MLS Cylinder-head Gaskets and Damage Analysis
Tips and Practical Information No. 5
Multi-layer Steel – for the best Cylinder-head Gaskets

Under Extreme Pressure
Victor Reinz® multi-layer steel cylinder-head gaskets set new standards for modern engine design. Thanks to sealing technology at the highest levels of performance and quality, they provide outstanding and efficient results under increasingly tough operating environments – the optimum preconditions for fuel-saving, environmentally compatible mobility.

Innovative cylinder-head gaskets must combine utmost sealing potential with reduced bolt force, low setting losses and low bolt force losses – even with wide bolt spacing – as well as pronounced elasticity and excellent durability. It is precisely these performance characteristics of Victor Reinz® MLS cylinder-head gaskets that make them the optimum solution for present and future engine generations – with lower total weight and reduced rigidity, less installation space, and narrower webs, coupled with higher engine torque and output plus continuously increasing combustion pressures.

Individual Design
Victor Reinz® MLS cylinder-head gaskets consist of two to five sheets of spring or carbon steel, which are sandwiched with the sealing material to form multi-layer steel cylinder-head gaskets. Shaped beads and stoppers plus the elastic properties of the spring steel increase the local line pressure around the combustion chamber and in the backland (macro sealing). Complete and partial elastomer coatings provide additional sealing tightness (micro sealing). For extreme application conditions, vulcanized and molded-on elastomer elements ensure reliable sealing in the backland.

In combination with the cylinder-head gasket’s quality, it is the surface finish of cylinder head and engine block as well as the gasket’s installation that are decisive for good sealing results. Component unevennesses and distortions, reused head bolts, and the use of grease, oil or liquid sealing compounds will deteriorate the sealing effect of even the best MLS cylinder-head gasket. Therefore, the manufacturer’s installation instructions must be strictly observed.

Typical three-layer MLS cylinder-head gasket with top sheet, active layer with Wave-Stopper® technology, and bottom sheet. Beads plus full-surface elastomer coatings improve the sealing potential of these modern sealing systems. Beads for macro sealing, and elastomer coating for micro sealing.
Victor Reinz® Solutions for Leaky, Damaged, Defective Elastomers

**Damage to Cylinder-head gaskets**
MLS cylinder-head gaskets manufactured by Dana are subjected to demanding quality tests during production. Leaks, damage, or total failure of the sealing system are mostly an indication of causes or defects in the engine/gasket system. Consequently, simply replacing the cylinder-head gasket will not automatically solve the problem.

Typical leaks between cylinder head, cylinder-head gasket, and engine block involve gas, oil, or coolant leakages. These leakages occur between combustion chambers, into the coolant circuit, or to the environment. Gas leaks can result in fatal engine damage within a very short time and oil leaks can cause severe environmental pollution.

Pressed-in dirt or foreign objects as well as rough surfaces also cause damage to cylinder-head gaskets. Component unevenness leads to gas blowby between the combustion chambers, and consequently to gasket failure.

**Causal Investigation**
Engine overheating in combination with component distortion, or inadequate compression of the cylinder-head gasket are the most frequent reasons for leakage.

Thermal overloading occurs as a result of defective components in the coolant circuit or incorrect maintenance. Other causes are irregular combustion due to coke deposits, and excessively high exhaust gas pressure after failure of the catalytic converter. Moreover, chemical additives in the coolant and low-quality antifreeze agents can attack sealant coatings.

While reworking the surfaces of cylinder head or engine block in case of component unevenness, distortion, waviness, or scores and grooves, dirt and foreign objects accumulate, which can result in damage to the cylinder-head gasket. Therefore, thorough cleaning of the sealing surfaces is essential before installing the cylinder-head gasket.

In professional terminology, leaks between cylinder head, cylinder-head gasket, and engine block all fall under the general term "leakage". This always involves an uncontrolled exit of media (gas, oil, coolant) between cylinder head, engine block, and cylinder-head gasket.
Fractured Beads and Damaged Elastomers

Broken web caused by high component dynamics

Elastomer coating damaged by overheating

Damage Analysis of MLS Cylinder-head Gaskets
Damage to multi-layer steel cylinder-head gaskets mostly involves two sealing elements: beads and elastomer coatings. The beads can fracture due to various factors, and elastomers can become detached from the substrate material or be scorched. Both of these damage profiles indicate different causes.

Bead Fractures due to excessively high Component Dynamics
Possible causes for excessively high component dynamics are faulty, reused, or un lubricated cylinder-head bolts; incorrect bolt torquing due to excessively high friction during installation; and damage to cylinder head or engine block. Component distortions can also be the result of engine overheating. Similarly, if an engine is operated under pinging conditions (pre-ignition), the high temperatures and pressures can lead to higher component dynamics and possible bead fractures.

Detached Elastomer Coating due to Overheating
Classical causes for overheating are defects of the water pump, radiator, thermostat or hoses, but also insufficient coolant or incorrect venting of the coolant system can lead to thermal problems. Failure of the catalytic converter can also result in higher temperatures due to increased exhaust back pressure.

TIP FROM THE EXPERTS
If the elastomer coating of a removed defective cylinder-head gasket can be peeled off the metal substrate easily with a fingernail, engine overheating is the most likely cause of the failure.

Elastomers are highly specialized rubber that has been optimized to comply with the specific demands of engines. Their outstanding features include excellent slip characteristics, high resistance to media, and function-optimized flow behavior.
Elastomer scorched by Gas Leaks
During so-called blowby, combustion gases flow from one cylinder to the other via the web, or from a combustion chamber into the coolant circuit. This gas flow “scorches” the elastomer or the elastomer coating in the affected area. The resulting lack of micro sealing leads to disturbances in the combustion process and reduced performance – and to a possible pressure build-up in the coolant circuit. Causes for blowby are excessively high combustion pressures, rough sealing surfaces, component distortions, or inadequate compression of the cylinder-head gasket.

Elastomer Coating destroyed by Antifreeze Agents
Contact with antifreeze agents that have not been approved can cause the elastomer coating to become detached from the metal surface. Subsequently, the dislodged elastomer particles can clog the coolant channels and interrupt the coolant flow. The result is an overheated engine. Other typical damage profiles for MLS cylinder-head gaskets are destroyed combustion chamber seals due to incorrect cylinder liner protrusion or faulty liner flange seats, as well as severely damaged Ricardo squish areas due to detached swirl chambers.

TIP FROM THE EXPERTS
Cylinder-head bolts tightened using the torque-angle method are elongated permanently. After disassembly, they are clearly longer than new bolts. If reused, they can break. Therefore, new cylinder-head bolts should always be used when replacing a cylinder-head gasket.

Further detailed information about the optimum compression of cylinder-head gaskets is given in the brochure "Practical Information No. 2 – Cylinder-head bolts and cylinder-head installation" issued by Dana. Simply request your personal copy in an e-mail to reinz.service@dana.com.
**Tips for a Perfect Seal**

**Surface Finish**
The surface finish of cylinder head and engine block has a decisive effect on the performance potential of MLS cylinder-head gaskets. Principally, the better a surface is, the better will be the sealing effect. Surface roughness $R_z$ should not be greater than 15 $\mu$m and $R_{\text{max}}$ not greater than 20 $\mu$m.

**Practical Tip**
Before installing the cylinder-head gasket, check the surface finish and remove any dirt and foreign particles with the Victor Reinz sealant remover RE-MOVE. Component unevenness and distortion can be determined by means of a straightedge; waviness (deviations in parallelism) and roughness are detected with the help of a sensing probe. Possible distortions of the component surfaces should be less than 0.1 mm over a measured length of 1000 mm, or less than 0.03 mm within a measured area of 100 x 100 mm. Stay within the specified values, and process/machine the surfaces according to manufacturer specifications.

**Cylinder-head Bolts**
The choice of suitable cylinder-head bolts and the correct torquing procedure have a lasting effect on the surface pressure quality, and therefore on the perfect compression of the cylinder-head gasket.

**Practical Tip**
Only so-called stretch bolts (waisted bolts) should be used, which can be torqued beyond their elastic limit into the plastic region. With the torque-angle tightening method, the bolt is tightened further by a defined amount (prevailing angle or torque) after a certain torquing value (pretorque) has been reached – re-torquing of the head bolts is no longer necessary.

**Sealing Compounds**
MLS cylinder-head gaskets are designed individually to suit specific engines. Beads, stoppers, elastomer coatings, and partially vulcanized or molded-on elements are adapted precisely down to the $\mu$m. Additional sealing measures are only required if they are specified explicitly by the manufacturer.

**Practical Tip**
When installing cylinder-head gaskets, no sealing compounds, grease or oil should ever be used. Sealing compounds will cure and harden, which changes the coating thickness, and results in leaks. What’s more, they can flow into oil and coolant channels, where they cause clogging. Sealing compounds applied in the combustion chamber area will burn out and impair the bead’s function.

**TIP FROM THE EXPERTS**
*Following the production process, quality experts check the exact layer thickness and profile heights as well as the adhesion properties of the elastomer coatings and sealing elements. When installing a cylinder-head gasket, make absolutely sure not to damage the elastomer coatings and profiles.*
About Dana Holding Corporation
Dana is an integral partner for virtually every major vehicle and engine manufacturer worldwide. Dana is a leading supplier of drivetrain, sealing, and thermal technologies to the global automotive, commercial-vehicle, off-highway markets and for industrial applications. Founded in 1904, Dana employs thousands of people across five continents.

What Can Dana Do For You?
Dana provides high-quality product solutions. This lineup of technologies from one source is designed to offer flexibility to vehicle manufacturers around the world – whether in automotive centers or emerging markets – and ensures that customers get the latest state-of-the-art technologies, as well as products adjusted for specific local markets. With technology centers strategically located throughout the world, Dana engineers have the superior resources to develop, design, test, and manufacture to suit individual customer needs. This close collaboration allows Dana to create everything from advanced single components to fully integrated modular systems.