Cylinder-Head Gaskets

Everything for a Reliable Seal.
ELRING – DAS ORIGINAL
Elring spare parts are supplied by the ElringKlinger Group, a leading development partner and approved OEM supplier to the international automotive industry. Since 1879, the company has been a byword for engineering excellence in gasket technology. ElringKlinger develops and produces cylinder-head and specialty gaskets, plastic housing modules and thermal and acoustic shielding components for engines, transmissions, exhaust systems, underbody applications and auxiliary units – for almost all vehicle and engine manufacturers around the globe. In addition, the company develops and manufactures cell contact systems for lithium-ion batteries and is committed to building its expertise in exhaust gas aftertreatment. Drawing on this experience, ElringKlinger is well placed to tackle the challenges of the future – be it the optimization of the combustion engine or the advancement of alternative drive systems.

The growing success of the Elring aftermarket brand worldwide is founded on the company’s expertise in the OEM sector. By using original Elring products in OEM quality, dealers, workshops and their customers around the globe can enjoy the benefits of superior performance – for an improved driving experience and, ultimately, eco-friendly operation.

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Cylinder-head gaskets are complex high-tech components that are used in modern combustion engines; they are available in a wide range of designs and in various materials. As key components, they help ensure that engines run efficiently, reliably and economically.

In the engine their function is to seal off the various media, i.e. combustion gas, coolant and oil, from each other and from the exterior. As a power transmission element between the crankcase and the cylinder head, cylinder-head gaskets have a major influence on force distribution within the bolted system as well as the resulting deformation of components.

Modern high-performance gasket systems are extremely reliable. Investing a great deal of time and effort, products are developed that ensure reliable operation even under critical boundary conditions, e.g. aggressive media, elevated pressures and high temperatures, throughout the life of the vehicle.

When it comes to the development of cylinder-head gaskets at ElringKlinger and engine manufacturers, intensive test runs are performed on state-of-the-art engine test stands. In addition, premium quality is guaranteed by stringent inspections and tests during the manufacturing process. This ensures that the gasket meets all the technical and design requirements for a perfect 100 percent engine seal.

**Requirements and influences**

**INFLUENCES ON THE CYLINDER-HEAD GASKET**

| **Combustion gas temperature** | +1,800 °C – +2,500 °C |
| **Temperatures in the cylinder head area** | Gasoline engines ≤ 270 °C  

| Diesel engines ≤ 300 °C |
| **Combustion pressure** | Gasoline engines ≤ 140 bar  

| Diesel engines ≥ 200 bar |
| **Deformation** | Due to the ignition pressure in each ignition process, the sealing gap is deformed by 2 – 10 μm in the direction of the stroke. Bending of the cylinder head and cylinder tube also causes transverse sliding movements, depending on bolt arrangement and dimensioning |

| **Materials** | Sealing surfaces on the cylinder head/engine block made of special gray cast aluminum alloys.  

| Thermal stresses cause additional sliding movements |
| **Surface roughness** | $R_z \leq 15 \text{ μ max.}$  

| $R_{max} \leq 20 \text{ μ max.}$ |
| **Coolant and lubricant** | Water – antifreeze/anticorrosive mixture  

| +80 °C – +110 °C; pressure 1 – 2 bar  

| Engine oil +80 °C – +150 °C; pressure 2 – 4 bar (warm) to 10 bar (cold) |
| **Special design features** | e.g. in reciprocating engines, combustion chamber, coolant channel |
ElringKlinger supplies three types of cylinder-head gaskets: Metaloflex™, metal-elastomer and metal/soft-material for various engine designs.

**Types**

**METALOFLEX™ METAL LAYER CYLINDER-HEAD GASKETS**

**METAL-ELASTOMER CYLINDER-HEAD GASKETS**

**METAL/SOFT-MATERIAL CYLINDER-HEAD GASKETS (FERROFLEX™/FERROLASTIC™)**
Metaloflex™ metal layer cylinder-head gaskets

Metaloflex™ from ElringKlinger is a globally recognized brand of innovative metal layer cylinder-head gaskets made of beaded, elastomer-coated spring steel layers. These gaskets are of single-layer or multilayer design, depending on the application. Due to the modular design elements, this gasket system can be matched individually and reliably to suit the specific requirements of the engine. That eliminates time-consuming and cost-intensive iterative steps in development and trials.

The technological superiority of this solution is particularly evident in the case of diesel engines and high-performance gasoline engines with direct injection:
• Metal technology
• Elastic sealing with beads for macro sealing
• Elastomer coating for micro sealing
• High thermal stability
• Compensation of high dynamic sealing gap oscillations
• Variable installation thicknesses, dead space minimization

This sealing system is currently acknowledged as the world's undisputed champion in the passenger car sector, while Metaloflex™ has underpinned ElringKlinger’s position as the leading producer of metal layer cylinder-head gaskets worldwide.

STOPPERS
Around the perimeter of the combustion chamber, engine components are elastically preloaded by the stopper. This brings about a reduction in sealing gap oscillations caused by the force of the gas. Conventional solutions consisted of folded and laser-welded stoppers, whereas coined stoppers represent the latest generation. A basic distinction is made in the case of stopper coining in spring steel: in functional layers (segment, serpentine, dimple) and in the carrier plate (honeycomb).

HALF BEADS
Half beads generate two-line compression. They provide a seal along the coolant and engine oil passages, along the bolt holes and all round the outer gasket contour.

FULL BEADS
Full beads generate three-line compression around the perimeter of the combustion chamber. With this elastic sealing element it is possible to seal very high ignition pressures, even when subjected to significant dynamic sealing gap oscillations.

FUNCTIONAL LAYERS
These elastomer-coated spring steel layers feature elastic beads.

CENTER LAYER
The main function of the center layer is to adapt gasket thickness to the installation conditions required by the design.
METALOFLEX™ STOPPER GENERATION I: FOLDED STOPPER LAYER

Without carrier plate

With carrier plate

METALOFLEX™ STOPPER GENERATION II: LASER-WELDED STOPPERS

Without carrier plate

With carrier plate

METALOFLEX™ STOPPER GENERATION III: COINED STOPPERS

Segment stopper in functional layer

Serpentine stopper in functional layer

Honeycomb stopper in center layer
Metal-elastomer cylinder-head gaskets from ElringKlinger are comprised of metal carriers with vulcanized elastomer profiles. This gasket technology is chiefly used in high-performance-capable generations of engine in the commercial vehicle sector with turbocharging and intercooling. They are tailored in particular to innovative drive concepts with four-valve technology, modern injection systems, lighter weight design, higher ignition pressures and maximized engine power. Ignition pressures of up to 250 bar, engine power ratings of above 2,000 kW and engine mileages of over 1.5 million kilometers are handled reliably. These high-performance characteristics are attributable to the specific sealing pressure distribution in the areas of engine block and cylinder head. The sealing pressure is high in the combustion chamber area, while it is low in the fluid area.

**ELASTOMER SEALING LIPS**
They take care of the cooling water and oil sealing. The materials and geometry are adapted to the particular engine. Applying this metal-elastomer design, it is also possible to seal narrow sealing webs.

**CARRIER LAYER**
Depending on the requirements of the engine, the carrier layer uses corrosion-protected steel grades, micro-alloyed steel grades, stainless steel or a special-purpose spring steel in the multilayer version. In the combustion chamber area it has a bead that, together with the combustion chamber underlay (in the single-layer version) or together with the combustion chamber eyelets (in the multilayer version), defines installation thickness and handles gas sealing. The elastomer sealing lips are directly vulcanized, whereas the combustion chamber eyelets and supports are mounted.

**COMBUSTION CHAMBER EYELETS AND COMBUSTION CHAMBER UNDERLAY**
The combustion chamber eyelets and the combustion chamber underlay (in the multilayer version) use thickness to regulate bolt force distribution to the combustion chamber, elastomer sealing lip and support. By means of the combustion chamber eyelets or combustion chamber underlay the installation thickness of the cylinder-head gasket in the combustion chamber area is raised slightly relative to the rest of the sealing area. Sealing pressure increases at the combustion chamber, which, together with the combustion chamber bead, accomplishes gas sealing. For the purpose of micro sealing, a thin, organic coating is applied to the surface.

**COMBUSTION CHAMBER BEAD**
The combustion chamber bead brings about an increase in sealing pressure in the form of a line contour. In the single-layer version the bead provides a static seal. An elastic bead made of spring steel provides homogeneous sealing pressure along the edge of the combustion chamber in the multilayer version. The latter is capable of following dynamic sealing gap movements. In this design the bead is located directly below the combustion chamber eyelets and hence in the main frictional connection between the cylinder head and the engine block.

**Single-layer solution**

![Single-layer solution diagram]

**BAFFLE**
Vulcanized baffles with various flow cross-sections are used in order to control coolant flows.

**Multilayer solution**

![Multilayer solution diagram]

**SUPPORTS**
The metal supports that are used especially in multilayer versions limit the amount of cylinder head flexing and also protect the elastomer sealing lips against excessive levels of compression.
Ferroflex™/Ferrolastic™ metal/soft-material cylinder-head gaskets

Metal/soft-material cylinder-head gaskets from ElringKlinger are comprised of a tanged carrier plate with a soft lining rolled onto both sides. The combustion chamber opening is provided with metal eyelets – these increase compression in the combustion chamber and protect the soft material from the hot combustion gases. If required, a linear elastomer coating is applied in order to provide a fluid seal. That creates higher local compression and hence optimal adaptation of the sealing surface to surface roughness. Elastomer elements are used particularly in pressurized oil systems if the engines are subjected to higher dynamic loads. Complete surface coatings prevent sticking and ensure micro sealing.

The special strengths of metal/soft-material cylinder-head gaskets are to be found in the following areas:
- Adaptation of engine components by soft material sheets
- Compression increase and thermal protection by metal eyelets round the combustion chamber
- Micro sealing by means of coating (10 – 20 μm)
- Additional reliability in fluid sealing due to silicone screen printing

Due to the expanded functionality of the Metaloflex™ and metal-elastomer designs, this type is hardly ever used any more for new designs of engines. However, the metal/soft-material cylinder-head gasket will play a key role in the repair and servicing of used engines for many years to come.
Engine damage – caused by the cylinder-head gasket?

Actual causes and remedial measures
In the case of engine failures the cause is often wrongly sought in the cylinder-head gasket. From the perspective of a mechanic, this is fully understandable because the assumption is that the gasket has been installed carefully in compliance with the repair instructions.

THE HIDDEN REAL CAUSES
If you analyze practical cases over many years, the situation becomes clear: the root causes of engine damage are often completely different. A cylinder-head gasket is usually the last link in the chain to show signs of damage – when it can no longer completely fulfill its actual task of stopping leaks. Consequently, the cylinder-head gasket is finally returned to the manufacturer as a damaged part subject to complaint.

What possible leaks can occur in cylinder-head gaskets?
As regards leaks in the seals of a cylinder head, the substances involved are usually
- Gas
- Water
- Oil

TYPES OF GAS LEAKS
- From one combustion chamber to the adjacent combustion chamber via the sealing web
- From the combustion chamber to the cooling circuit
These leaks normally cause considerable damage and ultimately destroy the seal. Depending on the load on the engine, this can take place suddenly or only after a certain length of time.

TYPES OF WATER LEAKS
- From the inside to the outside
- To the oil circuit
- To the combustion chamber

TYPES OF OIL LEAKS
- From the inside to the outside
- To the cooling water circuit

Slight sweating of water or oil (no drops) on the sealing edge or dried coolant does not constitute leakage. Water or oil leakage can arise over a longer period of time and often initially goes unnoticed until for instance water or oil has to be refilled within an unusually short amount of time.

Taking warning signals seriously and acting on them
If you discover irregularities in operation of the engine, e.g. poor cold-start performance, engine fails to run on all cylinders after a cold-start, loss of power, cooling water temperature in the red zone, oil in the cooling water, etc., you should take appropriate action without delay. At this stage it is still possible to prevent major engine damage.

IMPORTANT
First establish the cause before having the repair done. It is absolutely essential to refer to the engine manufacturers’ general installation instructions. Otherwise the damage can occur again if the repair has not been performed properly.
Black discoloration is a clear symptom
Over-blow of combustion gases at the combustion chamber eyelets of the cylinder-head gasket is one of the most common causes making it necessary to disassemble the cylinder head.

A clear indication is visible black discoloration on the metal eyelets or in the adjacent soft-material area of the gasket. Due to the high gas temperatures, the soft material at these points is overheated and can even burn. The gases often find their way into the cooling circuit. This is indicated by rising gas bubbles in the radiator or by the cooling circuit overheating (pressure in the cooling circuit increases and coolant escapes from the pressure relief valve, resulting in loss of coolant). In the worst case the eyelet is completely destroyed as a result. Uniform discoloration of the combustion chamber eyelets, however, can be regarded as normal and depends on the steel material and the surface coatings used.

Most common causes
In many cases, insufficient compression of the gasket in this area, which is subjected to very high temperatures, is a possible cause. This can be brought about, for example, by failure to subject the cylinder head to the specified tightening torque, failure to comply with the installation guidelines, or the use of old bolts. Components that are not flat (deformed) or have surfaces that are too rough also contribute to insufficient compression of the gasket. Unusually high engine loads in operation can also result in excessive thermal stress for the combustion chamber seal and consequently destroy it.

AN EXAMPLE
Full-load operation directly after a cold start causes extreme sliding movements between the crankcase (gray cast iron) and the cylinder head (aluminum), subjecting the gasket to extreme stress. In addition, the preload forces of the cylinder-head bolts under these conditions are low, thus increasing the dynamic sealing gap movements toward the crankcase and cylinder head.

Very often, especially in the case of truck engines, the specified liner protrusion is not provided – due to lack of knowledge – or is adjusted incorrectly due to installation errors, the liner seating surface in the engine block was not reworked or the liner was not pressed into place properly. That causes the liners to drop, and the required sealing compression is lost. Combustion gases are now able to enter the rear areas of the gasket, where they then destroy the elastomer sealing elements or the soft gasket material in the water and oil openings.
Damage symptoms and causes of gas blow-by

1. Failure of the cylinder-head gasket on commercial vehicles due to gas blow-by

**DAMAGE SYMPTOMS**
Between cylinders 2 and 3 (exhaust area) there is considerable gas over-blow. The soft material of the gasket has been destroyed in the area of the water holes.

**CAUSE**
The cylinder-head gasket was not compressed sufficiently because the bolts were not tightened in compliance with the method specified by the manufacturer. That caused gas blow-by into the cooling water. The result was an increase in coolant pressure, loss of coolant and destruction of the cylinder-head gasket.

**OTHER POSSIBLE CAUSES**
- Cylinder liner has dropped
- Components have become distorted
- The surfaces of the engine components, i.e. cylinder crank case and cylinder head, became too rough
- Cylinder-head bolts used were not new or were of insufficient quality

**MEASURES**
Always use new cylinder heads for reasons of quality and safety. Tighten cylinder-head bolts with the required tightening torque as specified by the manufacturer. Follow the general installation instructions issued by the engine manufacturers.

**DAMAGE SYMPTOMS**
The elastomer sealing element has become detached from the gasket carrier at the tappet opening. The same has occurred at the water opening, thus causing a significant loss of water.

**CAUSE**
An uneven cylinder head surface caused gas blow-by. The elastomer sealing elements were pushed away from the carrier plate by the high gas pressure. The destructive process was accelerated by constant full-load operation of the engine.

**OTHER POSSIBLE CAUSES**
- Insufficient torque on the cylinder-head bolts
- Liner protrusion not adjusted properly
- Cylinder head surface not flat
- Problems in the injection system

**MEASURES**
Before installation, carefully check to make sure the component sealing surfaces are flat; have them faced by a qualified contractor if necessary. Follow the general installation instructions issued by the engine manufacturers.
2. Failure of the cylinder-head gasket on passenger cars due to gas blow-by

**DAMAGE SYMPTOMS**
Combustion chamber sealing web between cylinders 1 and 2 burnt through.

**CAUSE**
The gasket was not compressed sufficiently in the destroyed section because of non-compliance with the specified bolt tightening torque and because the old cylinder-head bolts were used, resulting in gas blow-by. Overheating then destroyed the sealing web.

**OTHER POSSIBLE CAUSES**
- Engine components not flat; sealing webs deformed on the engine block and cylinder head
- Engine not properly adjusted, resulting in overheating

**MEASURES**
During installation, make sure the required installation specifications are observed.

**DAMAGE SYMPTOMS**
Combustion chamber sealing web and soft material between cylinders 3 and 4 are scorched. Onset of dark discoloration between cylinders 3 and 4.

**CAUSE**
Uncontrolled combustion process caused the gasket material to overheat and ultimately destroyed it.

**MEASURES**
Before installation, inspect the injection nozzles carefully and check to make sure they are not leaking. After installation, check injection adjustment. Follow the general installation instructions issued by the engine manufacturers.
3. Failure caused by gas blow-by on 2-layer metal gasket for motorcycles

**DAMAGE SYMPTOMS**
The metal stopper layer and the functional layer show significant black discoloration near the cooling duct. Gas has leaked between the stopper layer and the functional layer.

**CAUSE**
Inadequate clamping forces due to insufficient bolt tightening torque, thus causing insufficient sealing compression.

**OTHER POSSIBLE CAUSES**
- Engine components not flat (deformed by overheating)

**MEASURES**
During installation, ensure that the specified bolt tightening torque is applied.

4. Failure due to pressure build-up in the cooling system as a result of gas blow-by

**DAMAGE SYMPTOMS**
On the multilayer metal cylinder-head gasket, distinct linear impressions can be seen in the area of the water ducts. These originate from the cylinder-head sealing surface and run toward the combustion chamber. The water passages are distinctly light-colored.

**CAUSE**
The surfaces of the cylinder head were machined either insufficiently or not at all. This resulted in blow-by of combustion gases into the cooling circuit and overheating (pressure build-up).

**OTHER POSSIBLE CAUSES**
- The cooling system was not completely vented, thus preventing the circulation of coolant
- Cooling circuit interrupted (water pump, thermostat, fan)
- High exhaust back pressure caused the engine to overheat (e.g. defective catalytic converter)

**MEASURES**
Before installation, check the condition of the sealing surface very carefully and make sure the cylinder head and cylinder block are flat. Have them faced by a qualified contractor if necessary.
5. Failure of the cylinder-head gasket due to pressure build-up in the cooling system as a result of gas blow-by

DAMAGE SYMPTOMS
Clear linear impressions can be seen around the media openings. These originate from the cylinder-head sealing surface and run toward the combustion chamber.

CAUSE
The surface structure of the cylinder head was either machined too coarsely or not at all. This caused combustion gas blow-by into the cooling circuit and overheating (pressure build-up).

OTHER POSSIBLE CAUSES
- The cooling system was not completely vented, thus preventing the circulation of coolant
- Cooling circuit interrupted (water pump, thermostat, fan)
- High exhaust back pressure caused the engine to overheat (e.g. defective catalytic converter)

MEASURE
Before installation, check the condition of the sealing surface very carefully and make sure the cylinder head is flat. Have it faced by a qualified contractor if necessary.
Damage symptoms and causes of overheating

A cylinder-head gasket that has failed due to overheating, for example, is very easy to recognize because of warped soft material in the direct vicinity of the water passages.

If the cooling system overheats, coolant penetrates the soft material matrix of the gasket, where it evaporates due to the adjacent hot engine components and detaches the soft material from the metal carrier. That causes waviness in the material.

One should not underestimate the consequences of using antifreeze and anti-corrosion agents that have not been approved. Additionally, only absolutely pure water may be used as a coolant. The metal carrier plates of the gasket suffer massive decomposition as a result of corrosion, resulting in destruction of the gasket.

Destructive heat
In many cases, damage to cylinder-head gaskets induced by overheating is caused by an engine component that stops functioning. This can be the water pump, a thermostat that does not open, or a radiator clogged with lime deposits (no circulation). However, insufficient water in the cooling system or an improperly vented cooling circuit after the installation of the cylinder head can also be the cause.

Nevertheless, it may be necessary to also consider other destructive factors that were taken into account during initial damage analysis.

For instance, the exhaust system can also be responsible for overheating. A loose component in the muffler or a melted catalytic converter can, for example, lead to a constricted exhaust duct cross section. This increases the exhaust back pressure and causes engine parts and the cylinder-head gasket to overheat. The result is a loss of engine power.
1. Failure caused by overheating in the 2-layer metal gasket

DAMAGE SYMPTOMS
In this type of gasket the metal functional layer is integrated into the combustion chamber seal. Here it is broken in the area of the sealing web. Significant black discoloration is a sign of over-blown combustion gas.

CAUSE
Component distortion resulted in over-blown combustion gases. The resulting overheating destroyed the metal layer.

OTHER POSSIBLE CAUSES
- Low quality fuel (insufficient octane rating)
- Compression ratio too high
- Engine tuning (sparkplugs with incorrect heat rating)
- Insufficient bolt preload force (bolt quality, bolt tightening)

MEASURES
Before installation, check the condition of the sealing surface very carefully and make sure the cylinder head is flat. Have it faced by a qualified contractor if necessary.

2. Failure caused by overheating of the metal/soft-material cylinder-head gasket

DAMAGE SYMPTOMS
The exposed soft material on the gasket is heavily swollen around the water passages.

CAUSE
After installation of the engine the cooling system was not vented sufficiently. The engine overheated because the coolant temperature was too high. Evaporation caused the soft material of the gasket to swell in the water duct area. As a result, the soft material of the gasket became detached from the metal carrier.

OTHER POSSIBLE CAUSES
- Functioning of the cooling circuit was restricted by water pump or thermostat
- Water circulation in the cooling system (e.g. in the radiator) was restricted due to lime deposits
- Use of coolant additive that was not approved by engine manufacturers

MEASURES
After installation, ensure that the cooling system is vented properly.
Damage symptoms and causes of oil and coolant leakage

Careful inspection: where is the leak?
Many complaints that are blamed on the gasket were often caused by some other factor, e.g. crankcase ventilation lines, the boost pressure tube or misaligned components (timing gear case on the cylinder block, etc.). Before assuming that the gasket has caused the damage, the technical surroundings of the engine should be inspected closely. For instance, fan wind or an airstream can blow oil or water away from where it actually originated. The gasket is then blamed for not providing a proper seal.

Cylinder head installed professionally?
After repairs, complaints about oil and coolant leaks are very common. In many cases, however, such leaks were caused by improper installation of the cylinder head. For instance, if the installation instructions were not followed in detail.

If the gasket is not aligned when the cylinder head was mounted, because the centering pins or sleeves are missing for example, leaks can occur. This occurs if the sealing elements of the cylinder-head gasket are not positioned exactly where they were designed to be. Cylinder-head gaskets installed in this way can often be recognized because of bolt through-holes having been deformed. Leaks are particularly common in pressurized oil bores if the cylinder-head gasket is misaligned.

Cylinder-head gaskets for commercial vehicles: it's all about the groove
Various gasket designs are used in commercial vehicle engines. In most cases, they are metal-elastomer gaskets with mounted or vulcanized elastomer sealing elements. Depending on the design, there are recessed grooves in the cylinder block and cylinder head, and sizing is such that the sealing elements operate reliably under all engine operating conditions.

With these types of gaskets it is particularly important for the grooves to be cleaned carefully before installation in order to remove any dirt or residues. If this is not done, leaks will occur.

Damage in the form of crushed elastomer sealing elements can even arise during the installation procedure if care is not taken when mounting the cylinder head on the cylinder block.

AN ACTUAL CASE
A truck engine developed a water loss that could not be detected from the outside. Cause: the cylinder liner had a porous area that was only visible under a microscope. When the engine was running, water got into the combustion chamber and evaporated. The cylinder-head gasket was not to blame in this case either – the cause was a material flaw in the form of a blowhole in the cylinder liner.
It's the surfaces that are crucial

The condition of the component surfaces has a major impact on the sealing function. The various types of cylinder-head gasket designs such as metal/soft material, Metaloflex™ metal layers and metal-elastomer, mean that component surfaces have to meet defined requirements. For instance, the surfaces of the cylinder block and cylinder head have to be machined very finely and may not exhibit any waviness. The transitional areas from one component to another, for instance when a timing gear case is flanged, are particularly crucial. Special care is required in order to ensure that at the joint there is no raised edge or distortion that could prevent a force-locked seal.

Only use approved antifreeze/anti-corrosion agent

When considering all these factors that cause a loss of fluid, the chemical impact of the fluids themselves must also be taken into account. This includes antifreeze and anti-corrosion agent. Many fluids available on the market have not been approved by the engine manufacturers. Due to aggressive additives they destroy the sealing material and cause leaks. So-called leak stoppers that are added to the cooling water have the same effect. Chemical plasticizers cause the sealing materials to swell. After a short period of time this process destroys the gasket. Additional sealing compounds that are applied to cylinder-head gaskets can also have a negative impact because they can interfere with the sealing function of the sealing elements integrated into the cylinder-head gasket. Generally speaking, Elring cylinder-head gaskets are designed in such a way that they do not require any additional sealing compounds.
Damage symptoms and causes of oil and coolant leakage

1. Failure caused by an oil leak, sealing element destroyed during installation of the cylinder head (truck)

DAMAGE SYMPTOMS
The elastomer sealing elements have been pressed away from the carrier plate and have been cut or torn.

CAUSE
Due to incorrect positioning, the cylinder head was mounted more than once during installation. As a result, certain areas of the sealing element were compressed excessively or cut by the edges of the cylinder head.

OTHER POSSIBLE CAUSES
• Sealing element was pressed away by gas blow-by
• Sealing element was excessively compressed due to insufficient liner protrusion

MEASURES
Take great care when preparing and performing the installation work. If the cylinder head needs to be mounted a number of times, the gasket must be inspected for damage.

2. Failure caused by an oil leak, sealing compound on sealing element (truck)

DAMAGE SYMPTOMS
The elastomer sealing element has been pressed away from the carrier plate. The sealing groove contains particles of dirt.

CAUSE
Additional sealing compound was applied to the metal carrier plate. As a result of vulcanization the elastomer sealing element was subjected to additional pressure and pushed away. The result was an oil leak. The damage was accelerated by deposits of dirt particles.

OTHER POSSIBLE CAUSES
• The sealing element was damaged during installation/mounting of the cylinder head.

MEASURES
Before installation, check the condition of the sealing surface very carefully and make sure the cylinder head is flat. If necessary, have it faced by a qualified contractor. Do not use sealing compound. Make sure oil is changed regularly.
Damage symptoms and causes of mechanical factors

Damage due to parts becoming detached
Serious damage can be caused to the engine by the mechanical action of parts becoming detached. For this reason the cylinder-head gasket naturally also exhibits substantial signs of damage.

1. Failure of the cylinder-head gasket due to a loose precombustion chamber

DAMAGE SYMPTOMS
The variable tumble control system plate area of the multilayer metal cylinder-head gasket is badly damaged due to mechanical action.

CAUSE
The swirl chamber for the first cylinder became detached during operation and fell into the combustion chamber. The result: serious damage to the cylinder head, valve train and pistons.

OTHER POSSIBLE CAUSES
• Protrusion at the turbulence chambers did not conform to the manufacturer’s specifications.

MEASURES
Before the cylinder head is mounted, it is absolutely essential to check turbulence chambers for secure fit and protrusion.

2. Failure of a commercial vehicle cylinder-head gasket due to installation error

DAMAGE SYMPTOMS
The metal combustion chamber eyelets of the cylinder-head gasket were completely compressed together internally by the collar of the liner. The collar of the liner was blasted away by the extreme forces when starting the engine (see picture on the right) – the result was serious engine damage.

CAUSE
During installation of the cylinder-head gasket the combustion chamber diameter of the cylinder-head gasket fitted was not checked. The gasket used had a through-hole design that was similar to that of the cylinder-head gasket removed, but the combustion chamber diameter of the replacement gasket was smaller.

OTHER POSSIBLE CAUSES
• The cylinder-head gasket was not an original Elring but an inferior-quality replica that was too thin.

MEASURES
Before installation, place the cylinder-head gasket on the collar of the liner and check to make sure it fits without having to apply force.
"Knocking" damages the gasket
Damage to cylinder-head gaskets as a result of an irregular combustion process is very common in practice. Very often this is associated with knock damage in gasoline engines, resulting in uncontrolled combustion processes.

This is problematic because of the resulting thermal and mechanical overload on the components. The cylinder-head gasket is one of the most susceptible engine parts and it can only withstand this extreme stress for a short period of time. The uncontrolled combustion process generates shock waves accompanied by an extremely rapid increase in pressure (over 100 bar) and also high temperatures (well over +3,700°C). In many cases, crushed combustion chamber eyelets are evidence of cylinder-head gaskets affected by knock damage.

POSSIBLE CAUSES
• Use of non-anti-knock fuel with an insufficient octane rating
• Sparkplugs with incorrect heat rating
• Compression ratio too high
• Gasoline mixed with the diesel

IN DIESEL ENGINES
• Start of delivery for fuel injection not adjusted properly
• Fuel dribble from injection nozzles
• Thickness of cylinder-head gasket installed is incorrect
• Piston protrusion not taken into account when selecting the cylinder-head gasket
• Poor fuel quality

1. Failure caused by uncontrolled combustion process acting on multilayer metal gasket
DAMAGE SYMPTOMS
Onset of black discoloration in the sealing web area of the functional layer points to the destruction process, triggered by unprofessional chip tuning.

CAUSE
An uncontrolled combustion process caused high-frequency vibrations. The resulting shock waves destroyed the sealing web.

OTHER POSSIBLE CAUSES
• Poor fuel quality (insufficient octane rating)
• Compression ratio too high
• Fuel injection system
• Engine tuning

MEASURES
Comply with the installation specifications. Follow the general installation instructions issued by the engine manufacturer.
2. Failure of the cylinder-head gasket due to knock damage

DAMAGE SYMPTOMS
Recesses and deformations can be clearly seen on the metal combustion chamber eyelets. This causes the eyelets and the soft material to fuse. At these points the bare metal of the combustion chamber eyelets can usually be seen and the soft material shows traces of burning.

CAUSE
Engine tuning (ignition advance) was not performed in accordance with the manufacturer’s instructions. That subjects the engine to thermal and mechanical overload. Uncontrolled combustion generates shock waves with extreme pressures and high temperatures, thus exposing engine parts to undue stress. The most frequent damage is caused to pistons and the cylinder-head gasket.

OTHER POSSIBLE CAUSES
- Poor fuel quality (insufficient octane rating)
- Compression ratio too high
- Sparkplugs with incorrect heat rating or defective sparkplugs
- Incorrect ignition timing

MEASURES
Comply with the installation specifications. Check engine tuning immediately after installation.
Professional installation of the cylinder-head gasket in seven steps

Please follow the general installation instructions issued by the engine manufacturers

1. Carefully clean and degrease the SEALING SURFACES of the components (cylinder head / cylinder block), removing any coating residues or gasket remnants.

2. Clean the THREADED HOLES for the cylinder-head bolts to remove dirt and oil. Inspect threads for damage and make sure the bolts turn smoothly.

3. Inspect COMPONENT SURFACES:
   - Remove any raised material with an oil stone
   - Determine the flatness of components over the entire component using a straight edge: longitudinally = 0.05 mm, transversely = 0.03 mm Scores must be removed (have the surfaces faced by a qualified contractor)

4. Center the CYLINDER-HEAD GASKET on the engine block (without applying any additional sealing compound):
   - Make sure the coating is not damaged

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Rmax</th>
<th>Rz</th>
<th>Wt</th>
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<tbody>
<tr>
<td></td>
<td>15 – 20 µm</td>
<td>11 µm</td>
<td>11 – 20 µm</td>
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<td></td>
<td>20 – 25 µm</td>
<td>15 µm</td>
<td>15 – 20 µm</td>
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<td>8 – 10 µm</td>
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5. MOUNT THE CYLINDER HEAD

- Avoid damaging the sealing surface with scratches
- Look out for any residues such as metal swarf that can emerge from the cylinder head and land on the gasket

6. CYLINDER-HEAD BOLTS

Recommendations from the automotive manufacturers:
- Always fit new cylinder-head bolts and washers
- Lightly lubricate threads and bolt seat surfaces with oil

7. TIGHTENING BOLTS

- Follow the tightening sequence indicated in the manufacturer’s instructions
- If bolts have to be retightened, follow the retightening instructions

- If a washer is also being fitted, only apply oil between it and the bolt head
- Important: Under no circumstances should the seat surface of the washer be oiled on the cylinder head
All data specified has been compiled with great care on the basis of our extensive experience. However, no liability can be undertaken, since sealing can only be successful if the particular circumstances of each individual case are taken into account.

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