Cylinder head covers
Advanced Engine Plastics - Modular, flexible, intelligent
Treat it rough, make it tough:
While your customer enjoys
a fast drive, our cylinder head cover module endures a grueling test.

It's good to know it's made by VICTOR REINZ.
For more than 50 years, VICTOR REINZ has been an established name among the world’s top automobile manufacturers. Reliable, top-quality products and on-time delivery are as much a part of VICTOR REINZ as our innovative design and systems competence. At VICTOR REINZ, good ideas continue to evolve and our cylinder head cover modules continue to improve. This spirit of innovation enables us to consistently find new ways to upgrade the performance of our cylinder head cover modules – and, in turn, your engine. We will continue to meet the demands of engine builders now and in the future.

Beyond our competitors
By continually improving the performance of our cylinder head cover modules in terms of durability, sealing, acoustics, and oil separation, we frequently discover solutions that determine future market developments. Each change is designed to help maintain the optimum balance between performance and economy. We call this »Advanced Engine Plastics«.

However, we don’t stop there. We utilize the most advanced equipment, the most rigorous testing standards, finite element analysis (FEA) compliant hardware and software, and deep expertise to provide products that truly stand out in the marketplace. Equally important, every employee at VICTOR REINZ is truly committed to serving our customers.

When you choose VICTOR REINZ, you benefit from the most sophisticated manufacturing and material technology, from injection and injection/compression molding to technical thermoplastics and thermosets. And you’ll receive the highest level of consulting, development, production, logistics, and service competence.

Just one example: in Neu-Ulm, VICTOR REINZ operates Europe’s most modern manufacturing plant for cylinder head cover modules created with thermosetting plastics.

Sealing Products – VICTOR REINZ: A global presence
In 2003, DANA Corporation consolidated and reorganized its five gasket, shielding system, and cylinder head cover module facilities into a central, clearly defined group: Sealing Products – VICTOR REINZ. As a world leader in gasket production, DANA now delivers service and support from 19 locations in Europe, North America, South America, and Japan through subsidiaries and affiliates. You’ll find us in every important automotive manufacturing hub providing the most innovative system solutions in the world.

Performance defined.

VICTOR REINZ
- Recognized for providing the world’s most innovative gasket solutions
- Top-quality products and high process reliability
- Total systems competence
- Worldwide access to consulting, development, production, logistics, and servicing at the highest level through new organizational structures

FEA – Finite elements analysis
Always faster, always better - From initial concept to series production

STREAMLINED PRODUCTION CYCLES

Every business strives to perform faster and better, but this is especially critical in the rapidly changing automotive world.

**Fast response**

Time and again, our customers are surprised by the short lead times at VICTOR REINZ. We do this by employing all necessary experts in-house, from development to series production. Our design system is compatible with your in-house CAD system, whether it’s CATIA, ProEngineer, IDEAS, or Unigraphics. In addition, we can perform all the important validation tests on-site with our own equipment. As a result, handling times are greatly reduced, and we can deliver installation-ready cylinder head cover modules directly to your assembly line, based solely on environmental data.

**Smart combinations**

Form follows function – and fabrication – at VICTOR REINZ. During the design stage, close attention is paid to simplifying installation. We not only test different mounting options and sequences with FEA simulation, we also use modern prototyping procedures to build functional cover modules at a very early stage. When testing the specific sealing functions, these prototypes supply extremely valuable data. This enables us to determine in advance whether a cover module’s performance is maximized so that individual functions don’t require optimization later.

**Quality from the start**

Since approximately 70 percent of an automobile's components come from external suppliers, the quality of a vehicle depends greatly on the quality of the supplied products. Because quality cannot be improved later, we understand that intelligent product design, exact planning, and compatible engineering from the start will ensure quality assurance in product development and manufacturing.

**Partners with the best**

VICTOR REINZ’s expertise has been valued by the European automotive industry for decades. From the MCC Smart to the Maybach V12 engine and the high-tech head gaskets for Formula One racing engines, VICTOR REINZ supplies complete gasket systems and cylinder head cover modules that are unmatched for quality and performance.

Our aim is to continue partnering with the best by providing top-quality products and service. See our reference list at [www.reinz.com](http://www.reinz.com) for details.
Design that’s right the first time

STEPS TO OPTIMUM PRODUCT DESIGN

Transforming vision into reality
Our project teams consist of application engineers who work with developers, designers, manufacturing and quality experts, logistics specialists, and buyers to find the best solution. In this way, the expertise of each participant is taken into account from the beginning. This close collaboration exemplifies the value we place on our relationship with our customers.

At VICTOR REINZ, repeat trial-and-error prototyping is a thing of the past. Today, clear and direct communication with the customer along with computer-aided analysis reduces testing time and ensures that our designs are correct from the start. This optimized development procedure allows our teams to be fast and flexible. The viability of our processes is borne out when the first prototype goes into series production practically unchanged.
Responsibility from beginning to end

PROACTIVE DEVELOPMENT PARTNERSHIP YOU CAN TRUST

We look forward to being your partner throughout the design and production process and welcome open dialogue at any time – whether it’s contract development or purposeful, objective product consultation. The scope of VICTOR REINZ expertise covers all aspects from development to logistics. Here are a few examples:

Assessment of requirements:
The earlier the better

Cylinder head cover modules provide far more than dust protection, noise shielding, and oil separation, so it pays to consult with us early. If all functional requirements are considered from the beginning – including additional features such as sealing and isolating elements, oil separators, or integrated electronic components like CPUs – complications and loss of time are greatly reduced during subsequent project stages. This attention to detail begins right away, during your first consultation with our application and development engineers. Design procedures are straightforward. We require just a few parameters on installation space geometry – the rest is determined by our engineers.

Design and construction:
Built to fit

While vehicles are not built around the cylinder head cover module, it is still a critical component. Attention to product design combined with high-quality materials is the best foundation for functional, reliable, high-quality cylinder head covers.

Through years of experience, our lessons learned in cylinder head cover design have allowed us to expand and optimize design guidelines. Ever-improving standardized designs allow typical applications to be implemented quickly, cost-effectively and with increased constructional safety.
During the cylinder head cover's design phase, we simulate the automated assembly sequence in the production line and also consider the packaging aspects. Even recycling issues and clean separation of the materials used is factored in. It's all part of going the extra mile for the customer at VICTOR REINZ.

Interfaces:  
> Built-in understanding

Cylinder head cover modules from VICTOR REINZ not only fit the engines for which they are designed, they also fit the 3D computer-design worlds of our customers. We speak the same language as your designers and supply geometrical data of the required cylinder head cover in the specified data format, using the fastest available online data transmission methods.

Finite elements analysis (FEA): Working smarter from the start

Much of the time and cost for development required in the past can now be saved with computer component simulations. In addition, our wealth of practical experience also streamlines FEA simulations at VICTOR REINZ. We're able to continuously refine our computing models and simulations to make our programs smarter and more effective. In fact, during FEA calculations in the design phase, all relevant functional parts and critical areas of the entire composite structure and environment of a cylinder head cover module are examined in detail to ensure optimum cylinder head cover development.

The virtual test bench 1:
2D analyses and load-balance determination for absolute tightness

In the initial testing stage, the profile geometry and gasket groove are optimized by calculating the load curve in the 2D cross-section. Different combinations of geometries and materials are tested in numerous cycles to determine the optimum working range for the cylinder head cover gasket. The aim is to obtain uniform stresses for maximum seal tightness and durability, with simultaneous minimum material creep and stress. Fine tuning between narrow and wide profiles, as well as hard or soft sealing characteristics, is critical, especially with roughnesses or blowholes in the cylinder head.

With isolated cylinder head cover modules, a subsequent axial-symmetric analysis determines the load curves of the isolating elements. Stress calculations enable the characteristics of the elements to be modified precisely to obtain an optimum working range. Special attention is given to the compartmentation of the isolating elements (so called grommets) to prevent damage from excessive compression.

The results of the 2D analyses for the cylinder head cover gasket and isolating element permit the load-balance diagram to be determined. This shows the resulting force of the system across the gap between cylinder head and cylinder head cover, assuming an infinitely stiff cylinder head cover module. During assembly, spacer sleeves ensure a creep-free and captive connection and prevent cracks or even breaks in the plastic. Based on a design sealing gap of 1 mm (0.0394 in), the precise functional dimensions and the number of bolts for the isolating system can be determined.

Optimal alignment of cylinder head cover gasket and gasket groove is achieved via 2D-analysis.

Fine tuning of the force deformation curves of cylinder head cover gasket and isolating element (load-balance determination).
The virtual test bench 2: 3D analyses for optimum cylinder head cover design
In this analysis, the results of the 2D computer testing (characteristics of cylinder head cover gasket and isolating elements) are combined with the cover module’s CAD data to obtain a complete 3D model of cylinder head cover, gasket, bolts, isolating elements, and cylinder head. This model provides very precise information on the mechanical stresses in the cylinder head cover, especially the deflection between the bolts that could create leak locations. In this way, the ideal working range of the cover gasket and the rigidity of the cylinder head cover module can be determined in several cycles for different cylinder head cover designs, including different wall thicknesses or additional ribbing. The analyses are carried out both at room temperature and at extreme temperatures (-30° C/-22° F and +150° C/+302° F).

The virtual test bench 3: Modal analysis combats noise
To prevent a cylinder head cover module from vibrating at undesirable resonant frequencies, it can be examined with time-consuming shaker tests and subsequent step-by-step optimization. VICTOR REINZ employs fast and sophisticated modal analysis.

First, material and structural properties are determined with FEA simulations. Based on a 3D model of the CAD data that takes the mounting points into account, we generate a grid network with vibration characteristics that deliver precise information on resonant frequencies – and the intrinsic stiffness of the cylinder head cover module. In this way, every cylinder head cover module can be constantly improved, speeding up development significantly.

If the model exhibits areas that would oscillate at a critical frequency – such as 200 Hz, a typical limiting frequency for four-cylinder diesel engines – this behavior can be eliminated by defined stiffening ribs, modifying reinforcements, or adding mounting points. This ensures that the first prototype absorbs noise reliably without producing any noise of its own.

The virtual test bench 4: Mold-filling simulations for even better process reliability
Mold-filling simulations are rheological, thermal, and structural-mechanical analyses that ensure both the cylinder head cover module design and manufacturing process are as efficient as possible. Filling analyses simulate the injection process even before the first injection mold is built, to ensure it will be filled completely. As a result, the gate point, necessary filling pressure, mold temperature, and other process parameters can be optimized.

Evaluation of mold tempering, also known as cooling analysis, allows precise evaluation of the solidification process from mold to demolding. With technical thermoplastics, a balance must be found between uniform cooling and an adequate but not excessive injection cycle time. This helps to minimize cycle times, so time and cost savings can be realized at a very early stage in development.
Deformation analysis permits material-, geometry-, and process-specific component deformations to be evaluated after final mold design. This ensures that critical areas are localized more quickly and easily so the mold can be adapted or modified with suitable re-working methods.

**Individual prototyping with added value**

We know all the ins and outs of prototype construction, so a variety of prototypes can be produced on our premises quickly and cost-effectively, based on customer requirements.

- Stereolithography (STL) prototypes check accuracy of the fit and provide the first oil separation tests in the laboratory.

- Temperature-resistant, vacuum-cast prototypes for first engine runs examine basic functions and determine the performance data of cylinder head cover modules. For this, new materials such as polyamide are used.

- Injected space puzzle mold (SPM) prototypes are made of original materials, such as glass-fiber reinforced materials. These prototypes can be manufactured in small series and are used for continuous engine runs under real conditions, as well as field tests.

- Close-to-production aluminum or steel prototypes supply important data for optimizing the final production tooling.

And from VICTOR REINZ you get that decisive extra: Time gained. Our excellent in-house prototyping facilities ensure fast assembly, customization, and adaptation in close cooperation with our laboratories. What’s more, our in-house sealing experts manufacture prototypes for gaskets in and on the cover module within a few hours or days. Modern CNC-controlled measurement equipment ensures optimum quality monitoring, all relevant data recorded in a technical document. Thanks to precise coordination of external and internal resources, our prototyping is extremely cost-effective.

**Testing: Tougher than practical use**

Along with the latest engine testing methods, we conduct extensive testing in our chemical and physical laboratories. Leakage tests, dynamic shaker tests, heat aging tests in climatic chambers, and noise tests ensure that our cylinder head cover modules, like the engine, deliver a long service life under all conceivable operating and environmental conditions. A variety of test and simulation possibilities are available, allowing you to determine the testing scope and budget.

**Cooling analysis:** Amount of solidified material in relation to processing time. Distortion analysis determines component distortion, taking fiber orientation into account.
VICTOR REINZ has worldwide access to 27 engine test benches and associated laboratories for analysis and static/dynamic pre-testing through DANA Sealing Products and its four development centers in Germany, North America, and Japan.

All activities are coordinated by the Competence Center R & D in Germany to ensure your testing incorporates the most advanced technology in the world.

Fuji test according to RPM 550
Sealing tightness measurements are the key to success for the validation of cylinder head cover modules. One of the most critical elements is the cylinder head cover gasket, which seals the cover module against the cylinder head.

In the first step, pressure-sensitive Fuji film reveals the gasket’s pressure distribution on the cylinder head. For this test, the cylinder head cover is mounted on the original cylinder head using original bolts and a precisely defined torque. If the pressure distribution is uneven, correction is possible with a suitable rework of the injection mold (camber) or a modified gasket topography. Finally, the results are compared with the FEA calculations. In this way, we can ensure that our simulation models become more precise with every step.

Leakage test
The leakage test determines the sealing tightness of the overall system. In addition to the gasket, particular attention is given to other sealing elements, such as injection nozzle seals and the lead-throughs for electronic contacts.

For this test, the cylinder head cover module is mounted on a perfectly flat metal plate. The sealing gap of the gasket is measured, and a defined internal pressure is applied to the cover module at room temperature.

After a specified time, the leakage rate can be calculated from the difference between reference pressure and pressure loss, and the precise location of the leak is determined. According to the corresponding technical and customer-specific demands, this is the measure of the module’s sealing tightness.
Car wash test according to RPM 563
For a cylinder head cover module, considerable tensions can arise from sudden drops in temperature, due to the different expansion coefficients of the materials used. The possible consequences include reduced sealing forces, leakages, or even hairline cracks in the plastic. The car wash test provides certainty – and safety. After the cylinder head cover module has been heated in a climatic chamber, it is submerged in a bath of cold water under defined conditions. The testing procedure corresponds to that of the leakage test.

Heat aging test
In normal operation, cylinder head cover modules are subjected to continuous temperature changes that alter the properties of plastics. During the heat-aging test, our modules prove their stability. Usually, due to module setting, the sealing forces are increased in the vicinity of the bolts and decreased between the bolts. Using specific holding times and temperatures, the sealing gap and leakage rate are measured at specified intervals.

Dynamic test
During simulation on the shaker, cylinder head cover modules are cycled through a defined frequency range using various acceleration rates with peak values up to 90 g. Dynamic tests are carried out at different temperatures between -40° C (-40° F) and customer-specific maximum temperatures. Sealing gap, leakage rate, and the resulting pressure values are also measured before and after the test run. In addition, the cover module and its attachments are examined for cracks and breaks.

Compared with virtual simulation, the response generally shows only slight deviations. Data gathered from the test runs is fed back directly to the simulation programs. Dynamic tests offer further possibilities to simulate real operating conditions by shaking the cylinder head together with the mounted cylinder head cover module.
Transport test
At VICTOR REINZ we test from start to finish. In addition to the dynamic and shaker tests — and depending on the attachments for the cylinder head cover module — we carry out a transport test upon request. A complete pre-assembled cylinder head cover module packed in the original transport system is vibrated on the shaker for several hours at negative temperatures. This helps make sure that all seals, bolts, decoupling elements, or other attachments stay in place during transport for smooth operations at the assembly line.

Stability tests
Normally, a cylinder head cover module consists of numerous components that are injected, pressed, or plugged into the module. Various tests ensure the high stability of all components, as well as durability of the entire module, including:
- Inserts — The pull out and back out forces plus a possible bolt fracture (break out) are established when new, and after heat aging in the climatic chamber.
- Venting valve, injectors — Determination of the pull out force.
- Oil filler cap — The assembly, locking, and releasing torques are measured before and after heat aging and a car wash test.

Real tests provide final certainty
VICTOR REINZ can carry out additional loading tests under real operating conditions using original engines and cylinder head cover modules on our engine test benches. Here, our cylinder head cover modules are subjected to years of material stress within a few weeks. All actual test runs for cylinder head covers are decided in consultation with our customers.

Synergy effects during testing
The comprehensive range of testing and simulation equipment available at VICTOR REINZ is the result of synergy between testing of head gaskets, secondary sealing systems, and shielding systems. We use the same equipment and benefit from the expertise of all the engine experts at VICTOR REINZ.

Systematic safety
With the transport test we guarantee consistent quality up to the assembly line.

From icy cold to burning hot: The thermal shock test at -30 °C (-22° F) causes engine and cylinder head cover module to age several years within hours.

Manufacturing process for a cylinder head cover module of thermosetting plastic: Injection and injection/compression molding, deflashing, cooling, insert assembly, gasket assembly, baffle assembly (oil separator), bolt insertion, sealing tightness check, laser inscription, final inspection, and packaging.
Manufacturing: A decision with consequences

The VICTOR REINZ injection and injection/compression molding process
With VICTOR REINZ, you can choose between thermoplastic and thermosetting plastic to select the material that best meets your demands for a new cylinder head cover module. Our manufacturing methods feature the latest technical developments – regardless of the material you choose. The VICTOR REINZ injection molding process combines a high level of integration and simple tooling technology with short cycle times. Our injection and injection/compression molding processes are more suitable for cylinder head cover modules with high flexural strength, minimum creep, and tight tolerances. Both methods are suitable for processing thermoplastics as well as thermosetting plastics.

Intelligent manufacturing procedures
Innovative manufacturing procedures often result from a need for cost-efficiency. VICTOR REINZ manufactures all cylinder head cover modules using in-house facilities. At present, our site in Germany is the largest and most modern processing plant for thermosetting plastics in Europe.

Regardless of location, our manufacturing procedures and technologies are state-of-the-art and in accordance with international quality and ecological standards. This ensures that the economic advantages offered by our manufacturing technologies are maintained for the benefit of all our customers.
Practically all manufacturing procedures at VICTOR REINZ are automated and robot-controlled. Our production lines have a modular layout with clearly structured manufacturing cells, which increases overall productivity and allows us to offer an attractive price/performance ratio. This structure also permits us to install a new production line on short notice in any of our sites worldwide.

VICTOR REINZ is also paving the way in tooling technology. Due to quantity-related tooling concepts, only the truly necessary costs are incurred, which is especially beneficial for small runs.

Highly automated production lines minimize time and cost.
Logistics and packaging: Custom-designed for your line

VICTOR REINZ delivers cylinder head covers packed and ready for installation directly to your assembly line, thus simplifying your logistics.

We also design packaging to maximize economic, ecological, and logistic aspects. To ensure that «just-in-sequence» really means quality all the way to the assembly line, we employ logistic tracking systems such as DLL, CMMS3, and eCAP.

Our technical expertise and best quality practices would be in vain if the last link in the chain was not as strong as the preceding ones. And we do all that for one simple reason: to go above and beyond the expectations and requirements of our customers. That’s why every day at VICTOR REINZ we strive to turn satisfied customers into delighted ones.

Put us to the test

- Single-source responsibility from beginning to end
- State-of-the-art development and prototyping tools
- Worldwide access to services
- Coordination through the Competence Center R & D in Germany
- Systematic quality assurance from production at VICTOR REINZ up the customer’s assembly line
Modern cylinder head cover modules not only protect against moisture or dust, and control pressures, they also guide oil vapors back to where they belong – and look good while doing the job.

»All in one«: Focused performance and high functionality

At first glance, the basic function of a cylinder head cover module is simple: Seal the cylinder head against oil leaks and emissions such as moisture or dust. As a global leader in sealing, achieving this task is easy.

But today’s engines require ever-greater functionality. This includes pressure control, oil separation, engine electronics, and air filtering. The integration concept for modern engine design can be extended freely and into practically any direction.

In addition, application-specific requirements such as the use of different electronic injection systems for diesel engines or additional ignition coils for gasoline engines create even more challenges for cylinder head cover modules. Cylinder head cover modules from VICTOR REINZ are designed to answer all these challenges.

A cylinder head cover module must do far more than combine sealing with a few other functions. For example, unaffected by ambient temperatures up to 150° C (302° F), it must also withstand contact with partially aggressive media. Simultaneously, the cylinder head cover is expected to absorb sound without generating any noise of its own at the vehicle’s typical operating frequencies. This requires a combination of complex, sometimes contradictory properties, such as blending pleasing design, thermal resistance, and reliable sound absorption. The result is a highly stressed component that combines numerous functions – and is also expected to look good.
WHY YOU SHOULD PLAY IT SAFE

A growing number of automotive manufacturers are placing their trust in VICTOR REINZ cylinder head cover modules. In addition to meeting all of the above demands, our cylinder head covers are so reliable that they perform their tasks throughout the vehicle’s lifespan.

For our customers, this makes the selection of a suitable cylinder head cover concept a simple matter.

Functional demands for cylinder head cover modules

- Sealing the cylinder head against oil leaks
- Sealing the cylinder head against emissions such as moisture (corrosion prevention) and dust
- Pressure control
- Oil separation
- Good sound absorption properties, or noise, vibration, and harshness (NVH)
- Temperature resistance
- Good adaptability to surrounding component shapes
- Lightweight construction
- Attachment of additional parts
- Reliable operation throughout the vehicle’s lifespan
Two solutions for any challenge

THE FUTURE BELONGS TO PLASTICS

Because cylinder head covers have been around nearly as long as automobiles, many new materials and concepts have been developed for them. Today, there is a confusing diversity. VICTOR REINZ offers two cylinder head cover concepts based on thermoplastics and thermosetting plastics. With outstanding material and processing properties, as well as the efficient and economic integration of additional components and functions, these two options greatly simplify your choice. We strongly believe that the future belongs to plastics.

If need be, VICTOR REINZ also has the capabilities to develop and manufacture other concepts with selected business partners, including cylinder head cover modules of aluminum or magnesium. But the simple fact is, the two basic VICTOR REINZ concepts are not only adequate, they are far superior to all competitive solutions.

NOT ALL PLASTICS ARE CREATED EQUAL

By no means are all plastic cylinder head cover modules on the market the same or even comparable. The advantages offered by plastics must be based on a solid technical foundation. Cylinder head cover modules and their components must withstand accelerations up to 90 g, resist temperatures between -40° C (-40° F) and 150° C (302° F) and remain fully functional during the engine’s entire life.

VICTOR REINZ is your guarantee for that level of quality and performance.

MANY ADVANTAGES OVER METAL

Plastic cylinder head cover modules reduce weight. Molding flexibility permits designs that deliver outstanding sound-absorption properties. Plastics enable cylinder head cover modules to be manufactured simply, cost-effectively, and quickly. Time-consuming machining steps such as turning, milling, and drilling are eliminated because injection-molded plastic cylinder head cover modules come out of the machine in their final shape and finish.

What’s more, plastic reduces processing and logistics costs because the granulated raw material is easily transported and stored. Once the mold has been made, manufacturing of cylinder head cover modules can be started quickly and without hitches anywhere in the world.

Ready for your next successful series.
TWO CHOICES: ONE GREAT RESULT

Thermoplastic or thermosetting plastic? An excellent choice is: Both. A manufacturer who settles for just one type runs the risk of shortchanging the finished product. VICTOR REINZ can give unbiased advice, because at present we are the only manufacturer with in-house production capabilities that allow you to choose – and we will help you make that choice based on your requirements and budget.

The following pages illustrate which concept seems to be more suitable for different applications. In practice, however, consulting with a VICTOR REINZ applications engineer is highly recommended!

WHICH CONCEPT IS RIGHT?

The following table surveys several decision-making criteria. Numerous marginal conditions including the assembly situation or functional specifications must also be taken into account when determining the optimum system.

Discussing your needs with your VICTOR REINZ consultant will clarify the issue.

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<th>Thermoplastic</th>
<th>Thermosetting plastic</th>
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<tr>
<td><strong>Function</strong></td>
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<tr>
<td>Strength/stiffness</td>
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<td>Elongation at break</td>
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<td>Metal bonding</td>
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<tr>
<td>Temperature resistance (short and long-term)</td>
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<td>Media resistance (engine fluids)</td>
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<td>Lightweight construction</td>
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<td>Recyclability</td>
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<td><strong>Processing</strong></td>
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<td>Freedom of design/shaping</td>
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<td><strong>Connecting and joining techniques</strong></td>
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<td>Bolts (self-tapping)</td>
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<td>Clipping</td>
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<td>Welding</td>
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<tr>
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<td>Small runs</td>
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Quick survey: Specific advantages of thermoplastics and thermosetting plastics.
Technical thermoplastics: The classic material

A MATERIAL MAKES VISIONS COME TRUE

Due to numerous advantages in processing and application, plastics are finding increasing use in areas of the automotive industry that were inconceivable just a few years ago. The development of plastics into a high-performance material has made applications in the engine compartment possible at ambient temperatures up to 150 °C (302° F) (and considerably higher short-term peak temperatures). An important role in this evolution was played by technical thermoplastics, as recipes were continuously improved to obtain the necessary high performance properties. An ideal material for our innovative cylinder head cover modules, it permits virtually any vision to be shaped in plastics.

SUCCESS RECIPE NO. 1: TECHNICAL THERMOPLASTICS

In order to use thermoplastics for applications in the engine compartment, their initial monomeric structure is transformed into a polymeric structure. By admixing various chemical substances, partially crystalline thermoplastics are created, and their chemical, mechanical, and thermal properties can be individually modified. These technical thermoplastics make it possible to vary fluidity and processing speed during injection molding. In turn, this allows precise customization of subsequent dynamic strength, warping tendency, and media resistance of cylinder head cover modules. An industrial chemist’s skills are required to determine the right balance from the wide range of different properties. In this way, technical thermoplastic is transformed into the required material for high-performance cylinder head cover modules – polymer by polymer.

Glass-fiber content

By increasing the content of glass fiber or other filler/reinforcing material, tensile strength, stiffness, and temperature resistance can be improved. This also reduces the tendency toward brittleness and thermal expansion.

Mineral filling

Targeted admixture of minerals reduces the anisotropy of individual properties. This results in a considerably improved warping behavior and better dimensional stability.

Additives

Additives are beneficial in areas other than fuel. In technical thermoplastics, they can provide better heat stabilization for optimum thermal properties.

TECHNICAL THERMOPLASTICS: MADE FOR INNOVATION

Unlike conventional materials like aluminum or magnesium, technical thermoplastics invite creativity and innovation in terms of processing, design, and material properties. This makes them ideal for nearly all standard cylinder head cover module applications.

Innovation potential

In addition to new material recipes, the wide range of potential injection-molding procedures for technical thermoplastics opens up exciting new possibilities. These include single and multi-component injection molding using different material combinations, assembly injection molding, or various joining methods using friction welding or laser welding.
Integration possibilities
One of the most significant properties of technical thermoplastics is their potential for integrating additional functions into a cylinder head cover module simply and easily. No other materials offer more possibilities. For example, a complete oil separator system can be incorporated into the cylinder head cover module in a single manufacturing step. In comparison, aluminum or magnesium require complex threaded fastenings, and fitting additional components such as seals.

Freedom of design
Now more than ever, space in the engine compartment is at a premium, and technical thermoplastics offer more freedom of design. Say a cylinder head cover module had to be designed around the intake manifold or some other component: In this situation, the processing techniques for technical thermoplastics not only permit complex shapes to be molded, they also allow an appealing design and a perfect surface finish.

Raw material costs
Without a doubt, plastics are superior in value to alternative materials such as aluminum or magnesium. They will remain so in the foreseeable future as a basic requirement for cost-effective cylinder head cover modules.

Development time and costs
Development time has a direct influence on development costs. Thanks to established processing methods, both time and cost remain within manageable limits for technical thermoplastics. Below the line, it is attractively priced when compared to aluminum or magnesium.

Manufacturing precision
Modern technologies permit technical thermoplastics to be manufactured with the required dimensional accuracy and tight tolerances are achievable. For example, by changing the injection mold's topography, camber of the cylinder head cover's gasket groove can be corrected precisely.

Reduced weight
Another highlight of technical thermoplastics is that no other material can provide the same combination of lightweight construction and strength. For example, stiffening ribs at specific points permits wall thickness to be decreased – thus reducing the overall weight of the cylinder head cover module.

NVH characteristics
In spite of their extremely lightweight construction, our cylinder head cover modules remain quiet – even at vibration frequencies that would exclude other materials. Although acoustic behavior usually improves with increased weight, lighter construction and outstanding acoustic properties are always possible with technical thermoplastics.

Criteria in favor of thermoplastics
- Small to large batches
- Medium temperature levels
- High demands on flexibility
ALTERNATIVE FOR TECHNICAL THERMOPLASTIC

For cylinder head cover modules designed to operate at temperatures with brief peak values of 200°C (392°F) and above, two options exist. The first is very expensive high-performance thermoplastics. The second is thermosetting plastics. Not only are they considerably cheaper, thermosetting plastics exhibit very stable mechanical and chemical/physical properties over the entire temperature range. Additionally, thermosets are non-flammable, making them a smart alternative when things start getting hot in the engine compartment.

SUCCESS RECIPE NO. 2: THERMOSETTING PLASTICS

As opposed to the predominant, high intermolecular forces found in partially crystalline technical thermoplastics, thermosetting plastics have a closely meshed, chemically bonded structure. This gives the material a considerably higher dimensional stability from the start.

Other advantages of this structure are reduced swelling and a lower creep tendency under mechanical loading.

THERMOSETTING PLASTIC: IDEAL FOR DIFFICULT AMBIENT CONDITIONS

Thermoset is ideal for applications where technical thermoplastics approach their limits and plastic materials still have a decided advantage over conventional materials like aluminum or magnesium.

Innovation potential

Thermoset is well established in plastics processing, and its potential is far from being exhausted. By introducing stepped wall thicknesses in the design and

Suitable adaptation of the recipe enables the properties of thermosetting plastic to be changed. The parameters for individual processing steps can also be adjusted, including:

- Temperature-resistance
- Media-resistance, especially for oils, fuels, and their additives
- Electrical stabilization
- Electrical breakdown

Close cooperation with our suppliers ensures that our thermoset plastic cylinder head cover modules always represent an optimum combination of quality, strength, and durability.

Thermosetting plastic: Combining quality, strength, and durability.

Through close cooperation with our material suppliers, we can make maximum use of the design freedom offered by thermosetting plastic.

All properties at a glance: Thermosetting plastics are the perfect choice if the material is to be used in unfavorable temperature conditions.
manufacture of cylinder head cover modules, a new world of possibilities has opened up. Savings in material and costs can be realized, without limiting the module's strength or sound-absorption properties.

Integration possibilities
Today, new approaches in design and production permit numerous functional elements, such as a complete oil separator system, to be incorporated into the cylinder head cover module in a single manufacturing step. (Our rule of thumb: Not everything can be done, but a lot is possible.)

Freedom of design
In principle, thermoset offers the same possibilities as thermoplastic, including complex geometries, appealing designs, and more. The advantage of thermoset over all other plastics is a high-quality, attractive surface for cylinder head cover modules, without the need for any further finishes.

Raw material costs
Here's a big advantage for thermosetting plastic: No other raw material is as inexpensive for producing state-of-the-art cylinder head cover modules. Lower cost for raw materials is an advantage shared by all plastics when compared to metals and alloys such as aluminum or magnesium.

Development time and costs
In contrast to technical thermoplastics, the development costs of thermoset are significantly lower due to less complex designs and simpler manufacturing. Combined with the lower costs for raw materials, cylinder head cover modules of thermoset frequently offer a double advantage.

Reduced weight
Although cylinder head covers of thermosetting plastic are slightly heavier than comparable modules of technical thermoplastic, they are still considerably lighter than those constructed of aluminum or magnesium. Once more, the weight advantage lies with plastics.

NVH characteristics
Lightweight construction and excellent acoustic properties are not contradictory with thermosets. Although they are lighter, cylinder head cover modules made of thermosetting plastic remain quiet even with a noticeable increase of vibrations in the engine compartment and drive train.

As shown by the E-modulus: High mechanical stiffness and low temperature-dependency are properties in favor of thermosetting plastics.

Thermoset plastic advantage: minimum creep behavior.

Criteria in favor of thermosets
¬ Large batches
¬ Constant high temperature levels
¬ High dimensional stability
THE PROBLEM

During operation of every internal combustion engine, slight amounts of the fuel/air mixture and exhaust gases flow down between the pistons and cylinder walls, past the piston rings. This blow-by gas—which is contaminated by fine oil mist and remnants of fuel, water vapor, and soot particles—initially collects in the crankcase.

Blow-by amounts in automobile engines can reach 100 l/min. In truck engines, they can be 360 l/min or more. This can add up to 1 or 2% of gas circulation during combustion. For technical reasons, the crankcase must be ventilated. At the same time, there must be a permanent slight negative pressure in the cylinder head cover module and crankcase, so the gas is not permitted to escape directly to atmosphere. This is not only dictated by law, but also by economic and ecological considerations. The blow-by gas is disposed of by recirculating it to the engine's intake air. However, it must be cleaned first, as thoroughly as possible, by means of a high-performance oil separator system. There are three important considerations in this process:

1.) Combustion residues, including those deposited in the channels of the intake manifold or in ancillaries such as the turbocharger, diesel particle filter, intercooler, or airflow sensor.

2.) The oil in the blow-by gas, which must not be removed from the engine's lubrication system. This prevents the oil level from falling too low between the regular inspections, especially with «long-life» service intervals.

3.) Tougher legislation on exhaust emissions is requiring new solutions. The use of new particle filters for diesel engines in particular is helping to reduce the filter regeneration time.

It’s clear that investments made by VICTOR REINZ in the development and integration of highly effective oil separator systems into cylinder head cover modules are worthwhile—for the environment and for the engine’s efficiency and service life.

NEW EVALUATION AND SIMULATION METHODS

If you want to integrate a high-performance oil separator system into a cylinder head cover module, you need to know the oil particle sizes, oil content, negative pressure requirements in the crankcase and in the intake manifold, and the amounts of gas involved.

To start with, we collect the necessary data utilizing sophisticated measurement equipment, fine filters, and particle size determination. Next, advanced simulation techniques help us obtain an overall view of the problems involved before testing any prototypes.

Every application has different peripheral conditions, so each oil separator system must be adapted to its particular engine and environment. Among other factors, the blow-by amount depends on engine speed and load conditions. To obtain the best oil separation results under all circumstances, our choice of four oil separator concepts offers individual and flexible solutions for coarse and fine separation—and they all have been proven to deliver the highest oil separation efficiency. The choice is simple, really. Why spend the same amount of money for inferior performance?

SAME COST, BETTER QUALITY

It’s a fact that the prices for oil separator systems integrated into cylinder head cover modules are all pretty much the same. There’s a wide range of different concepts too, to make matters more confusing. So, how do you choose?

At VICTOR REINZ, there is a difference.
circumstances, VICTOR REINZ has developed our own procedures in which various evaluation and simulation methods are applied to deliver the best possible solution for every situation.

**Computer fluid dynamics (CFD) flow simulations**
Flow can be simulated by means of CFD. Following the first layout of the oil separator system, a CFD analysis helps to acquire detailed information about the separator’s performance. This fast, cost-effective procedure eliminates the need to build expensive prototypes. The computer-aided drafting (CAD) data of the separator system serves as raw input data for CFD calculations, which are based on FEA. The CFD calculation of an oil separator system permits visualization of the pressure loss (Δp), the oil particle paths in the separator, and an estimate of the separation of defined particle size. Furthermore, by visualizing dead spaces and local turbulences, this method supplies indicators for the first optimization of the oil separator concept or its design.

**X_{50} procedure (engine map-based oil separator design)**
Another popular standard procedure is engine map-based separator design. This procedure employs calculations based on the engine’s speed/load map involving the pressures and X_{50} values. The X_{50} values are characteristic values for the degree of oil separation, such as the performance (efficiency) of an oil separator. From the entire spectrum of oil particles contained in the blow-by gas, the X_{50} value defines those particle sizes of which 50% are removed by the separator.
Starting values for an engine map-based design of an oil separator are the map for volume flow (blow-by gas) and the map for the negative intake manifold pressure. Both are characteristic for every combustion engine. The experimentally based calculation procedure allows very precise initial design and optimization of different oil separator concepts and designs even before a first prototype is built. This permits different oil separator systems to be optimized much more quickly, with a drastic reduction in development time. The aim of the procedure is to keep the oil separator’s specific efficiency curve as close as possible to the range of the smallest particle sizes for optimum separator performance.

Measurement procedures and resulting values
In the first step on the engine test bench, the 3D blow-by gas map shows the amount of blow-by gas based on engine speed and load. This is accomplished by using fine filters to remove the oil contained in the blow-by gas and weighing the oil to calculate the amount.
An optical particle counter allows measurement of the characteristic particle spectrum. For this, the volumetric distribution of oil particles ahead of the separator (raw gas) is measured. Within the size range of 0.2 μm up to 12 μm, the number of different sized oil particles is determined – and thus the size distribution ahead of the oil separator system.

In this way, the typical characteristic of an combustion engine is established, in terms of blow-by gas quantity and the size distribution of suspended oil particles. Now it is possible to reach further conclusions about the engine characteristics and make a preselection for an optimum oil separator system.

Establishing the efficiency curve
In the second step, the particle distribution (particle spectrum) established on the engine test bench is simulated by means of an artificial oil mist on the aerosol test bench. With the help of a functional sample produced by rapid prototyping, the separator’s efficiency curve is determined from the ratio of raw gas (upstream of the separator) and clean gas (downstream the separator). At the same time, the pressure losses across the oil separator system are measured.

Determining the \( X_{50} \) value
Along with the aerosol test bench measurements, the engine map-based design now enables an optimum balance between specified pressure loss and maximum separator system performance to be determined quickly and easily. With this method, the precise \( X_{50} \) value can be established for every load condition of the engine together with the associated characteristic blow-by volume flow, thereby permitting the oil separator behavior to be described precisely.

Validation on the engine test bench
In addition to other evaluations, the system can also be validated on the engine test bench. Using a prototype of the cylinder head cover module with integrated oil separator built according to the optimized engine map based design, the customer-specific performance of the separator system is verified. Typical results of this test run would reveal the remaining oil quantity (measured in g/h), assurance of the specified oil pull through prevention, and proof that the maximum permitted crankcase pressure is not exceeded.
Comparison of our oil separator concepts: How they work, how they perform

**THE SAFE WAY OUT**

When selecting a suitable oil separator system, the general conditions are as varied as the choice of different concepts. With VICTOR REINZ, the choice is made simple. We focus on the most important factors – best performance and efficiency. Viewed in this light, the number of proven separator concepts becomes very limited.

**FOUR CONCEPTS COVER ALL NEEDS**

VICTOR REINZ relies on four established oil separator concepts, ranging from simple inertial or impact separation to complex centrifugal separation, as listed below:

- Volumetric separator
- Labyrinth separator
- Multi-cyclone
- Multitwister™

**INDIVIDUAL AND FLEXIBLE COMBINATION**

VICTOR REINZ oil separator systems can be used singly or in combination with each other. To ensure maximum performance and efficiency, systems consisting of coarse and fine separators are recommended. The final decision about which oil separator or combination is used depends on the operating conditions, including:

- Engine type
- Negative intake pressure
- Pressure loss
- Crankcase pressure, and
- Available space in the cylinder head cover module

Depending on design and operating conditions, volumetric and labyrinth separators can be used as coarse pre-separators, while multi-cyclones are used primarily as fine separators. Based on the design, our Multitwister™ can be used as a coarse or fine separator.

**ADVANTAGE OF PLASTICS**

One valuable feature is shared by all our oil separator systems: The advantages offered by plastics compared to other materials for cylinder head covers. Plastics allow unusual freedom of design and separator layout and the separator can be integrated into the cylinder head cover in a single step during injection molding. Plastic is clearly a simpler and more cost-effective option than cylinder head cover modules of aluminium or magnesium – in which the oil separator system must be installed in several processing steps. And that’s another reason to choose thermoplastics and thermosetting plastics from VICTOR REINZ.

**LOW-COST SOLUTION: THE VOLUMETRIC SEPARATOR**

Volumetric separators are based on the principle of inertial precipitation and are normally used as coarse separators. Due to the separation principle, oil particles of approximately 8 μm and above are removable. A volumetric separator requires a relatively large amount of space, but it simultaneously serves as a pulsation damping volume since pulsations arise both in the crankcase and the intake manifold.
Crankcase pulsations are produced by the oscillating movement of the pistons in the cylinders. In the intake manifold, pulsations arise in the flow of intake air due to the cyclic opening and closing of the inlet valves to admit air to the combustion chambers. In both cases, the pulsation amplitudes and frequencies depend on engine speed and load condition.

Volumetric separators help to create crankcase venting flow that’s far more uniform. This significantly improves the performance of the subsequent oil separator, independently of engine speed or load condition. If sufficient space is available, the volumetric separator can be easily integrated into every cylinder head cover module, making it a very cost-effective solution.

**SIMPLE BUT EFFECTIVE: THE LABYRINTH SEPARATOR**

Labyrinth separators are based on the impact principle. They are used mainly for coarse separation, but they also serve as fine separators in special applications. Due to the reduced cross-section in the area of the lamellae, the oil particles entrained in the blow-by gas are first accelerated and then deflected before they impinge on the lamellae and are precipitated. This works for oil particles of about 6 μm and larger.

Like the volumetric separator, the labyrinth separator can serve as a pulsation damping space. Separation performance is scalable by varying the number, shape, arrangement, and angle of the lamellae.

**PEAK PERFORMANCE: THE MULTI-CYCLONE**

The multi-cyclone is a special version of the radial cyclone — its operating principle is based on centrifugal separation. Depending on the manufacturer’s engine demands, two or more radial cyclones are operated in parallel as a multi-cyclone. As they enter the radial cyclone tangentially, the oil particles are translated into a rotational movement. The resulting centrifugal forces make them impinge on the outer wall of the cyclone.

Because multi-cyclones are able to separate oil particles from about 0.6 μm and greater, they are ideally used as fine separators. They can also be combined with a volumetric or labyrinth separator for coarse separation and pulsation damping. Compared to the other separator concepts, the constructional complexity of a cyclone is relatively high. By varying the cyclone geometry, separation performance is scalable within limits.
The VICTOR REINZ Multitwister™ separates oil particles down to approximately 0.6 μm. It’s an axial cyclone that is based on centrifugal separation. Depending on the demands of the engine manufacturer, two or more axial cyclones are operated in parallel in the Multitwister™. Oil particles enter the Multitwister™ axially, as opposed to the radial cyclone, where particles enter tangentially.

Upon entry into the Multitwister™, oil particles are transferred into a rotational movement and precipitated by the turbulence created at the oppositely directed guide vanes. Gas flow and the separated oil use the same channels, and the forced flow prevents the separator from becoming fouled.

Operation of the Multitwisters™ is independent of its mounting position. Scaling of separation performance is easy and flexible, and can be achieved simply by varying the number of parallel axial cyclones, their diameters, and the number and angle of the guide elements. This permits the Multitwister™ to be used either as a coarse or fine separator. As a coarse separator, the Multitwister™ can also act as a pulsation damper.

The Multitwister™ only requires about one-third of the space of a comparable multi-cyclone separator, so it’s the perfect solution for miniaturization. Thanks to its simple manufacturing concept and high separation efficiency, the Multitwister™ is the most cost-effective, space-saving, and efficient oil separator available today.
WHICH CONCEPT IS THE RIGHT ONE?

The following table surveys several decision-making criteria. In practice, numerous marginal conditions, such as the assembly or functional specifications, must be considered when determining the optimum system. Talking with your VICTOR REINZ consultant will help clarify the issue.

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<table>
<thead>
<tr>
<th></th>
<th>Volumetric separator</th>
<th>Labyrinth separator</th>
<th>Multi-cyclone</th>
<th>Multi-twister™</th>
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</thead>
<tbody>
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<td>Inertial separation</td>
<td>Impact separation</td>
<td>Centrifugal separation</td>
<td>Centrifugal separation</td>
</tr>
<tr>
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<td>≥ 6 μm</td>
<td>≥ 0.6 μm</td>
<td>≥ 0.6 μm</td>
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<tr>
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<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Space requirement</td>
<td>0</td>
<td>0</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Application area</td>
<td>Coarse separation</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Fine separation</td>
<td>(X)</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

++ very good       + good        0 satisfactory        X possible        (X) conditionally possible

Oil separator systems: The clean solution from VICTOR REINZ

- Highly precise analysis of ambient conditions
- Exact determination of oil particle sizes, size distribution, pressure drop, and X₅₀ value by means of the latest analysis techniques and simulation procedures
- Representation and implementation of defined oil separator performances
- Already available today: Progressive oil separator concepts that fulfill tomorrow’s emission regulations

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Comparison of X₅₀ values for different oil separator concepts.

The comparison shows: Oil separator systems from VICTOR REINZ offer more.
AN EAR FOR THE VEHICLE

VICTOR REINZ keeps things quiet. And it’s quite a challenge, considering that cylinder head cover modules and the drive train are major sources of noise in a vehicle. VICTOR REINZ has long been involved with improving NVH characteristics with engine components such as shielding systems, to ensure that the engine compartment and vehicle are as quiet as possible.

SOURCE OF NOISE: CYLINDER HEAD COVER MODULE

Cylinder head cover modules are noise sources for two reasons:
¬ About 80% of sound emission stems from mechanical vibration, which transmits noise to the cylinder head cover via the cylinder head.
¬ The remaining 20% of sound emission is caused by acoustic excitation in the engine due to ignition noise, bearing play, chain slack, or valve bounce.

Several parameters affect the frequency and amplitude of noise emission, including the number of cylinders, two- or four-stroke operation, the effectiveness of possible balance shafts, and materials used for the engine block and cylinder head. The frequencies below 200 Hz are especially important – they correspond approximately to the ignition frequency of a 4-cylinder, 4-stroke engine at 6,000 rpm.

In general, only a system capable of isolating oscillation amplitudes by itself is able to reduce noise emission effectively. The aim of our sound engineers is simple: keep the resonant frequencies of cylinder head cover modules above the engine’s maximum excitation frequency of 200 Hz. By maintaining a potentially large separation from the engine’s re-sonant frequencies, the cylinder head cover’s resonance is minimized, which in turn reduces overall noise emission.

MAKING NOISE MEASURABLE

Only a system capable of damping oscillations by itself will be able to reduce noise emission. That’s why VICTOR REINZ cylinder head cover modules are subjected to corresponding tests and evaluations from the design stage onwards. The measures for good resonant behavior are transmissibility $TR$ and noise emission $SPL$.

Both values depend on the materials used (E modulus), their surface weight, the cylinder head cover design, the applied isolating system, and temperature effects. Moreover, reinforcing ribs integrated in the cylinder head cover at specific points permit adherence to the ideal design, while simultaneously eliminating the shift of the resonant frequencies.

Response characteristic TR (transmissibility)

To determine the response characteristic (TR), the cylinder head cover module is excited via the cylinder head, and the amplitude of the noise emission from the cylinder head cover is measured as a function of frequency. This leads to a logarithmic relationship between the (resultant) cylinder head cover amplitude and the induced amplitude (excitation).

Several procedures are available for optimum acoustic design and validation of cylinder head cover modules:

1.) FEA calculation: Based on material data, and apart from the response characteristic, the noise emission for every range can be calculated. By means of structural changes to the model and selection of corresponding materials with specific parameters, the NVH behavior of the planned component is determined in advance.

Using modal analysis, the cylinder head cover’s natural frequencies are moved outside the exciting frequencies to prevent resonance conditions.

Tracking down noise: Cylinder head cover modules are a major source of noise in vehicles.
2.) Shaker test with a substitute model: The shaker test with a substitute model determines the response characteristics and system isolation due to the isolating element and cylinder head cover gasket. During this test, all of the module’s isolating components are reduced to a mathematical substitute model.

Depending on the number of bolts \((n)\) and mass \((m)\), the cylinder head cover module is represented by a metal disk \(m_{\text{disk}} = \frac{1}{n} \times m_{\text{cylinder head cover}}\). Similarly, length \((l)\) of the gasket groove is reduced to \(l_{\text{disk}} = \frac{1}{n} \times l_{\text{cylinder head cover}}\). Using this greatly simplified model on the shaker, a basic optimization of the isolating system is possible for different designs of cylinder head cover gasket and isolating elements, materials, or gap widths.

3.) Shaker test: This test is carried out by exciting the cylinder head with the cylinder head cover module mounted. Excitation is measured at the mounting bolts, and the response is detected by sensors fitted to the surface of the cylinder head cover module. The acceleration curve of the excitation and the resulting response signals are recorded against time and subsequently transposed to the frequency range. In this way, transmission response and emissions of a real system can be determined in the laboratory. By modifying the isolating elements, gasket, and the materials for the cylinder head cover, the influences and trends can be determined. They are then utilized as the basis for an optimum design of the overall system.

4.) Engine test bench measurement: Response characteristics are measured on the engine test bench under real conditions. The acceleration curves are recorded under different load conditions and at different speeds and temperature situations.

5.) Vehicle measurements: Noise emission of real vehicles is measured on chassis dynamometers by using microphones. Typical measurements are near-field, engine compartment, and passenger compartment.

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FEA-supported modal analysis, taking hotspots into account.

Results of the dynamic test on the shaker and the simulation based on FEA calculations show good conformity.

Tests on the engine stand for final confirmation.
Transmissibility of gasket geometry [dB Re: 1]

Frequency [Hz]

-100 1250 2500 3150 4000 5000 6300

Transmissibility of decoupling element [dB Re: 1]

Frequency [Hz]

-100 1250 2500 3150 4000 5000 6300

Fine tuning in detail: Dependency of response characteristic on the geometry of cylinder head cover gasket and isolating elements, on the elastomer material of the gasket, and on cylinder head cover stiffness.

The example of a cylinder head cover module with a VICTOR REINZ isolating system shows no significant radiation behavior in the critical frequency range around 200 Hz. From about 250 Hz and higher the cover module starts to oscillate more strongly in relation to excitation via the cylinder head.

Maximum noise emission occurs at 400 Hz. The natural frequencies of the module are clearly higher (first natural frequency at 650 Hz). Compared to non-isolated cylinder head cover modules,

the response characteristic of isolated systems is up to 12 dB lower. The response characteristic can be influenced by the following parameters:

- Improvement of damping factors of cylinder head cover gasket and isolating elements
- Change in the geometry of cylinder head cover gasket and isolating elements
- Modification of the elastomer material for the cylinder head cover gasket
- Alteration of the cylinder head cover module’s mass
- Change in structural stiffness, e.g., by including stiffening ribs

Noise emission SPL

Sound pressure can be determined theoretically with FEA calculations. This permits the noise and vibration behavior of cylinder head cover modules to be optimized through suitable design and material adaptation even before the first prototypes are built.
To determine noise emission, the sound pressure level (SPL) is measured with microphones or sound intensity meters at defined excitation frequencies. For this test, both the distance from the cylinder head cover module and the direction of the noise emission are taken into account. The main conclusions on the noise and vibration behavior of a cylinder head cover module are drawn from the interrelation between response characteristic TR and sound pressure level SPL.

Normally, the excellent damping behavior of a isolating system reduces the sound pressure generated by a cylinder head cover module. On top of that, suitably designed plastic cylinder head covers generally perform far better than other materials in terms of sound emission behavior. In this way, the sound behavior of our cylinder head cover modules can be optimized even before the first prototype is built, and the design is matched perfectly to the materials used.

PERFORMANCE IN A NUTSHELL

Increasingly complex and powerful engines require innovative sealing and isolating concepts for their cylinder head cover modules. The recent trend toward components made of magnesium and other lightweight materials has led to reduced component stiffness and increased deformation of the cylinder head cover module. This must be compensated for by the sealing and isolating system. Similarly, the use of fewer mounting bolts and complex component geometries increase the demands placed on the sealing and isolating system even more.

All sealing and isolating elements from VICTOR REINZ are matched precisely to meet each of these demands and provide the best possible safety and functionality even under extreme conditions. Features include:

- Optimum sealing, with low surface pressures
- Compensation of large component tolerances
- Reduced bolt forces and fewer bolts
- Acoustic isolating of components

A typical isolating system from VICTOR REINZ contains the following components:

- Mounting system (bolts, isolating elements, sleeves)
- Cylinder head cover gasket

Unlike metals, plastic materials demonstrate a marked tendency to creep under pressure. That’s why sleeves play a special role in plastic cylinder head cover modules. They permit the bolts to be tightened with a defined torque during the entire service life of the cylinder head cover. This prevents deformations, cracks, and breaks in the plastic and ensures perfect pretensioning of the cylinder head cover gasket and the isolating elements.
Through elastic decoupling of the resonant body cylinder head cover, noise levels can be reduced drastically. However, when this is done, the contrasting demands and component properties of the isolating system must be combined – the first-rate sealing properties of a hard cylinder head cover gasket with the excellent damping of a soft isolating element. The solution is for this is to optimize of the force equilibrium (load balance) by means of FEA simulations.

The following factors are critical in the design of decoupling elements:
- Continuous operating and peak temperatures
- Tolerances of the isolating elements and the compartmentation, cylinder head cover flatness
- Matching the working range of the cylinder head cover gasket
- Matching the applied forces for an optimum balance between gasket sealing function and cylinder head cover distortion
- Service life

The characteristics of the isolating element are determined by the hardness and profile of the elastomer material used. To prevent the isolating element from being squeezed out of shape, its compartmentation must be matched to both the amount of compression and the required volume. FEM calculations provide reliable predictions for tension, expansion, damage from elongation at break, and line pressures for the sealing function of the isolating elements.

For perfect function: FEM calculation of a isolating element.

Everything is taken into account: From the initial idea to service and maintenance.

The quiet solution from VICTOR REINZ.
Isolating elements come with circular or conical profiles. Conical profiles are particularly suited for high compression due to lower creep tendency. Isolating elements can also serve as oil seals and effective bolt retainers.

A gasket’s characteristics are also determined by the hardness and profile of the elastomer material used. The softer the elastomer material, the lower the forces transmitted to the cylinder head cover module (this improves recovery behavior). Harder elastomers must be used if the necessary line pressures are not achieved. Macro-sealing properties can be influenced by varying the gasket height, while the micro-sealing properties change based on local increases of surface pressure. In general, narrow and high profiles are best.

FEA calculations permit reliable predictions to be made on tension, expansion, damage from elongation at break, and both surface pressure (minimum pressure) and width (minimum width) of the cylinder head cover gasket. Under the influence of temperature and time, critical creep of the cylinder head cover gasket can be determined in order to predict the gasket’s service life.

For even longer service life: FEA calculation of a cylinder head cover gasket.
Elastomer gaskets must provide a safe and reliable seal under widely varying engine conditions. This includes operating temperatures from -30° C (-22°F) to +150° C (302° F), in addition to media influences such as aggressive additives or sea water. This is true no matter what application area is considered.

### Abbreviation (to ISO 1629)

<table>
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<th>Abbreviation</th>
<th>ACM</th>
<th>AEM</th>
<th>HNBR</th>
<th>FKM</th>
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<table>
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<th>Ethylene acrylic rubber</th>
<th>Hydrogenated nitrile rubber</th>
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<td>-30 to +150 °C</td>
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### Media resistance

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<td>Coolants</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>++</td>
</tr>
<tr>
<td>Permeability</td>
<td>0</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
</tbody>
</table>

++ very good, + good, 0 satisfactory
matter how large the dynamic sealing
gap movement is between the cylinder
head cover module and cylinder head.
For elastomer gaskets, VICTOR REINZ
relies on four standard materials (see
table).

**PERMEABILITY: NO CHANCE
FOR DIFFUSION**

Permeability, or diffusion of the hydrocarbons contained in gasoline, is a hot topic in American and European automotive circles. While the cylinder head covers themselves hardly permit the diffusion of hydrocarbons, the critical elements in permeability are the elastomer gaskets. The elastomer materials used by VICTOR REINZ are perfectly suited for applications in which hydrocarbons cannot be allowed to diffuse through the cylinder head cover module. In this respect, FKM materials offer advantages over AEM or ACM materials.

![Image of bar chart showing TSG 24h emissions for different gasket materials. The measurement offers proof: Elastomer materials used by VICTOR REINZ exhibit impressively low permeabilities.]
FROM SIMPLE CYLINDER HEAD COVER TO A COMPLEX CYLINDER HEAD COVER MODULE

Individuality can be beautiful, especially when it comes to customized cylinder head cover modules. Indeed, numerous attachments are necessary to create a multi-functional system. We call this »Progressive Advanced Engine Plastics«. These attachments can range from a simple captive bolt to a complete oil separating system integrated into the cylinder head cover. The choice and combinations of attachments are virtually limitless.

FINE TUNING YOUR CYLINDER HEAD COVER MODULE

At VICTOR REINZ, the tuning of your cylinder head cover module encompasses not only its extended functionality, but also its design. Our cylinder head cover modules offer smartly packaged functionality. They’re an integral part of the overall system that work as beautifully as they look. Styling isn’t a purpose in itself, but like everything else, we pay close attention to it.

Operation at higher temperatures up to 150° C (302° F): Cylinder head cover gaskets of AEM elastomer.
Seals and gaskets are critically important components in a cylinder head cover module. They prevent the emission of oil into the engine compartment and the environment, and protect against the entry of dust or humidity into the cylinder head cover module. Sealing off the cylinder head is just one of many sealing functions of a complex module. The sealing system of a highly integrated cylinder head cover module encompasses:

**Cylinder head cover gaskets**
Cylinder head cover gaskets are the workhorses of gaskets. In addition to their primary function of sealing off the cylinder head, they also assume a significant part of the sound-decoupling task. Depending on temperature and functionality demands, different materials (ACM₁ or AEM² elastomers) and varying gasket designs are used.

**Injection nozzle seals**
Especially with diesel engines, severe vibrations can cause isolated cylinder head cover modules to move several tenths of a millimeter relative to the injection nozzles. The »bellows design« of VICTOR REINZ injection nozzle seals, with a metal support and spring ring that are simply pressed into the cylinder head cover, provides a reliable seal. It also offers simple assembly with maximum tolerances of up to 3 mm (0.0118 in.) around the central position. Depending on ambient conditions, these gaskets are manufactured of ACM₁ or highly media-resistant HNBR³ or FKM⁴ elastomers.

**Spark plug seals**
The design of molded rubber seals of ACM₁ or AEM² elastomer is optimized for fast, simple assembly and to provide an absolutely gas tight closure.

**Air filter seals**
Powerful engines need clean air to breathe. Our ACM₁ molded rubber seals ensure safe and reliable sealing. An alternative for sealing air filter housings is PUR foam.

**Oil filler cap seals**
The standard molded rubber seals of ACM₁ elastomer are available in various sizes.

**Bolt seals**
VICTOR REINZ bolt seals provide safe and fast assembly with low vertical integration. The bolt seals for mounting the injection nozzles can be delivered with the cylinder head cover module. They are guaranteed to stay absolutely tight and not get lost during transport. They are made of ACM₁ or AEM² elastomer.

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ACM₁ = Acrylic rubber  
AEM² = Ethylene acrylic rubber  
HNBR³ = Hydrogenated nitrile rubber  
FKM⁴ = Fluorine rubber
FASTENERS

Fasteners hold, guide, close, provide permanent or flexible connections, and are highly variable. In short, our fasteners are true all-around performers.

Bolts

Various standard bolts are used to attach the cylinder head cover modules. The version with a pin (with or without thread) extends the functional range. For example, it can be used to mount a cable support or other ancillary components.

To protect the plastic cover and add stability, inserts can be injection-molded directly into the cylinder head cover. Self-tapping bolts are another fast alternative for attaching ancillary components — simply position, turn, and you’re finished.

Cable clips

Cable clips hold the connecting cables for injection nozzle control, the camshaft sensor, or the ignition cables. Depending on the application, integration into the cylinder head cover module can be simple or complex. They can be attached by undercutting, pushing into inserts, or injection molding.

Hose clips

These are ideal for attaching coolant hoses, heating hoses, or guidance of blow-by gases. Depending on the application, integration into the cylinder head cover module can be simple or complex. It can be accomplished by undercutting, pushing into inserts, or injection molding.

Cable channels

Function or design — or both combined. Cable channels serve as protection for sensitive electronic components and make the cylinder head cover more attractive. Both two-part cable channels and cable channels with integral hinge are available and provide an elegant method of concealing cable quickly and securely.

Quick-connect hose fittings

Quick-connect hose fittings are an excellent alternative to conventional hose clips. They’re easier to install, which is advantageous in certain areas such as the blow by outlet for oil return.
OIL PERIPHERALS

Oil centrifuges
A clean approach to peripherals: In diesel engines, oil centrifuges remove the soot particles from the oil reliably, which serves to increase the oil change intervals. As by-pass centrifuges, they are driven by the operating oil pressure.

Moreover, the pressure control valve helps prevent oil entrainment.

Important factors for the construction of pressure control valves are frost resistance, durability, and control characteristic. Pressure valves are completely preassembled and integrated in the cylinder head cover module.

Oil separators
VICTOR REINZ offers various oil separator systems. Volume and labyrinth separators are preferred as pre-separators, while multi-cyclone and Multitwister™ are used as the main separators. The selected method depends on engine design, crankcase pressure, and pressure loss.

Flexible, individual, and cost saving: The oil filler neck adapter permits various positions for different vehicle models.

Clean and reliable: Oil centrifuges remove soot particles from the oil.

Always under pressure: Our pressure control valves keep the lid on.

Adapter for oil filler neck
If the cylinder head cover module is used in several vehicle models, but the oil filler neck is located in different positions, individually variable adapters are the simple answer. The injection-molded or blown plastic adapters are simply snapped onto the existing oil filler neck. These adapters are a cost-effective alternative to redesigning the entire cylinder head cover module.

Pressure control valves
The pressure control valve ensures that the specified negative crankcase pressure is maintained to prevent blow-by gases from escaping to the environment. However, the negative pressure must not reach a level at which unfiltered air (with dust particles) can enter the engine via leakage or sealing points.

Advanced technology at its best: Multitwister™ (axial cyclone) for perfect oil separation.
VACUUM ACCUMULATOR

Vacuum accumulators serve as a reservoir for power brakes and are able to compensate for pressure variations. The cost-optimized VICTOR REINZ version is injection-molded directly into the cylinder head cover module.

ELECTRONIC COMPONENTS

As the number of vehicle electronics continues to increase, the need to protect them from moisture and other influences also increases. This challenge is easily solved by our cylinder head covers. This is especially important when the engine management system or ignition coils are mounted close to the cylinder head.

Engine management system

Usually, the engine management system is mounted directly to the cylinder head cover module as a complete assembly. It is fixed with self-tapping bolts, and cables are held by special cable clips or cable channels.

Ignition coils

VICTOR REINZ delivers multiple ignition coils mounted firmly to the cylinder head cover module and delivered as a pre-assembled unit. For versions with one ignition coil per cylinder, it makes sense to include inserts in the cylinder head cover module as mounting facilities. This improves fail-safety. On the assembly line, the ignition coils are simply mounted to the cylinder head cover.

FILTERS

VICTOR REINZ integrates both air and oil filters in flat or circular design, with or without integrated sealing elements. Normally, filters are attached directly to the cylinder head cover module for easier disassembly/reassembly during servicing. Corresponding gaskets can be included depending on filter design.

NVH (NOISE VIBRATION HARSHNESS)

Engine noise can be reduced effectively by elastic decoupling of the cylinder head cover or with suitable sound-absorbing covers. This makes covers not only functional, but also attractive.

Isolating elements

LSR elastomers are used in varying designs and degrees of hardness. This ensures that cylinder head cover modules stay absolutely tight and do not generate noise themselves.

Injection nozzle encapsulation

Injection nozzles are potential sources of noise. If a beauty cover with sound absorption is not required, encapsulation of the injection nozzles is often sufficient to control noise effectively. Fitted with a sound absorber on the bottom side, they are simply clipped into the cylinder head cover module.

Intelligent cylinder head cover module: The integrated engine management system makes it possible.

Fewer individual parts and more safety: Ignition coils mounted in the cylinder head cover module.

Keep everything clean: Integrated air and oil filters.

Small parts with a big effect: Noise reduction with isolating elements from VICTOR REINZ.

LSR = Liquid Silicon Rubber
**Beauty covers**
Engine compartment covers from VICTOR REINZ not only ensure an attractive appearance, they also perform several tasks. Excellent noise reduction is possible with isolated mounting and a special sound-absorbing foam layer on the underside. Targeted heat removal to prevent heat accumulation can be achieved with guide channels in the foam, or through special shaping of the beauty cover. VICTOR REINZ engine compartment covers feature pop-in connections that permit simple installation without further mounting elements or tools.

Form and function: Beauty cover by VICTOR REINZ.

**Intelligent detail solutions: Additional VICTOR REINZ components at a glance**

- Gaskets and seals
  - Cylinder head cover gaskets
  - Injection nozzle seals
  - Spark plug seals
  - Air filter seals
  - Oil cap seals
  - Bolt seals

- Fasteners
  - Bolts
  - Cable clips
  - Cable channels
  - Hose clips
  - Quick-connect hose couplings
  - Adapter for oil filler neck

- Oil peripherals
  - Oil separator
  - Oil centrifuges

- Pressure control valves

- Vacuum accumulator

- Electronic components
  - Engine management system
  - Ignition coils

- Filters
  - Oil filters
  - Air filters

- NVH
  - Isolating elements
  - Injection nozzle encapsulation
  - Beauty covers
When it comes to the powertrain, we are the experts. So it’s no wonder that our competencies are not limited to sealing the cylinder head. The name VICTOR REINZ stands for innovative gasket systems – from the engine and transmission to the exhaust system – including shielding and cylinder head cover systems.

The entire world of gasket technology

- Single and multi-layer metal gaskets (RETAILL™)
- Metal gaskets with elastomer coating (Progression™)
- Metal gasket with fiber coating (MatriCS™)
- High-temperature gaskets (Xtreme™, thermo-glide™)
- Sensor gaskets for temperature and pressure measurement (SensoriCS™)
- Composite gaskets (AFM™)
- Screen-printed gaskets
- Molded rubber gaskets (CIPG®, FIPG®)
- Injected rubber gaskets
- Shielding systems for thermal and acoustic insulation
- Multi-functional cylinder head cover systems with efficient removal of oil mist
- Customized solutions for commercial vehicle applications

> “Thanks to VICTOR REINZ, we are using innovations that are just being invented elsewhere.”

1) CIPG = Cured-in-place gasket
2) FIPG = Fluid-in-place gasket
As part of DANA Corporation, VICTOR REINZ has the resources to provide the best solutions worldwide – including ideas, service, and products in automotive manufacturing hubs located in points around the globe.

For this, we have networked all of our competences that optimally supplement and support each other.

As one of the world’s largest independent automotive suppliers, DANA Corporation is represented on every continent. DANA Sealing Products boasts 3,900 specialists who are part of 45,000 DANA employees worldwide. They develop and manufacture innovative gasket systems for the international automotive industry on three continents. This includes technology agreements for emerging markets, providing complete global access to DANA’s expertise.

DANA experts work together with our customers to develop the most advanced innovations based on true company synergy. This multi-disciplined approach allows us to see the big picture, supplying state-of-the-art components, modules, systems, and complete assemblies matched to the needs of the global automotive market.

As a result of this companywide synergy, we at VICTOR REINZ have become faster, more innovative, and more competitive than ever before. Our purchasing, development, and sales advantages are passed on directly to our customers. Our strength and synergy also positions us well for the future.

The DANA Corporation is also committed to promoting mobility, today and tomorrow. At our facility in Neu-Ulm, VICTOR REINZ is already engaged in the production of series-ready components for fuel cells. We are on the threshold of a technology that will no longer be hampered by emissions challenges that plague today’s combustion engines and threaten our environment.

For these developments and anything else the future holds in store, you can be confident that with VICTOR REINZ you’ll always have access to the most advanced and on-target developments, inspired by the close cooperation of our experts worldwide. Like we said in the beginning, it’s good to know it’s made by VICTOR REINZ.

Today. Tomorrow. And as long as there are automobiles.

Solution for the future: Series-ready blupack™ fuel cell stack «Made by DANA».