definitely not manufacturing defects, but a different phenomenon altogether: pitting corrosion or cavitation.

CAVITATION—A VIBRATION PROBLEM

The contact side of the piston in the cylinder changes at the top and bottom dead centre. In wet liners, the force of the contact can lead to vibrations in the surrounding water jacket. During a vibration cycle, a vacuum is temporarily created in the water. Small vapour bubbles form close to the outside of the cylinder, which implode when the water column swings back. The water then accelerates towards the cylinder liner and strikes its surface. The kinetic energy tears minute particles away from the liner. As a result, the side wall of the cylinder can become so heavily eroded that water enters the cylinder. The fatal consequence: if the cylinder surface is already damaged, this makes it vulnerable to further cavitation and, subsequently, corrosion.

THE GREATER THE RUNNING SMOOTHNESS, THE LOWER THE DANGER

When designing pistons, MAHLE places great emphasis on maximising the running smoothness—the greater it is, the fewer vibrations occur. To achieve this goal, numerous tests are conducted both inside and outside the engine, and the piston is optimised accordingly. The cylinder liner itself should also be operated with minimal vibration. To ensure this, it is secured with maximum precision directly under the liner flange at the top and to the engine housing at the bottom. Extremely precise manufacturing and compliance with the narrowest tolerances guarantees this precision.

COOLANT TEMPERATURE AS A RISK FACTOR

Engines that run with low coolant temperatures ranging between 50 and 70°C are particularly vulnerable to cavitation. Between temperatures of 90 and 100°C,

however, overpressure builds up in the closed cooling system. The greater this pressure is, the fewer vapour bubbles form. Therefore, the cover of the coolant radiator or compensating tank and the ventilation screws must seal completely tight, too. However, if the overpressure does not form because of a defective seal, for example, the boiling point of the coolant is inevitably reduced and the risk of cavitation increases.

To quickly reach the desired operating temperature and maintain the correct temperature control—in accordance with the operating condition and load case of the engine—optimal thermal management with highly accurate thermostats is important. So if a truck driver removes the thermostat and operates the engine without it, he will achieve the exact opposite!

WHAT PROTECTS AGAINST FROST ALSO PROTECTS AGAINST CAVITATION

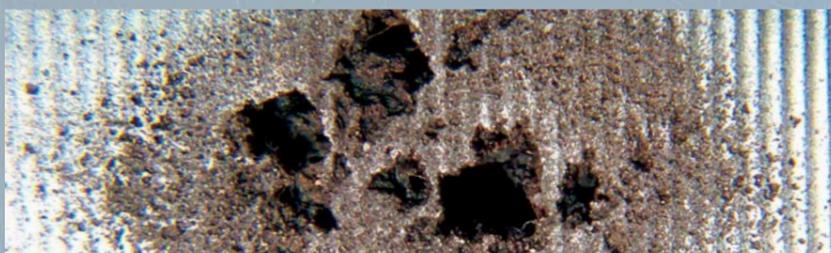
In addition to its main task of preventing the cooling system from freezing, anti-freeze has more work to do: it also raises the boiling point and thus reduces the risk of vapour bubble formation. At the same time, the gaskets of the coolant pump are lubricated, preventing corrosion in the engine. It is therefore generally necessary to add anti-freeze to the cooling water—even in summer or in hot areas of the world, or in generators running inside buildings.

THE BEST INSURANCE AGAINST PITTING CORROSION: HIGH-QUALITY MATERIALS AND WORKMANSHIP

MAHLE cylinder liners are made from high-quality materials using very narrow manufacturing tolerances. The quality of the microstructure, the outer and inner surfaces, and the perfectly matched O-ring seals in particular are quality characteristics that contribute to the resistance to cavitation.

FROM ORIGINAL EQUIPMENT TO THE AFTERMARKET

Good to know: MAHLE develops and produces cylinder liners for virtually all engine manufacturers worldwide—and, together with its original equipment customers, determines the composition of the alloy, the melting and heat treatment, and the narrow tolerances during machining. The strict quality standards apply to the manufacturing of all MAHLE products—regardless of whether they are delivered directly to the production lines of engine manufacturers or installed by engine reconditioners in the aftermarket.



The accumulation of many small holes around the water jacket is a clear indication of cavitation.



The sectional view shows the typical cavitation damage even more clearly: cavities that get larger towards the inside.

BREEDING GROUND EVAPORATOR

WHAT MODERN CABIN AIR FILTERS ARE—AND ARE NOT—CAPABLE OF.

Dust, pollen, spores, smoke, and soot, brake and tyre abrasion dust, ozone and other gases, benzene and sulphur compounds—the list of unhealthy and dangerous substances in the air is a long one. Accordingly, stringent requirements are placed on cabin air filters. A passenger car filter has to clean up to 100,000 litres of polluted air per hour, and truck filters need to deal with as much as five times that amount.

To cope with this workload, modern cabin air filters are equipped with highly active filter media. As a rule, these consist of several layers: a layer of activated carbon embedded between two layers of high-performance fleece. The tasks here are clearly defined: the fleece keeps out pollen, particulate matter, and other solid substances, and the activated carbon captures gaseous pollutants such as ozone, odorous substances, nitrogen oxides, and water vapour or petrol molecules, and stores them.

The filter performance and storage capacity of a cabin air filter is precisely defined in the specifications of the original equipment. The service life of a cabin air filter is up to 30,000 km or two years, depending on the vehicle manufacturer. However, because of the high microbial load, it is recommended that the filter is replaced at least once a year.

THE EVAPORATOR: THE FILTER SYSTEM'S HYGIENE HANDICAP

These calculations are based purely on the performance of the filter—that is, the intake and separation of ambient air under normal conditions. Yet in practice, the cabin air filter has a handicap that should not be underestimated: the evaporator—the part of the HVAC system that cools the air in the cabin. The humidity of the ambient air condenses on its closely set cooling fins. This condensation is, in itself, completely unproblematic. However, if the bacterial load increases because of an inferior filter insert (cheap filter) or an old and heavily contaminated filter, this can quickly lead to the formation of mould. On the moist surface of the evaporator, it combines with various other microorganisms to form living deposits. This unhealthy colonisation only becomes noticeable when a mouldy, rotten smell exudes from the ventilation nozzles. Itching in the eyes and nose can be an indicator of this problem.

ACTIVATED CARBON TO COMBAT POLLUTANTS

Regularly changing the cabin air filter remains the most effective method against bacterial contamination in the cabin. Although efforts are being made to make cabin air filters antibacterial by means of various coatings, these have proven to be absolutely ineffective in both laboratory and on-road tests.

During the filtering and adsorption of toxins, oxidation processes take place, which gradually consume the carbon in the filter core.

At this stage, it has fulfilled its task and should be replaced. If an unpleasant odour emanates from the ventilation nozzles, this is a clear sign that the replacement is overdue. By now the contaminated and polluted environment should also be cleaned, particularly the evaporator. If this also is delayed for too long, there is a danger that the evaporator will need to be completely replaced—with associated cost implications for your customers.

WHAT CAN YOUR CUSTOMERS DO TO KEEP THEIR HVAC SYSTEMS HEALTHY FOR AS LONG AS POSSIBLE?

Reliable protection can only be achieved by voluntarily shortening the replacement interval of the cabin air filter, ideally to twice a year:

In the spring—to eliminate the impurities accumulated by the filter during the cold season. This enables the HVAC system to work more efficiently over the summer and “breathe deeply”.

In the autumn—to remove the pollen and pollutants that accumulated over the summer. This ensures that full heating performance can be delivered in the cold season, allowing window panes to be cleared quickly.

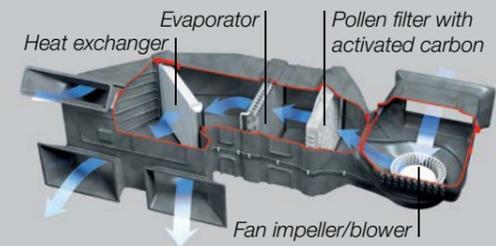
You can give your customer these practical tips at the same time:

The 20-second rule. If the car is parked in the sun, open all the windows first to let out the build-up of heat. Only then turn on the HVAC system, and close the windows. This saves a lot of energy, protects the HVAC system, and shortens the cooling time needed to reach a pleasant interior temperature.

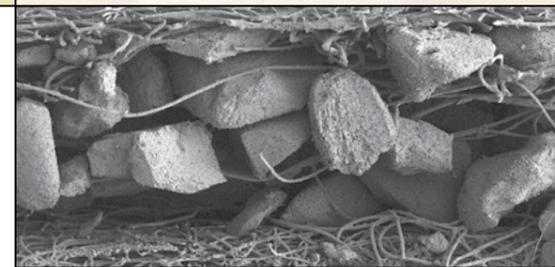
The 8-degree rule. On a vehicle's HVAC system, the cabin temperature should be set no more than 8°C lower than the outside temperature. This means: if the outside temperature is 30°C, the HVAC system should be set no cooler than 22°C.

The 10-minute rule. The HVAC system should be turned off around ten minutes before reaching your destination and the ventilation set to fresh air. This not only prevents a heat shock when leaving the vehicle, but also dries the condensation from the evaporator and the air ducts. This removes moisture, which significantly slows down the growth of mould, bacteria, and yeast.

The 2-year rule. An A/C service should be performed every two years. This is the only way to ensure that the cooling circuit is supplied with the proper amount of refrigerant and oil, which is essential for maximum cooling performance and the long service life of the refrigerant compressor.



Structure of an HVAC system with components. The pollen filter protects the directly underlying evaporator and heat exchanger from contamination of any kind. Water condenses on the evaporator when the HVAC system is in operation. The service life of the filter is severely impaired if it cannot dry.



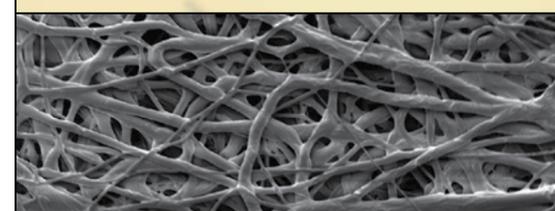
With LAK cabin air filters, an activated carbon layer is incorporated between two layers of fleece. This has an enormous surface thanks to its porous structure, which is ideal for trapping and adsorbing gaseous pollutants and odours. Harmful ozone is almost completely converted to oxygen, for example.



For direct comparison: on the left is a brand-new cabin air filter; on the right, one that has been replaced after 10,000 km.



The surface SEM image of a contaminated filter shows the pollen that has accumulated in the filter fibres. (The insect leg below left illustrates the proportions.)



This is what the surface of a new filter looks like when it is installed.



For comparison: a new evaporator and a heavily contaminated evaporator.

CONTINUOUS OUTPUT: a question of settings

HOW THE VARIABLE TURBINE GEOMETRY (VTG) IN MAHLE TURBOCHARGERS PROVIDES THE RIGHT BOOST PRESSURE AT ANY ENGINE SPEED.

Almost every diesel passenger car works with turbocharger technology nowadays: the exhaust gas energy is used to compress the intake air via a turbine and supply the engine with a larger air mass; as a result, speeds of up to 300,000 rpm are not uncommon. To protect these power packs from overspeeds and the engine from overloading, it is absolutely necessary to control the boost pressure—i.e. the turbine speed. This was previously done exclusively by the “wastegate” (Figure 1). This bypass uses a flap to control how much exhaust gas is routed via the turbine wheel. As soon as the flap opens, the turbine speed and, consequently, the boost pressure are limited.

Today, the boost pressure is largely controlled via the variable turbine geometry, or VTG for short. Adjustable guide vanes are mounted around the turbine wheel, which make the exhaust gas flow strike the exhaust gas turbine at various angles depending on the engine speed, thus always ensuring the required boost pressure.

In order to also provide sufficient boost pressure at low engine speeds, the guide vanes are set at a shallow angle. As a result, the exhaust gas flow only hits the outer edge of the turbine wheel and thereby produces greater leverage. In addition, the exhaust gases are heavily accelerated in this area by the constriction of the cross-section at the guide vanes (Figure 2).

As the engine speed increases, the angle of the guide vanes becomes steeper. The opening of the cross-section becomes larger and the entire exhaust gas flow now strikes the entire turbine surface with full energy (Figure 3).



Figure 1: Passenger car turbocharger with wastegate for boost pressure control. When the flap is open, the exhaust gases flow past the turbine wheel, decreasing the turbine speed and thus the boost pressure.

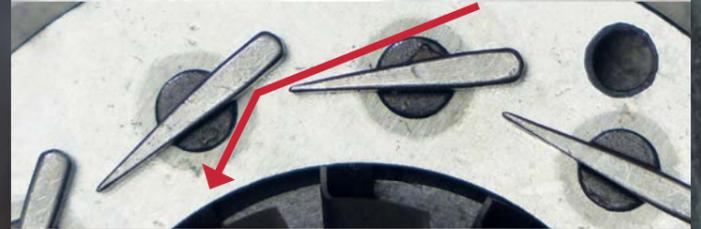


Figure 2: At low engine speed, the guide vanes of the VTG turbocharger sit at a shallow angle. They therefore concentrate and accelerate the exhaust gas flow and direct it only to the outside of the turbine wheel, where it exerts its greatest effect.



Figure 3: At high engine speed, the guide vanes of the VTG turbocharger are opened so that the full energy of the exhaust gas flow strikes the turbine surface.

NO PRESSURE DESPITE REPLACEMENT?

If poor performance or other problems are encountered after installing a new turbocharger, experience has shown that this is not due to the turbocharger itself. It is therefore important to locate and eliminate the exact cause before the new turbocharger is considered to be responsible for the fault. The factory settings of the turbocharger should not be changed under any circumstances!

Charge air line: everything tight?

Gaskets are often damaged during assembly or, in many cases, hose clamps have not been correctly positioned. The consequence: boost pressure escapes.

Fault memory: deleted?

If relevant fault memory entries are not deleted, then the engine control unit remains in emergency mode. It is not possible to carry out a test drive in this state to check the functionality.

Intake section: clear?

Any cleaning rags that have been stuffed in the intake lines as protection before the repair need to be removed immediately. (Many a turbocharger has been destroyed by a forgotten rag!) A contaminated air filter must always be replaced.

Sensor cable and hose system: attached?

A vacuum hose that has not been attached or an interchanged plug can quickly lead to a decline in performance. Careful visual inspection here will prevent anything worse from happening.

Exhaust system: free?

A diesel particulate filter that has become full can develop such high back pressure that the turbocharger is unable to reach its required speed. The load condition should therefore be checked whenever turbocharger damage is suspected.

N.B.: Since exceeding the maximum turbine speed will automatically destroy the turbocharger, maximum precision is required when adjusting the VTG control. This is why the functionality of each MAHLE turbocharger is carefully tested during the manufacturing process and is accurately calibrated in the final inspection. Changing the factory settings therefore poses serious consequences!



MAHLE

SHAPES *vehicle faces*

THE MAHLE FRONT-END MODULES PROFIT CENTRE IS THE ONLY GLOBAL DEVELOPMENT PARTNER TO THE AUTOMOTIVE INDUSTRY FOR COMPLETE VEHICLE FRONT ENDS. AS ONE OF THREE SPECIALISTS IN THE JOINT VENTURE, MAHLE BEHR PROVIDES INNOVATIVE COOLING COMPONENTS TO THE ORIGINAL EQUIPMENT MARKET.



*Manufactured by HBPO:
the complete front-end module for the VW up!*

A face makes up an essential part of a character so it should not only look good—it must also work well. Of course, we are talking about front ends of automobiles here: complex modules with integrated lighting functions, cooling components, and crash management systems. This is the specialisation of HBPO GmbH, the Front-end Modules profit centre. In 2004, three specialists formed a joint venture out of an existing joint venture, pooling their fields of expertise: Hella is responsible for state-of-the-art lighting technology and electronics, Plastic Omnium provides painted plastic body parts, crash management, and pedestrian safety, and MAHLE Behr primarily contributes innovative performance- and space-optimised cooling components.

The success story of HBPO began in 1992, at that time still known as Hella KGaA Hueck & Co., when it produced its first front end worldwide—for the VW Golf, no less. As the only system integrator for the development, assembly, and logistics of complete front-end modules, the company has numerous customers in the premium segment today. Porsche paid tribute to HBPO at their “Supplier Awards” for their outstanding achievement with the front-end module of the Panamera. HBPO also developed and manufactured the face of the Porsche Cayenne.

MAHLE Behr’s contribution is so important because, compared with standard solutions, the space-optimised cooling modules can save around 80 mm in height, 30 mm in depth, and thus a weight of approximately 1,000 g. The space thus saved can be used to meet the increased requirements concerning pedestrian protection, for example. Moreover, thanks to the overall reduction in the height of the cooling components, only an air inlet below the bumper is required for the engine cooling.

The company is headquartered in Lippstadt. To provide international customers with a competent, fast, and reliable service, HBPO has built up a network of 26 locations across Europe, the United States, and Asia, in which more than 1,600 employees produce 4.8 million front-end modules per year—and these figures are rising. Proximity to customers allows intensive development cooperation and demand-oriented supply in tight timeframes of 90 minutes to four hours after ordering.



The vehicle faces are fitted at a total of 26 international locations.



With sales totalling about 1.4 billion euros, HBPO is market leader in this segment.



MAHLE experts work closely with the international customs authorities. Here, a customs team holds a preliminary discussion with the owners of the intellectual property rights—just in front of the entrance to Automechanika Frankfurt.

Fighting COUNTERFEITERS on site

HOW MAHLE IS SUCCEEDING IN THE FIGHT AGAINST COUNTERFEITING AND PIRACY.

MAHLE's worldwide security offensive to protect against counterfeiting has many facets. It starts with product development, encompasses safety features on the packaging, and goes much further. MAHLE experts are always pushing the boundaries. Recently, for example, at the Port of Ashdod, Israel, they documented the official destruction of counterfeit MAHLE packaging seized by customs. Even at international trade fairs, the centres of trade, MAHLE is actively hunting down counterfeiters: MAHLE experts accompany large-scale raids, give customs valuable information about suspicious goods and packaging, and thus make it possible to efficiently track down counterfeits and their marketing chains.

At Automechanika Frankfurt, the automotive aftermarket's leading trade fair, MAHLE once again took targeted action against product pirates in conjunction with other renowned brand manufacturers, the police, and customs. The result: customs and public prosecutors discovered patent and trademark infringements at the trade fair stands of 89 non-European filter provid-

ers. In total, 18 of these counterfeits concerned MAHLE patents or trademarks. Over 600 filter catalogues and CDs were confiscated. Countless sections of the printed catalogues were blacked out. On numerous posters, photos from MAHLE were plagiarised beyond recognition. Immediate penalties—known as securities—totalling EUR 117,000 were imposed and collected, including EUR 36,700 alone relating to suspected counterfeiting of MAHLE products.

MAHLE also struck gold at the stands of European manufacturers. In cooperation with the police, several warnings were issued and securities demanded. The respective stand operators are also facing criminal charges.

Campaigns like these require a great deal of effort from everyone in the investigation team—both in advance as well as at the trade fair itself. However, they set an example, deter both counterfeiters and forgers, and actively contribute to protection against piracy. And thus ensure safer repairs—and safer driving.



Automechanika 2014 focused on the fight against product piracy. At the MAHLE Aftermarket stand a few particularly audacious counterfeits were displayed in an extra cabinet.



The trade fair becomes a crime scene: a customs officer at the stand of a product forger.



A counterfeit MAHLE oil filter with patented drainage pin was discovered in the display cabinet of a Belgian company with Chinese suppliers.



Shortly before destruction: counterfeit packaging, counterfeit security strips—seized by customs in the Israeli port of Ashdod.



The destruction of the counterfeit packaging is precisely documented.

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