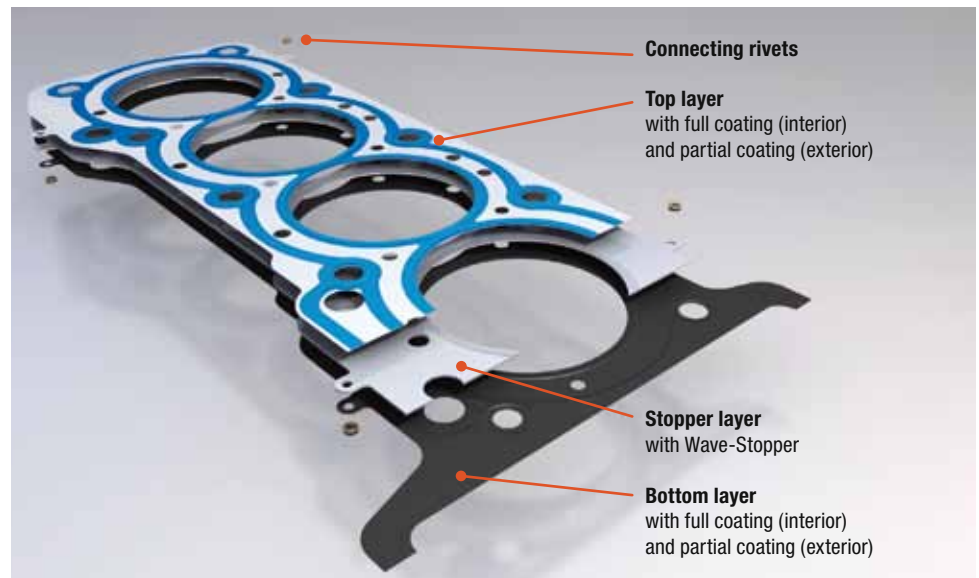


Multi-layer Steel (MLS) Cylinder-Head Gaskets – Innovative Sealing Systems for New Engine Concepts

►
Typical 3-layer MLS head gasket with top sheet, active layer with Wave-Stopper, and bottom sheet beads plus full-surface (interior) and partial (exterior) elastomer coatings improve the sealing potential of these modern sealing systems. Beads for macro sealing, and elastomer coating for micro sealing.



Trend-setting Developments

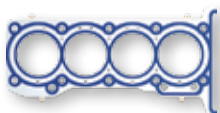
Improved torque and performance, better fuel economy, reduced emissions. During engine design, the development targets determine the demands placed on modern sealing systems. Increasingly high ignition pressures and temperatures lead to high stresses for head gaskets. The solution: Multi-layer steel cylinder-head gaskets – or simply MLS head gaskets.

By 1992 Dana had already developed and launched the first series-produced MLS head gaskets. Today, these gaskets are state-of-the-art, and enable development engineers worldwide to implement innovative new engine concepts.

Multi-layer Steel Offers Higher Sealing Potential

MLS 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 head gaskets. For improved sealing of gases and liquids, beads around combustion chambers and oil/coolant passages increase the local sealing pressure (macro sealing), whilst full-surface or partial elastomer coatings provide additional sealing tightness (micro sealing).



Optimum Surface Finish for Better Sealing

Properties of Sealing Surfaces

Also in future, MLS head gaskets will represent the leading sealing concept. Already today, sealing between cylinder head and engine block is achieved almost exclusively by means of multi-layer steel head gaskets. However, it is not only the head gasket's quality that is responsible for perfect sealing. An equally important role is played by the surface qualities of cylinder head and engine block.

The demands placed on the surface finish are a decisive factor for reliable sealing results. Therefore, it is essential that the specified values are observed when installing head gaskets. Hereby, there is no difference between composite gaskets and MLS gaskets.

Surface Deviations

The following surface deviations lead to reduced surface qualities of cylinder head and engine block:

- Component unevenness
- Component distortion
- Waviness (deviations in parallelism)
- Roughnesses (grooves and scores)

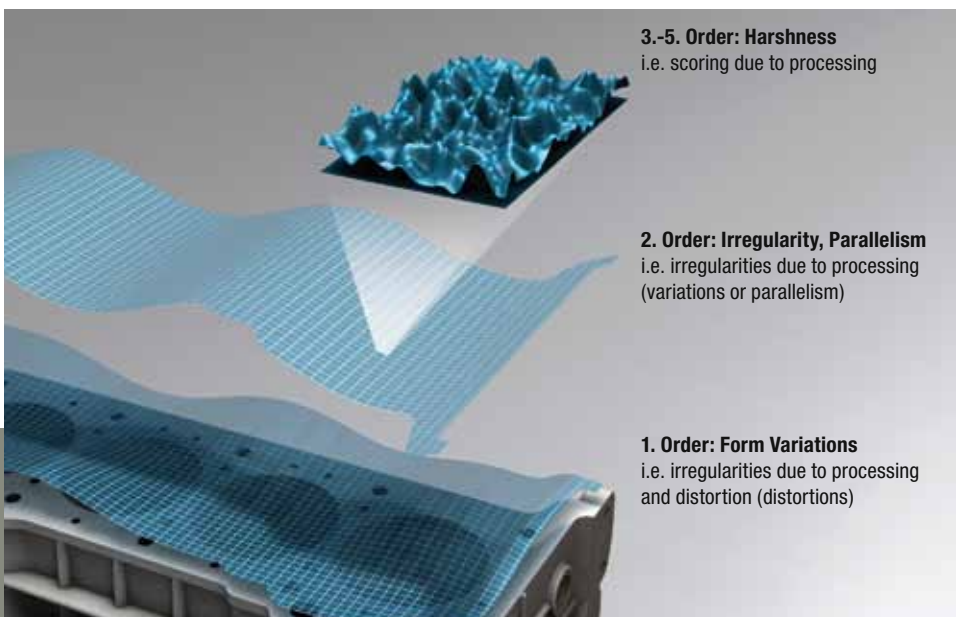
Component Unevennesses and Distortions

Component unevenness and distortion can be determined by means of a straightedge. Measurements are made using the light-gap method. The edge of the test device is placed on the surface, and moved over the bolt holes longitudinally and transversely. Hereby, any unevennesses are made visible by the light gap.

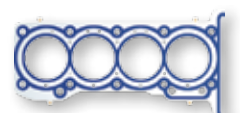
For passenger cars the measurement results over a longitudinal length of 100 mm must be less than 0.03 mm, and less than 0.05 mm over a length of 400 mm, whilst in the transverse direction they must be less than 0.03 mm over a length of 100 mm.

For commercial vehicles the measurement results over a longitudinal length of 100 mm must be less than 0.03 mm, and less than 0.10 mm over a length of 1,000 mm, whilst in the transverse direction they must be less than 0.03 mm over a length of 100 mm.

The standards for the surface texture of sealing surfaces are defined in DIN EN ISO 4287. The corresponding values are $Rz \leq 15 \mu\text{m}$ for roughness, and $Pt \leq 22 \mu\text{m}$ for profile depth. Consequently, cylinder head gaskets must provide comprehensive macro and micro sealing properties.



▲ Example of influences of surface quality due to surface deviations on an engine block.



MLS Head Gaskets – The Optimum Solution for Every Surface Quality



Waviness and Roughness

Waviness and roughness are measured with the help of a sensing probe that is moved horizontally over the sealing surface. Values should be less than 20 μm for waviness, and between 7 μm and 20 μm for roughness.

Amongst other results, evaluation of the recorded data gives the maximum roughness depth R_{max} . This is an important value for surface quality, as it indicates the largest possible leakage channel.

Practical Experience

In a large-scale test on 1,200 engine blocks with eight measure-

▲ *Maximum values for waviness and roughness (grooves and scores) practical measurement using a sensing probe, and indication of possible leakage channels.*

ments per block, the measured values for R_{max} were between 8 μm and 18 μm . Only very few surfaces exhibited R_{max} values up to 25 μm .

The special design of multi-layer steel gaskets enables them to adapt to every surface texture, provided that the surface quality lies within the specified tolerances. If the above values are observed, MLS gaskets provide the most reliable seals. Only if

the values are exceeded, will it be necessary to re-machine the surface.

Cylinder-head Bolts

Nowadays, manufacturers make exclusive use of so-called stretch bolts (waisted bolts). Without problems, these bolts can be extended beyond their elastic limit into the plastic region. When a certain tightening torque (pretorque) has been reached, the bolt is tightened further by a defined amount (prevailing angle or torque).

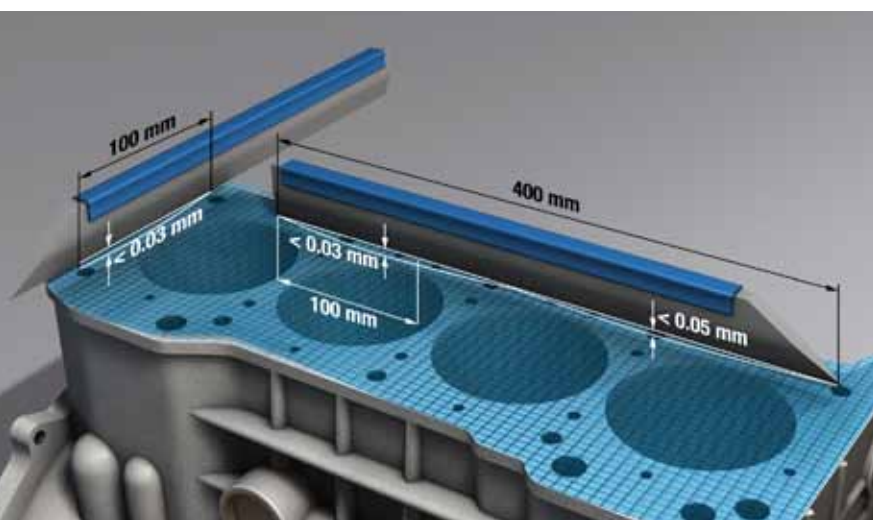
If the torque-angle tightening method is used, re-torquing of the head bolts is no longer necessary.

With the torque-angle method, the head bolts are elongated plastically, i.e. permanently. After disassembly, they are clearly longer than new bolts. For safety reasons, cylinder-head bolts should therefore always be used only once.

TIP FROM THE EXPERTS

Be sure to observe the demands placed on surface quality:

- **Component unevenness for passenger cars**
less than 0.03 mm over a longitudinal distance of 100 mm;
less than 0.05 mm over a longitudinal distance of 400 mm;
less than 0.03 mm over a transverse distance of 100 mm
- **Component unevenness for commercial vehicles**
less than 0.03 mm over a longitudinal distance of 100 mm;
less than 0.10 mm over a longitudinal distance of 1,000 mm;
less than 0.03 mm over a transverse distance of 100 mm
- **Waviness**
less than 20 μm
- **Roughness**
between 7 μm and 20 μm



◀ *Maximum values for component unevennesses and distortions for passenger cars. Practical measurement using a straightedge and the light-gap method.*

