Compression and recovery

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The optimum gasket

The optimum gasket would be highly compressible, in order to be able to adapt to all flange surface unevenness when it is fitted. It would at the same time recover 100%. The concepts of compression and recovery are explained in detail below.

Compression

Compression plays a major role in practical application. This property determines the adaptability of the gasket to the sealing surface. The more a material can be compressed, the greater its ability to adapt to faults in the sealing surface like scratches or grooves. Figure 1 is a diagram showing the surface structure of a flange. Surface leakage – leakage between the gasket and the sealing surface – can be reduced significantly thanks to the adaptability of the material.

Recovery

Theoretically speaking, a gasket recovers when the distance between the sealing surfaces in the application is increased by certain peripheral conditions (e.g. internal pressure). In view of this, strong recovery would be a priority.

Test procedure

Several different approaches can be adopted to determine the compression of a gasket:

ASTM F 36 J

There are different versions of the ASTM F 36 test for different materials. Procedure J is outlined in detail here. In this method, three gasket thicknesses are measured with defined loads using a tool with a Ø of ¼". Compression is defined as the deformation of the gasket under the main load compared with the original thickness. Recovery is defined as the change in thickness on removal of the load in relation to the change in thickness between the preload and the main load. Figure 2 shows the three relevant gasket thicknesses during the ASTM 36 test.
The recovery figure must not under any circumstances be considered in isolation; there is a direct connection between it and the prior compression.

Model calculation:
Original thickness P: 2.00 mm
Thickness under the main load
M: 1.8 mm → compression: 10 %
Thickness after load removal
R: 1.9 mm → recovery: 50 %

DIN 28090-2

DIN 28090-2 also describes a method for determination of gasket deformation, both at room temperature (cold compressibility ε_{KSW}) and at higher temperatures (hot creep ε_{WSW}). A standard sealing ring (55 x 75 mm) is tested in a hydraulic press in this context. Recovery levels (ε_{WRW}, ε_{KRW}) are also determined.
Cold compressibility ε_{KSW}, i.e. compression at room temperature, is defined as the change in the thickness of the gasket under preload and main load in relation to the original thickness. Cold recovery ε_{KRW} is defined as the change in the thickness of the gasket between main load and preload in relation to the original thickness of the gasket.
Hot creep ε_{WSW} and hot recovery ε_{WRW} are determined by similar means at a specific test temperature per material (graphite 300°C, fibre material 200°C, PTFE 150°C).
All the results are expressed in a percentage of the original thickness h_{d1}.

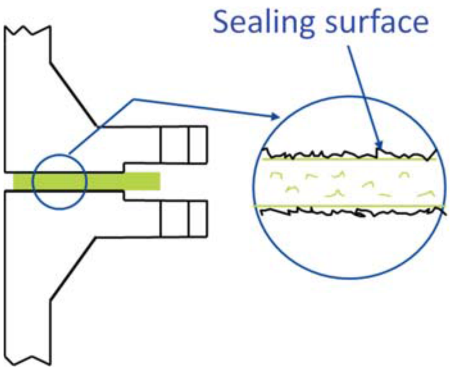

Figure 1: Surface structure of the sealing surface.

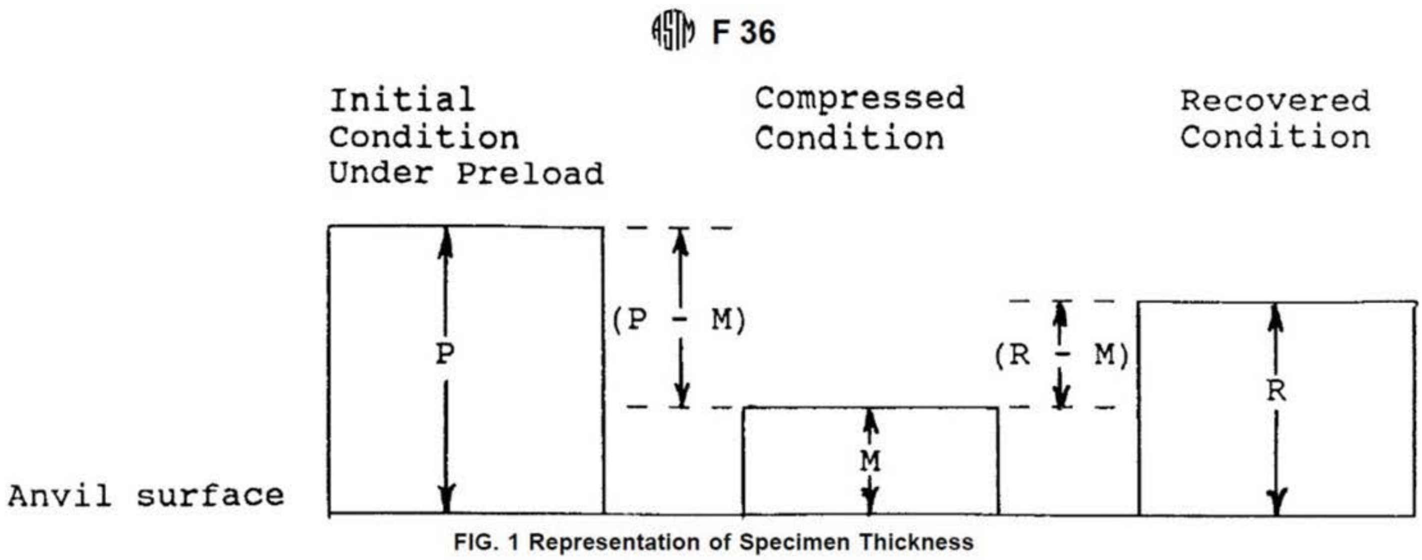

Figure 2: ASTM F 36 – compression/recovery (source: ASTM F 36).

Table 1: Comparison of the advantages and disadvantages of the individual methods

ASTM 36 J	DIN 28090-2	Compression graph
+ Simple testing equipment	+ The specimen tested is a practical sealing ring	+ The specimen tested is a practical sealing ring
- The gasket thickness tested must be at least 1.6 mm	+ Easily interpreted results	+ Test can be carried out at any temperatures
- Behaviour at only one defined surface pressure level is tested	+ Test is carried out at higher temperatures too	+ A complete range of surface pressure levels is tested
- The test is only carried out at room temperature	- Complex testing equipment	- Complex testing equipment is required
- Recovery results can only be interpreted together with compression levels	- Behaviour at only one defined surface pressure level is tested	
- Only a small area of the material is tested. Material inhomogeneity is not covered		

Compression graph

The compression graph is specified in a standard, e.g. DIN EN 13555-2014, and has the purpose of determining the deformation properties of a gasket material. The force applied to the gasket in a press is increased as defined and the respective thickness of the gasket is measured. The measurements can be taken at room temperature or at higher temperatures. The graph reveals the deformation in relation to the surface pressure.

The advantages of the compression graph are that a standard sealing ring is tested and that not just one surface pressure level is reviewed; the entire range from 0 MPa to about 250 MPa is covered instead (depending on the capacity of the testing equipment).

Comparison of the methods

The advantages and disadvantages of the individual methods are compared in Table 1.

The ASTM test carried out on the test equipment

The following graph – Figure 3 – visualises the ASTM F 36 J test procedure. The ASTM test procedure was carried out on two different materials on the test equipment: very adaptable gasket material (dashed black line) and relatively hard gasket material containing elastomer (uninterrupted green line). Most of the recovery with both materials only occurred at surface pressure levels lower than 5 MPa.

Summary

Both the standardised tests to determine compression based on ASTM F 36 and DIN 28090-2 produce results about the deformation of a gasket material at defined surface pressure levels in each case. Both processes are suitable ways to obtain an initial impression about material properties and to enable materials to be compared with each other.

The compression graph, on the other hand, provides a more in-depth insight into material compression, because it covers the entire range of surface pressure levels.

In view of the many different requirements, it is not possible to find an optimum gasket for all applications. The right gasket material must be selected according to the medium, the temperature, the pressure level, the structure of the sealing surface and many other parameters. Gasket manufacturers generally make the necessary information about the different materials available.

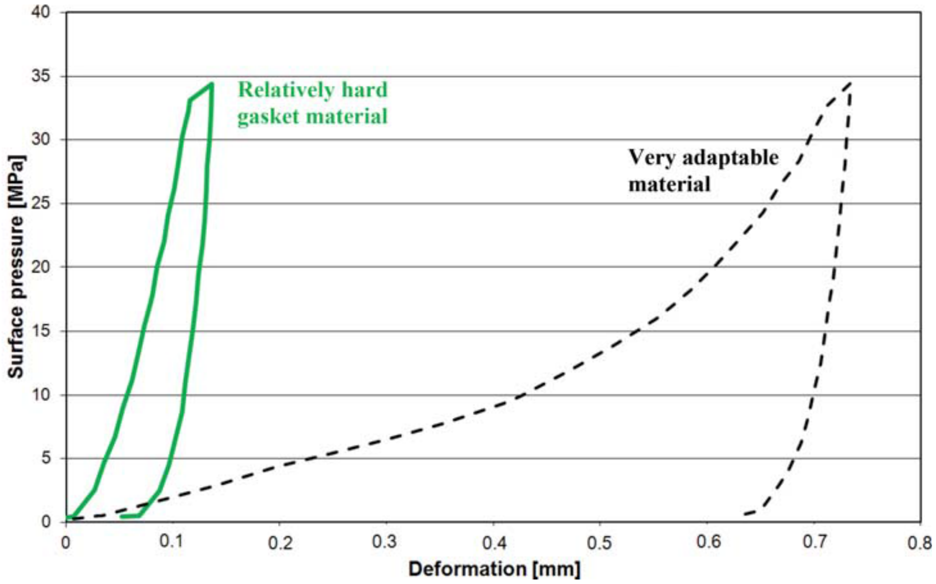

Figure 3: ASTM 36 J test on the test equipment.

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