AUTOMOTIVE news

Water separator has its premiere with Audi

Air cleaner innovation Flexline opens up new dimensions to utilize installation space

Active intake systems allow up to 30 percent higher torque

In focus
Modern engine technology
Dear Business Partner,

Last year we were able to further strengthen our position as the leading filtration expert in the international automotive and mechanical engineering industries. In the financial year 2015, MANN+HUMMEL achieved a turnover of three billion euros which represented an increase of eight percent on the previous year. The year was characterized by difficult market conditions in Brazil, Russia and China as well as a very positive development in Europe and North America. The business unit Automotive Original Equipment continued its constant growth and increased turnover for the sixth year in succession.

The success story of our company, however, goes back much further. The family-owned company was founded 75 years ago under difficult conditions and since then has developed to become the global market leader for filtration. Today, as a successful manufacturer of air cleaners, oil and fuel filters, intake manifolds and technical plastic parts, we employ about 17,000 people at more than 60 locations worldwide.

In the interview on page 9 you can read how the company culture creates the environment necessary to establish us as one of the most innovative companies in Germany and how a structured innovation process, in particular with regard to diversity of innovation and customer involvement, enables us to stand out from the competition. With our new concept to increase low-end torque (page 6), for example, we address the challenges of emissions legislation and offer our customers attractive technical solutions.

In the area of passenger car air cleaners, we are introducing Flexline, a new best-in-class type of air cleaner concept, which promises many opportunities to exploit previously unused installation space and further improve performance (page 22). We have also been a leader in the area of commercial vehicles for decades and are continuing our long tradition of innovation. In September at the International Motor Show (IAA) in Hanover we will give you an insight into our latest developments and ideas. We are looking forward to seeing you at our stand.

Your Kai Knickmann
MANN+HUMMEL was founded in 1941 by Adolf Mann and Dr. Erich Hummel. At that time, the filtration technology was still in its infancy. The filtration of air, oil and petrol in engine peripherals relied on relatively simple solutions and systematic R&D hardly took place at all. The company founders were convinced that far-reaching improvements could be made in this field. As a consequence the company established a development and testing department with engine test benches. In addition, a strategy of close collaboration with car manufacturers was pursued to enable the company to achieve the best results. This principle became a guiding principle in the history of the company and today still shapes the corporate philosophy.

Based on this approach the filter production company introduced numerous innovations up to 1945, including combi filters with cyclones as pre separators for heavy armored vehicles, main-flow oil centrifuges, strainer disc oil filters, and fine felt filters for fuel cleaning.

Continuous improvement
Immediately after World War II the filter production company concentrated on the manufacture of sanitary fittings and household items prior to entering a dynamic phase of innovation in 1950. Then, the focus changed from standard products over to tailor-made and installation-space optimized product solutions.

In this phase the intensive development of filter elements made from paper was decisive for MANN+HUMMEL. The ingenious star-pleated filters enabled a space-saving design which could be adapted individually to customer requirements. Replaceable oil filter elements were also developed.

The triumph of plastic
In the sixties the improvement of engine performance and reduction of fuel consumption gained in importance together with customized adaptation of air cleaner housings to the available installation space. The use of plastic played a crucial role, opening up completely new construction and design possibilities. The replacement of PVC by polyurethane and the increasing demand for system solutions by the automotive industry in the seventies resulted in the wide use of plastic.

In the eighties, the growing expertise of MANN+HUMMEL in the production of plastic enabled the changeover to become a system supplier. Advanced testing facilities with climatic chambers and the computer-based evaluation of tests led to new products such as the cylinder head covers and air intake manifolds in plastic.

There was a breakthrough in 1988 when MANN+HUMMEL developed a new production method up to series. Lost core technology revolutionized the seamless manufacture of complex hollow plastic parts. This production technique made a major contribution to establishing and consolidating MANN+HUMMEL’s position as a leading development and production partner for sophisticated module solutions.

Leadership in Filtration
Since the millennium MANN+HUMMEL has been able to do justice to its corporate vision ‘Leadership in Filtration’ with numerous new products worldwide. These include the series development of the worldwide first oil module in plastic and the first high performance diesel fuel filter using MULTIGRADE filter media technology. In 2016 a new Technology Center at the company headquarters in Ludwigsburg will open and ensure the best conditions to secure the future growth of MANN+HUMMEL through continued innovation.

From the simple felt filter to the modular system solution

In 2016 the filter specialist MANN+HUMMEL celebrates its 75th anniversary and takes the opportunity to look back on a long tradition of innovation. The rise from being a manufacturer of simple engine filters to become global market leader as a system supplier to the automotive industry was only possible due to a process of continual innovation. Today MANN+HUMMEL employs approximately 17,000 employees at more than 60 locations around the world.
Active intake systems with up to 30 percent higher torque

MANN+HUMMEL uses innovative engine charging concepts to increase low-end torque. This enables further downsizing and downspeeding and therefore also the reduction of CO₂ emissions.

Downsizing and downspeeding, real driving emissions, new limit values and driving cycles – these are the current challenges for engine designers. Therefore, low-end torque is gaining steadily in importance to reduce CO₂ emissions and consumption, especially under real driving conditions.

In order to meet these future requirements, MANN+HUMMEL has developed new intake systems, which have a positive influence on the combustion in the engine. Whereas in the past the strategy was to further improve single components, today the system supplier has adopted an integrated approach. It includes the design of the complete air intake path where primarily the section from the turbocharger to the cylinder head is of special importance. In this area MANN+HUMMEL has extensive expertise based on decades of experience.

There is a potential to improve engine performance characteristics, for example through resonance charging which is based on the intelligent variation of lengths and volumes in the air intake system. This principle has been successfully implemented by MANN+HUMMEL for decades in the area of intake manifolds and has now been applied at a different scale over the complete air supply increases performance. The torque mode exploits the existing resonance through a longer charge air duct. This leads to an improved torque build-up at low engine speed. Depending on the requirements, both duct lengths can be adapted by different methods to the existing installation space. An innovative rotary switch enables switching with minimal pressure loss between the two lengths.

Real driving emissions
The expression real driving emissions (RDE) describes the real exhaust gas behavior of vehicles in use on the road. According to a recent decision of the European Union which will come into effect in September 2017, real driving emissions (under consideration of conformity factors) will complement the laboratory test procedure in the determination of vehicle emission values.

Downsizing
Downsizing means the reduction of an engine’s displacement while at least having the same power output. The missing performance caused by the smaller displacement is compensated by turbocharging. Thereby one or more turbochargers are pressuring the air into the combustion chamber with overpressure. Due to lower weight and reduced friction the smaller engines are more efficient and therefore reduce fuel consumption.

Downspeeding
Downspeeding means optimizing the engine for the operation at low rpm ranges to improve the vehicle’s fuel efficiency. This is achieved, for example, by extending the transmission ratio.

ACAD: torque and power mode
The active charge air duct (ACAD) exploits the principle of resonance charging to increase performance. Depending on the engine load, the ACAD switches between a short or long charge air duct length. The power mode with the short length for the charge air duct maintains a low pressure drop and thanks to a maximum air supply increases performance. The torque mode exploits the existing resonance through a longer charge air duct. This leads to an improved torque build-up at low engine speed. Depending on the requirements, both duct lengths can be adapted by different methods to the existing installation space. An innovative rotary switch enables switching with minimal pressure loss between the two lengths.

DRS: ideal for 3-cylinder engines
The double resonance system (DRS) has a further increase in performance up its sleeve. Depending on the engines load condition the charge air duct can be switched to four different lengths. Additionally, two connectible volumes reinforce the existing resonance even more. The result is impressive with an increase in torque of up to 30 percent, especially at low engine speed, which is beneficial to the cars start-up performance. The principle is particularly suitable for 3-cylinder engines as the firing order of the cylinders enables perfect exploitation of the resonance in the intake system.

Active intake manifold system with electric compressor
The active intake manifold system developed by MANN+HUMMEL with integrated intercooling, tumble flap system and an additional electric compressor is a really high performance solution. The robust tumble flap system which meets the OB2 standard of the CARB (California Air Resources Board) controls the turbulence in the cylinder depending on the respective engine load. This results in optimum combustion and cylinder filling. Lower CO₂ emissions and lower fuel consumption. An additional electric compressor integrated in the system improves engine dynamics and also makes a contribution to the reduction of fuel consumption and CO₂ emissions. The fully integrated, indirect intercooler completes the module and enables a further reduction in CO₂ emissions by up to three percent.
Active Charge Air Duct
- Maximum air supply with short charge air duct length and low pressure drop
- Increased low-end torque in torque mode through resonance charging with longer charge air duct length
- Flexible concept, variable integration of different charge air ducts, for example as a spiral or U-shape
- Switching with low pressure loss between duct lengths thanks to special rotary switch

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Double resonance system
- Increased efficiency through quicker available torque
- Up to three percent less CO₂ emissions thanks to fully integrated, indirect intercooling
- Optimum build-up of low-end torque
- Intelligent control of exhaust gas turbocharger and additional electric booster through automatic bypass valve
- Improved combustion through robust tumble flap system for control of cylinder turbulence based on load and engine speed

In a very competitive field, car manufacturers expect suppliers to constantly churn out innovative products. How is MANN+HUMMEL set up to handle this?

Sturgess: Innovation is a part of our company strategy. We promote an active culture of innovation which allows freedom for exchanging ideas. For this purpose, we have special departments at different locations which are responsible for innovation. For example, at our development center in Ludwigsburg and also in the USA, France and China. In addition, every employee is encouraged to propose new ideas. We have an open working atmosphere which promotes creativity amongst our employees.

Jessberger: One of our strengths is that we have employees around the world who are solely dedicated to innovation. Local Advanced Development and Advanced Engineering teams develop new concepts to create innovation in the markets, for the markets. Our philosophy is to exploit local expertise for the development of local products.

How do you push innovations?

Sturgess: We have installed a concept we call ‘Free innovation time’. Ten percent of employees’ working time is dedicated purely to non-project related innovation topics. This gives our innovation team time to create and consider their new ideas and related research. During the innovation process we follow a structured approach. We start with numerous ideas and then shortlist them by passing through our innovation funnel, finally reaching a solution which is ready for the market. During this process cross-functional committees verify the concepts regularly with regards to their technical feasibility, but also make sure they fit our strategy and are ultimately relevant for the market. We do not regard discontinued ideas as failures, but rather document these as lessons learned and leave open the possibility of using those proposals in the future should market conditions change.

Thomas Jessberger, Manager Advanced Engineering

‘Meanwhile, the employees have become so sensitive that they are no longer content with a good idea, but want to turn a good idea into an excellent one.’

Professional career

Thomas Jessberger has, for the last four years, been responsible for Advanced Engineering and strategic product development in Automotive Original Equipment at MANN+HUMMEL, a group positioned between Advanced Development and Series Development. In 1994, his first position was as a project engineer for intake systems. Subsequently, he took up various positions in the development department and for five years was also responsible for Innovation Management for Automotive Original Equipment.
Jessberger: In Advanced Engineering we pursue the objective of improving our existing product range to enhance competitiveness. For established products, such as plastic air cleaners, the task to find a new approach is not an easy one. We hold innovation workshops, however, which frequently allow us to come up with improvements which have the potential to provide us with a competitive edge. The new products we develop are designed to ensure that also in the coming years our company can consolidate its No. 1 position in the market.

Can you give us an example?

Jessberger: In 2013, we introduced the radial sealing concept for air cleaner systems onto the market with considerable success. This enabled us to win a number of customer projects. Currently, we are working on Flexline, a new air cleaner innovation, which offers customers advantages with regard to acoustics, service life, pressure drop and filtration performance. This concept was presented at the last IAA Motor Show and will enter series production in 2017. Our core expertise is filtration. Accordingly, this is the focus of our activities.

Where do innovative ideas for products come from?

Jessberger: We observe trends on the market and consider which technology could possibly be transferred to MANN+HUMMEL from other fields. Furthermore, customers and our engineers add an important stimulus. Suppliers, institutes and universities are also an essential factor. Therefore, the ideas come from a total of five different sources.
MANN+HUMMEL is a system supplier to GM for decades and currently supplies various air cleaner systems for different applications. The company therefore employed a range of existing components providing a cost competitive solution to a long term vehicle manufacturing customer.

GM required specific focus on good vehicle and engine acoustics which is driven by the air intake system. MANN+HUMMEL achieved this with high attention to the dirty air duct which is made from an acoustically very effective nonwoven material and an additional side-branch resonator to help reduce the air intake noise level. A foam pad at the inlet prevents both hot air and water intrusion. The air cleaner housing itself, designed with a service friendly hinge design, includes a fleece filter element with a plastic overmolded frame. Positive crankcase ventilation inlet volume was integrated into the clean side duct. Additionally, a resonator – this time at the clean side duct – reduces the air intake noise.

The overall system results in a design solution developed by MANN+HUMMEL and produced at its plant in Munmak, Korea - an excellent example of a global solution but delivered to the customer at local competitive levels.

GM’s Chevrolet Spark, known in Europe as Opel Karl, is a small and innovative city car. The small car is based on the global mini platform of GM which was developed in Korea. MANN+HUMMEL Korea therefore was the location of choice to develop and produce the air cleaner system for this platform.

A spark of innovation

MANN+HUMMEL has been a long term global supplier to GM, building up a close working relationship across a variety of key automotive components and systems. A recent series product is a battery frames system for the new Chevrolet Volt.

Utilizing a new manufacturing process, together with the latest materials technology, MANN+HUMMEL produces plastic battery frames to accommodate the range of high voltage lithium-ion battery cells for this important mass production, range extender car.

A series of important considerations were required by GM for the component including weight saving, structural strength and high dimensional accuracy. In addition, the frames provide distribution of the coolant and importantly, electrical isolation.

Overall, eleven different components are stacked in various numbers to produce one battery system. Module end frames, different end caps and very important a high number of repeating frames are forming the different battery sections. A manifold frame is used to guide the coolant in the ‘T’ area.

The new manufacturing and injection molding process, developed by MANN+HUMMEL, fulfills high requirements regarding strict component cleanliness and delivers high output with precise component accuracy. Like the first generation which was launched back in 2010, the second generation of these battery frames are produced in the MANN+HUMMEL facility in Portage, Michigan, USA.
MANN+HUMMEL actively transfers its core competences to battery and fuel cell technology – for mobile and stationary applications.

The MANN+HUMMEL product portfolio for electrified propulsion at a glance:

1. **Battery trays for pouch cells**
   - Structure and stability for pouch cells in liquid-cooled high voltage batteries
   - Integrated cooling channels
   - High-precision injection molding fulfills high cleanliness requirements
   - Plastic design for lightweight solution

2. **Air dryer cartridge for battery systems**
   - Keeps the air inside the battery system dry through adsorption
   - Prevents water condensation at cooling plates
   - Special vacuum packaging avoids moisture adsorption before assembly

3. **Filter for air-cooled battery systems**
   - Holds back particles creating wear in blowers and terminals
   - Compressible filter element for restricted assembly access
   - Low pressure loss and part weight

4. **Degassing unit for battery systems**
   - Pressure balancing and emergency degassing
   - Protection from particles and liquids
   - Modular design to fit different functional requirements of the market

5. **Ion exchange filter for fuel cell coolant**
   - Keeps conductivity of cooling liquid for fuel cells low
   - Full-flow design with integrated particle filter makes bypass cooling loop obsolete
   - Replaceable cartridge dispenses with the need to exchange the housing

6. **Cathode air filter for fuel cells**
   - Critical gases and particles are removed from cathode air for increased lifetime
   - High flexibility in design, dimensions and function enables fast adaption to customer needs
   - Different design versions for the system optimization available
Water separator as add-on
Innovation complements fuel filter

Innovation in the area of fuel filtration: multi-stage water separation from MANN+HUMMEL is now available in a separate, highly efficient component for water separation designed for combination with an already existing particle fuel filter.

The water separator has its premiere with Audi and is designed for use in regions where diesel fuel has a high water content. This is particularly the case in the markets of North and South America, Russia and Asia, and especially India. The component will first be introduced in the A4. The concept enables easy integration of water separation technology in the fuel supply circuit.

High performance
The engineers at MANN+HUMMEL have developed a highly efficient, multi-layer coalescing nonwoven media. It consists of a mix of viscous and synthetic fibers. This is where the smallest water droplets in the diesel fuel combine to form larger droplets. These then settle in the sedimentation area and enter the water collection bowl. A specially developed hydrophobic sieve cloth serves as a final separator and ensures that the water droplets do not penetrate the injection system. The newly developed design achieves an excellent water separation efficiency with current diesel fuels for the whole service life of the filter element which is higher than 90 percent when the filter is in initial condition.

Service-friendly housing concept
The water collection bowl of the water separator with a volume of approx. 200 ml is equipped with a water sensor mounted on the bottom side to detect the level of water. When a predefined water level is reached, the service lamp lights up to signal the driver to visit the workshop. A further advantage is the service-friendly housing. During a service the filter element is simply removed from above using a tool included in the service kit.

Bypass valve for cold starts
In the cold-start phase a bypass valve protects the vehicle operation. It ensures that the fuel supply to the engine is not interrupted due to blocking of the element with gelled diesel. To ensure this, the bypass valve is temperature controlled.

The water separator allows MANN+HUMMEL to once again present its innovative drive and underline its position as a leading development partner and series supplier for highly efficient fuel filtration.

Advantages at a glance
- Water separation easy to combine with particle fuel filter
- Highly efficient water separation (> 90 percent)
- Excellent performance over whole service life
- Reliable protection of the injection system
- Service-friendly concept
- Environmentally-friendly metal-free filter element

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Audi A4 with newly developed water separator of MANN+HUMMEL (Photo: Audi AG)
The contact-free infrared welding process stands for high welding strength, fulfills highest cleanliness requirements and enables complex geometries.

The air cleaner which comprises a housing and filter element will in future ensure clean intake air for all engines used in the A4 series including gasoline and diesel units.

Different performance levels
When designing the round filter element, the filter experts opted for a high performance modular system able to cover many versions with different performance levels.

The possibilities include:
- different diameters
- different lengths
- additional variations with precleaner for diesel and V6 gasoline engines

The charged engines of the Audi A4 series radiate a lot of heat in the direction of the air cleaner. Accordingly, the filter housing is protected by a heat shield. Depending on the engine version, the heat shield is designed with thermal decoupling to minimize the transfer of heat from the heat shield to the plastic component.

MANN+HUMMEL supplies the air cleaner for the new Audi A4 series. The technically advanced component is characterized by high performance, improved acoustics, an additional heat shield, easy servicing and high component cleanliness.
The filtration specialists developed a special solution for the dirty air intake adapted to the available installation space which combines soft and hard plastic components. The injection-molded soft sealing lip produced with a two-component process takes over the sealing function and avoids the intake of warm air or ingress of water. The hard component is designed to ensure firm holding of the dirty air duct.

The integration of open cell foam in the air cleaner housing is another interesting technical feature. The acoustic measure dampens the intake noise and therefore makes a contribution towards improving noise characteristics.

Special attention was given to the water discharge from the air cleaner housing. By default the water separated at the inlet of the air cleaner runs through a hole at the lowest point of the housing. In addition, the A4 air cleaner family is fitted with a water drain which has an integrated coarse separator to protect against blocking caused by large particles. The vehicle is therefore perfectly equipped for use in climate zones with high rainfall levels or for long drives with persistent spray.

Ease of serviceability was a priority for the designers. As a result, when servicing, a twist-lock fixing system allows easy removal of the filter element from the air cleaner lid without the need for tools.

The connection of the end caps to the paper bellows of the round filter is realized by MANN+HUMMEL using a contact-free infrared welding process. This technology is particularly suited to production processes subject to the highest cleanliness requirements.

### Advantages at a glance

- Modular system - filter element versions possible with different diameters and lengths as well as versions with or without precleaner
- Heat protection - heat shield on the engine side, partly with thermal energy decoupling
- Water drain - automated water drain for regions with high rainfall levels
- Improved acoustics - open-cell acoustic foam to dampen intake noise
- Ingenious dirty air inlet - combination of soft sealing lip (sealing function) and hard component (holding function)
- High component cleanliness - contact-free infrared welding process for the highest cleanliness requirements

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**Fascinating engine sound**

*Symposer for powerful sound feedback*

The driving experience of high performance cars is not just a question of power, but also connected to a convincing and sporty engine sound. The MANN+HUMMEL symposer makes a contribution in this respect.

‘The symposer allows us to effectively support car manufacturers with sound design and sound branding – in particular with sporty models,’ says Roman Lechner, Program Manager at MANN+HUMMEL. At the end of the day, a convincing and balanced sound is a key purchase criterion for sporty drivers.’

**Natural sporty sound**

The strength of the compact symposer is that compared to artificially generated sounds it creates a natural sporty sound which corresponds directly to the engine load. The engine sound directly linked to load and engine speed tends to take a back seat with turbocharged engines. In the interior of the vehicle the driver cannot really perceive the typical characteristics of the engine. The symposer counters this effect. It transmits the intake pulses generated by the engine into the interior and thus supports the harmonious sound impression of the car. In the AMG the symposer is fitted to the plastic ports on the outlet side of the intercooler. This is where the dynamic pressure signal still reflects the characteristics of a naturally aspirated engine.

**Load-dependent sound feedback**

The acoustic transducer with a size of only a few centimeters comprises two chambers each on the engine and outlet side which are separated from each other by a common flap. The pulsations coming from the engine cause the movable flap to vibrate and this vibration is then transmitted to the chambers on the outlet side. The pulsations find their way to the interior via a pipe and generate the required load-dependent sound feedback.

A fully variable flap is integrated in the current application (2.0 liter turbo-charged engine). Depending on the engine load and engine speed, the map controlled flap is steplessly actuated to create sound feedback in different driving situations.

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**The symposer increases sporty sound in the passenger compartment**

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Flexline
Best-in-class air cleaner

The new Flexline air cleaner from MANN+HUMMEL opens up new dimensions to utilize installation space for filtration. This benefits filtration performance, lifetime, pressure loss and acoustics.

Current air filtration solutions usually take the form of flat air cleaners with rectangular, trapezoidal or polygon shapes which generally have straight side edges. The air cleaners of the current generation work perfectly well, but modern cars tend to have less available installation space in the engine compartment.

In recent decades the increasing importance of comfortable functions such as air conditioning, the use of turbochargers, exhaust gas recirculation and diesel particulate filters as well as the introduction of assistance systems and hybrid components has considerably reduced the available installation space.

**Designed to take interfering contours into account**

MANN+HUMMEL’s answer to the challenge of limited installation space is Flexline. The new air cleaner generation has a flexible outer shape which allows it to adapt to the interfering contours present in the engine compartment. It therefore uses the remaining available installation space more efficiently than previously. A further advantage is that Flexline has a seal profile with an extremely compact design. The seal profile enables pleats which are four millimeters higher than pleats with conventional filter elements while keeping the same overall height of the filter element. This also has a positive effect on the performance of the filter.

How can we measure the potential of the new filter technology? To answer this question, the experts of MANN+HUMMEL fitted a Flexline air cleaner system in an engine compartment with typical interfering contours and compared it to a conventional air cleaner system.

Flexline allows greater flexibility

- 18% stronger acoustic damping
- 27% higher dust holding capacity
- 21% less pressure loss

27 percent longer lifetime

The result is that Flexline increases the incoming flow surface area, in our example, by eight percent and the filtration surface area is increased by 20 percent, reports Dr. Michael Heim, head of R&D for air filter elements at MANN+HUMMEL. “This increase in performance offers further scope for the R&D team.” Three main strategies can be pursued:

- In pursuit of the strategy ‘lifetime increase’ the enlarged incoming flow surface area and the compact seal profile are used to generate more filter surface area, i.e. accommodate more filter media. The larger filter surface area leads to a longer service life of approximately 27 percent and simultaneously reduces pressure loss by five percent and a stronger acoustic damping of ten percent.

- In pursuit of the strategy ‘pressure loss reduction’ the additional installation space is used to realize an increase in the pleat distance, i.e. used to achieve more open pleats. For the same service life this reduces the on the system by 21 percent.

- In pursuit of the strategy ‘best acoustic performance’, a higher acoustic damping of 18 percent, in comparison to a conventional system, can be achieved. This results from the enlarged air cleaner housing relevant for acoustics thanks to Flexline as well as beneficial changes of cross-section.

**Improved acoustics**

‘Flexline also provides the R&D team with more scope here’, says Timo Dirnberger, team leader of R&D for air cleaner systems. ‘In the development process we generally have a conflict of objectives between pressure loss and acoustic characteristics. The potential of Flexline enables us to choose between high acoustic damping and low pressure loss.’

On the production side the introduction of Flexline has shown a technological change. Instead of the conventional cutting process, now modern laser technology is being used. This not only allows the manufacture of straight contours but also contours of almost any shape, even curved contours with radii, which are not possible using the existing process. In addition, the changeover from manual processes to laser technology has further improved occupational safety of the production workers.

‘Flexline, our new air cleaner generation, represents a great step forward in air cleaner technology,’ summarizes Dr. Heim. ‘It has enabled us to provide car manufacturers with a new best-in-class solution for complex installation spaces which through the exploitation of the smallest areas of available installation space enables an astonishing increase in performance and scope for further developments.’

**Advantages at a glance**

- Variable shape – perfect exploitation of the existing, sometimes complex installation space, for example, through enlargement of the filtration surface area
- Longer lifetime and higher performance
- Lower pressure loss – reduced pressure loss on the element through an enlarged incoming flow surface area
- Improved acoustics – higher volume of air cleaner housing relevant for acoustics
- Greater component cleanliness – further development of existing production processes

AUTOMOTIVE news
First oil filter module from Indian production

The MANN+HUMMEL strategy is to produce as close as possible to the customer. With the expansion of its global R&D and production network the system supplier has now been able to record a further success: at the Indian location in Tumkur the production of the first oil filter module from MANN+HUMMEL on the subcontinent has started.

Production in the South-East Asian market

The start of the local production of oil filter modules in the Far East is the module for the 2.2 liter 4-cylinder and 3.2 liter 5-cylinder diesel engines used in the Ford Ranger. The expansion of production capacity in India allows MANN+HUMMEL to offer customers the advantage of a local supply for the South-East Asian market.

Success factor for global projects

Up to now the oil module rolled off the production line exclusively at the Czech MANN+HUMMEL location in Okříšky to satisfy the global needs of Ford engine production in Thailand, South Africa and Argentina. Now the plant in Tumkur started production of the oil filter module in 2016 to serve the Asian market. A local supply is an important factor for success with global projects such as the Ford pick-up, which is marketed in 180 different countries.

Efficient oil management

In the modern Duratorq TDCi engines used in the Ford Ranger, the module from MANN+HUMMEL ensures an efficient and environmentally-sound oil management. The robust housing in die-cast aluminum integrates all main functions and includes an oil cooler, filter bypass valve, anti-drain valve and oil drain system.

Oil cooler with disk-stack design

The oil cooler with aluminum disk-stack design is positioned in the oil circuit upstream of the oil filter and has a very important function: at higher temperatures it cools the lubricating oil and thereby prevents the engine from overheating. When the oil viscosity is high (cold start condition) or when the filter element is clogged the filter bypass valve integrated in the center tube supplies the engine with sufficient oil. The anti-drain valve pressed into the housing also serves to provide greater protection against excessive wear. It prevents the oil filter from draining when the engine is switched off, thus ensuring that immediately after the start of the engine sufficient oil pressure is available at the lubrication points.

Advantages at a glance

- Expansion of the global production network for oil filter modules
- Production close to the customer in South-East Asia
- Modern oil cooler with aluminum disk-stack design
- Greater protection against wear through integration of filter bypass valve and anti-drain valve
- Clean oil change through patented anti-drain valve
- Environmentally-sound disposal through metal-free filter element

First oil filter module from Indian production

The module also features the patented oil anti-drain valve, which has already been successfully implemented in series. The valve enables a clean and easy oil change. The metal-free filter element is fully incinerable and after use can be disposed of in an environmentally-friendly manner.

Environmentally-sound handling

The new Ford Figo and Figo Aspire, compact four-door cars, are the latest cars from the Ford Motor Company set to take advantage of the growing consumer markets and the thirst for small cars in India and Africa. Both cars breathe clean air through air cleaner systems developed and produced by MANN+HUMMEL India.

A small car with big ambitions

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MANN+HUMMEL has huge experience of designing and producing air cleaner systems on a global basis. The company enjoys a long and productive relationship with Ford and is series supplier for numerous air cleaner systems for Ford’s global vehicle lines. Again, MANN+HUMMEL engineers have been working closely with Ford to develop and produce air cleaner systems for three engine options, a 1.2 liter as well as a 1.5 liter 4-cylinder gasoline engine and a 1.5 liter 4-cylinder diesel engine.

The various components that make up the air cleaner systems like the cover, the housing, the dirty side ducts, internal ducts and other components are produced locally at the MANN+HUMMEL plant in Tumkur, India. This is in line with the company strategy of supporting customers with manufacturing and engineering facilities located close to their car manufacturing plant. The Figo family is produced at the all new Ford plant at Sanand, Gujarat in India.

Cost reduction was an important objective of the air cleaner system achieved by using the latest technologies and production techniques as well as utilizing synergies of an existing product. The dirty side duct for example is an injection molded design composed of different welded and snap-fit components - a cost optimized solution compared to blow molded components when exceeding certain quantities.

The new Ford Figo is a very important and significant car within the car maker’s model line-up. It is produced in high volumes, with an expectation of taking advantage of burgeoning sales in new markets. Initial reviews and responses to the Figo have been positive from customers and the media with promising sales numbers in the first month of production.
High performance module for modern diesel engines

Highly efficient particle filtration, excellent water separation and an impressive heating power: the latest high performance fuel filter module from MANN+HUMMEL meets the highest requirements for the protection of modern diesel injection systems.

The high performance filter module is set to find application in the car models of the Mercedes-Benz MRA (Mercedes rear-wheel drive architecture) modular platform such as the C-, E- and S-Class and will be used for the first time in the new E-Class for the efficient preparation of diesel fuel.

High-end particle filtration
In the area of particle filtration MANN+HUMMEL has a wide range of filter media designed to meet worldwide all different market requirements. The MULTIGRADE F-MB 333, for example, is used for the first time in series production for passenger cars. It meets the highest requirements and is designed for engines with injection systems operating with an injection pressure of up to 2,500 bar. This high performance media achieves a separation efficiency of 99.7 percent for dirt particles larger than or equal to four micrometers particle size.

For injection systems with up to 2,000 bar injection pressure, the proven media MULTIGRADE F_HE finds application.

Three-stage water separation
In order to achieve the highest separation performance under real operating conditions, the new module will be fitted to Mercedes-Benz models to utilize the successful three-stage water separation from MANN+HUMMEL. For common diesel found at filling stations the module achieves an exceptionally high separation efficiency considerably above 90 percent for ultra-small water droplets down to a size of ten micrometers. This even remains the case at the end of the service life, i.e., just before the fully-loaded filter element is replaced. The three-stage water separation from MANN+HUMMEL clearly stands out compared to conventional solutions on the market.

Electrical heating
A further highlight is the integrated heating which prevents premature clogging of the filter element when the cold filtration plugging point (CFPP) is reached. This temperature value depends on the type of diesel used and usually indicates the end of the filterability as paraffin starts to clog the filter media. When the tank is filled with winter diesel conforming to the standard DIN EN 590 this temperature limit is -20°C. In this respect, the heating system used in the diesel filter module for Mercedes-Benz sets new standards. With a heating output of 500 W the high performance heater used splits flocculated paraffin chains. This therefore ensures reliable operation of the engine at low temperatures which are considerably lower than the CFPP.

Service-friendly concept
The filter module also impresses with its service-friendly concept. The filter housing can easily be opened from the underside of the car. A drain screw integrated in the filter cover enables discharge of the separated water downwards to completely empty the housing prior to replacement of the filter. And thanks to bayonet fasteners inside the housing the replacement of the filter is an easy operation.

High component strength
A mounting bracket integrated in the housing enables mounting of the diesel fuel module close to the diesel tank on the chassis. As a result, the filter is better protected in the case of a crash compared to a position in the engine compartment. The ribbed structure of the plastic housing increases the strength and stiffness of the module.

Advantages at a glance
- Improved design supports platform strategy of the customer
- Highly efficient protection of the injection system against water and particles
- High separation efficiency under real operating conditions over the complete lifetime of the filter element
- High performance heater for reliable engine operation at low temperatures
- Service and environmentally friendly concept thanks to accessible filter housing and metal-free filter element

The high performance filter module is set to find application in the car models of the Mercedes-Benz MRA (Mercedes rear-wheel drive architecture) modular platform such as the C-, E- and S-Class and will be used for the first time in the new E-Class for the efficient preparation of diesel fuel.
New commercial vehicle air cleaners for the Asian market

In order to meet the increasing requirements of commercial vehicle manufacturers regarding product durability, quality and a longer service life in operating conditions with extremely high dust levels, MANN+HUMMEL has developed two new air cleaners for the Asian market. Both concepts are freely available on the market and are not subject to exclusive rights.

Improved standard air cleaner for China

The first air cleaner is the successor of the NLG standard air cleaner which is successful on the Chinese market. The product is designed for use in medium to heavy commercial vehicles with nominal flow rates of 28 m³/min. One target of this new development was to adopt the proven technical solution of the previous filter. For example, polypropylene reinforced with fiber glass is used for the housing material and overmolded threaded inserts are used to mount the air cleaner to the vehicle. MANN+HUMMEL also falls back on proven technology for the filter elements. The main filter element has a traditional radial seal. A safety element available as an option is screwed into the air cleaner housing and sealed with an O-ring. The servicing of the element can be made without special tools. The filter cover is opened by opening fasteners mounted on the housing.

Higher dust holding capacity

Along with a robust product design, an important objective of the new development, however, was a significant increase in the dust holding capacity with the same dimensions and low pressure drop. This was achieved through a new design for the air inlet. While the previous design had an inlet in the middle and an additional air guiding device for dust pre-separation, the new design has a tangential air inlet and an air guiding fitting already integrated in the housing. The result of this change is a dust holding capacity which is greater by up to 50 percent and also cost savings as the air guiding device is no longer required. A further innovation is that a service indicator available as an option can be connected to the air cleaner.

The air cleaner can be mounted in 90° positions in relation to the air inlet which opens up a large number of mounting and fitting possibilities. In addition, by means of tool change actions, the air inlet can be set to be tangential to the right or left side of the housing and the position of the dust discharge valve can also be selected to match the installation position of the filter on the vehicle.

Alternative to metal air cleaners in India

The second air cleaner is a new development for the Indian market designed for use in light to moderately heavy commercial vehicles with a nominal air flow rate of 16 m³/min. The main objective of this new development was to offer an alternative to the sheet metal air cleaners which are still widespread on the Indian market. The aim was to increase filtration performance and simultaneously reduce weight and costs. Also here, the use of polypropylene reinforced with fiber glass served to reduce weight without compromising the robust concept.

Just as with the first air cleaner, this air cleaner exploits the advantages of a tangential air inlet and an air guiding fitting already integrated in the housing. The result, depending on the operating conditions, is a considerably higher dust holding capacity and cost savings through the simpler design of the filter using fewer parts compared to systems which are still commonly found on the market. The fitting of an optional service indicator is also possible with this air cleaner.

In this case a large number of fitting and mounting possibilities can be realized by the use of an additional metal holder to mount the air cleaner. In addition, by means of tool change actions, the air inlet can be set to be tangential to the right or left side of the housing. As with the first air cleaner the position of the dust discharge valve can also be selected to match the installation position of the filter on the vehicle.

The development of both air cleaners was carried out with global cooperation within the MANN+HUMMEL R&D network. As a result, R&D teams in the Indian and Chinese subsidiaries worked closely with company engineers in Germany. This allowed global and local experience and expertise from the development and production processes to flow into these innovative air cleaners.
Since autumn 2015 a long-term study is running at the MANN+HUMMEL cabin air filter center in Himmelkron, Germany, where the engineers are mainly focused on one task: ‘We want to measure exactly how many particles reach the passengers in the cabin’, explains project manager Eva Hallbauer. ‘We are investigating how the concentration of dust particles in the vehicle interior changes during different conditions in everyday operation such as, for example, with or without filter, with a new and a fully loaded filter, or with low or high ventilation mode. This leaves the affected persons exposed to higher health risks such as inflammation of the respiratory tract and a higher risk of thrombosis.

Real exposure recorded
As local dust concentrations are strongly affected by the weather situation and the distance from particle source, stationary measurements are only partly able to map the actual, constantly changing loads to which vehicle occupants are exposed. Therefore, measurements directly inside the vehicle are essential. They also represent an important correction for laboratory tests in which the filters are exposed to much higher particle concentrations according to ISO standards and other dust compositions than on the street.

It’s what reaches the vehicle occupants that counts
MANN+HUMMEL is not only testing cabin air filters on modern test benches according to ISO standards – they also test filter elements with scientifically conducted field trials under real operating conditions. In the tests the focus is on efficiency and the long-term effectiveness of the filters.

‘The results from the field tests will be directly used for the development of our media.’

Eva Hallbauer,
Project leading engineer

ALASKA project: clean air for fuel cells
In another current project, the focus is not on particles, but on the filtration of harmful gases. In the scope of the ALASKA project supported by the German Federal Ministry of Economics and Technology, the Daimler AG, MANN+HUMMEL Innenraumfilter GmbH & Co. KG, the Research Center Jülich GmbH and the Fuel Cell Research Center ZBT GmbH, Duisburg, are currently working together. The aim is to lower the influence of harmful gases on the sensitive fuel cells in order to improve regeneration and durability of the fuel cells. MANN+HUMMEL has the task of developing cost-efficient activated carbon filters and filter maintenance strategies for the air supply of fuel cells.

The engineers at MANN+HUMMEL use a commonly available middle class estate car for the tests fitted with a spectrometer to measure particle sizes. It records the number and size of the particulates in the cabin and ambient air. The following scenarios are currently under investigation:

- Long-term tests: How does the efficiency of cabin air filters change during filter lifetime?
- Stationary tests: These tests include a comparison of the particle concentration in the ambient air and in the cabin. How do different materials, operating modes of the air conditioning or a badly fitted filter element affect the filtration efficiency?
- Field trials: How does the load level in the cabin change on a defined test section including city traffic, country roads and motorway driving?

‘The results from the field tests will be directly used for the development of our media, especially for further improvement of the separation efficiency. This allows us further fine tuning of cabin air filters to special customer requirements for different real situations’, concludes the project manager.
Engineering competence in China

In the global automotive industry, vehicle manufacturers and suppliers are working more closely together to enhance the products. The systems developed by MANN+HUMMEL are a case in point with the company’s engineering center, established in Shanghai, delivering key components to local joint venture vehicle producers as well as for global OEMs.

The SGMW venture in China is a joint manufacturing facility involving General Motors (GM), Shanghai Automobile Industry Co. (SAIC) and Liuzhou Wuling. The company produces a range of utility vehicles for rural markets, which has accelerated SGMW into becoming the country’s largest auto maker of its type. MANN+HUMMEL has enjoyed a very successful relationship with the company and has recently developed intake manifolds for three different engine types. All of them posed significant technical challenges.

The first one is a passive intake manifold for a naturally aspirated 1.2 liter 4-cylinder gasoline engine. It utilizes a resonance effect delivering better torque performance due to the optimized runner length for good torque output at low engine speed. Another version of this intake manifold is an active one with variable runner length. The switching between the different runner lengths leads to an improved torque output and, therefore, boosts performance of the car. Also, two turbocharged gasoline engines (1.2 liter and 1.5 liter) from SGMW are equipped with newly developed intake manifolds by MANN+HUMMEL. This clearly demonstrates the successful relationship between the two companies. All intake manifolds will be supplied out of the company’s production plant in Liuzhou, China.

An important element of the development and supply of these intake manifolds is the structure of MANN+HUMMEL. The company has continuously extended its development and production capabilities all over the world within the last years. This has resulted in the establishing of an engineering center and five production plants in China only. The engineering center, located in Shanghai, has the expertise and capabilities to handle the complete product development process, including modern simulations and analyses. By using the different platforms of the global MANN+HUMMEL engineering network, each MANN+HUMMEL engineering center is able to share know-how and transfer solutions as well as experience across the globe. The successful engineering team concept delivers globally high standards together with local customer support all at the same time.

By opening its sixth plant in China in October 2015, MANN+HUMMEL further expands its global presence. Besides the plants and engineering centers in Shanghai, Changchun, Jinan, Liuzhou and Bengbu, the new production plant in Chongqing, located in Southwest China, will meet the requirements of local and global customers even better. Another goal of the new location is to accelerate the company’s development in China. With an investment of 30 million RMB (4.3 million EUR), MANN+HUMMEL provides its customers a convenient access to high-quality filtration products locally. At the new production site air cleaner systems and intake manifolds are already in production. Customers being served are for example Changan Ford and Changan Suzuki, and are produced in the Portage, Michigan plant.

The huge importance of China has already been recognized in 1996, when MANN+HUMMEL entered the Chinese market. Today around ten percent of MANN+HUMMEL’s global business is achieved in China.

The Soundpipe of MANN+HUMMEL is such a measure: It increases the pulsation of naturally aspirated engines by the use of a membrane and guides it via sound pipes into the passenger compartment. For decades MANN+HUMMEL contributes to the pleasant sound of engines with its acoustically sophisticated intake systems. One important role in doing so is to dampen undesirable noise from the air intake sound. This accommodates the high emotional importance the vehicle sound has for the purchase decision of cars. Moreover specific sound measures are used for sound branding and to increase the engine sound. As one example the sound feedback in the passenger compartment is increased for the drivers of sports cars without exceeding the legislation limits for vehicle noise on the outside.

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MANN+HUMMEL is awarded with ‘Open Innovation Award’

The Zeppelin University, based in Friedrichshafen, Germany, hands out the ‘Open Innovation Award’ for outstanding, entrepreneurial innovation performance. MANN+HUMMEL was awarded in the category ‘Best Cultural Change’ as the filtration specialist defined its orientation towards Open Innovation and for this purpose promoted an internal cultural change within a very short time.

With this prize the institute honors the most innovative companies in the German-speaking area. What matters in this respect is not the number of innovations, but how purposeful a company approaches innovations.

To enable systematic innovations it’s crucial to establish optimal framework conditions. Therefore, MANN+HUMMEL substantially revised its innovation process. Furthermore, the advanced development was set up globally in order to be able to develop innovations for the regions locally and to work closer together with local universities, customers and development partners.

Sustainable cooperation

The Japanese automotive company AISIN Seiki and MANN+HUMMEL maintain a strategic alliance for the production of intake manifolds through that the so-called blowby gas enters the crankcase. This blowby is a mixture of air, finest oil droplets and different combustion products. To protect components such as the turbo charger, the blowby has to be removed from the crankcase and the oil has to be separated from the aerosol. The oil free but very wet air can then be introduced to the intake air.

MANN+HUMMEL is a system supplier for all components of the crankcase ventilation system. One component besides the important oil separators (please refer to Automotive News 02/2015) are heating pipes. They are located at the inlet of the crankcase ventilation into the clean side duct and prevent the icing of the duct at low temperatures which can occur due to the high humidity in the air.

MANN+HUMMEL is awarded with ‘Open Innovation Award’

The Japanese automotive company AISIN Seiki and MANN+HUMMEL maintain a strategic alliance for the production of intake manifolds for years. The most recent result of this cooperation is an active intake manifold for the new V6 engine platform of Toyota. The volumes for the North American market are thereby produced - by MANN+HUMMEL out of the company’s facility in Portage, Michigan.

Due to an integrated resonance flap the plenum of the intake manifold can be divided in two volumes. This enhances the torque output of the engine, depending on its load condition, significantly. The switching of the resonance flap is achieved by a vacuum actuator controlled by a solenoid valve. The intake manifold is applied to a wide range of car models within the Toyota group such as the new Lexus RX, Toyota Highland and Toyota Sienna.

Active intake manifold from MANN+HUMMEL

Driven by ideas

Rely on ‘Made by MANN+HUMMEL’ for innovation, filtration competence and service throughout the world.

See for yourself by visiting us at the IAA Commercial Vehicles in Hanover from September 22 to 29, 2016.
We’ll do anything for our customers. And when it comes to CO₂, that’s a lot.

INTEGRATIVE, INTELLIGENT, INNOVATIVE.
Our intake manifold with integrated charge air cooler and E-Booster is a real power pack. At the same time, it makes an important contribution towards lower emissions and economical mobility without having to compromise on performance or torque. Such complex and intelligent products can only be created by those with a strong innovative drive, the necessary expertise, and the will to do it. For example – us.

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