VDI2290 – Resulting consequences for users and manufacturers of static gaskets

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The VDI2290:2012 is a technical guideline about the increasing demands of governmental requirements with regards to the reduction of fugitive emissions (e.g. German clean air act TA Luft), as well as to increase the safety and the efficiency of process units mainly used in the chemical and petrochemical industry. For instance in terms of TA Luft, it is applicable for the assessment of the technical leak tightness of flange joints and additionally it is the necessary update based on previous guidelines VDI2200 and VDI2240. Since 2012 the VDI2290 has been part of the legally binding federal emission control act in Germany. The original document is written in both English and German languages.
In general, this guideline is recommended for all users of gaskets, who are responsible for design, inspection and/or maintenance. Attention should be paid to the fact that the VDI2290s scope is currently only valid for steel flanges (service temperatures up to 400°C). It is not applicable to glass lined steel (GLS) flanges, plastic flanges or any clamped connections due to these flange classes lacking any solid calculation standards which work out tightness. This is because only the calculation standard EN1591-1 for steel flanges offers that option.
In addition to the tightness calculations, VDI 2290 also demands trained fitters to install gaskets according to EN1591-4 – therefore correctly calculated torque values for each different flange connection are mandatory – and a quality management system to track everything is required.

Minimum tightness (TA Luft) in VDI2290

VDI2290 defines a maximum allowed leakage limit and rate for flanged joints. Therefore in Germany as VDI2290 is required according to the TA Luft regulation, users are required to calculate via EN1591 and show that the maximum tightness level is reached. This has been newly defined at a lower L0,01 tightness class, which has a specific calculated leak rate (L) of less than 0,01 mg/(s·m).

One of the consequences of this lower tightness class requirement is that some traditionally approved combinations of flanges, bolts and gaskets are no longer sufficient; and will have to be replaced. For instance, the bolt quality 5.6 will in many cases need to be replaced by higher quality bolts such as 25CrMo4, and traditionally proven gaskets may have to be replaced by higher quality gasket types with better tightness performance as measured to the EN13555 standard.

Principle of minimisation

In addition, the tightness class L0,01 is just the minimum requirement and the VDI2290 actually attempts to reduce fugitive emissions as much as possible. It states that the gasket stress during assembly should be as high as possible. With this approach tightness levels can be significantly lower than class L0,01. As an example Figure 1 shows the result of a tightness/leakage test according to EN13555 with a filled PTFE gasket. The red arrows show that the L0,01 class is reached at roughly 22 MPa. Now assuming that the flange and bolt materials allow the use of a gasket stress of higher levels like 40 MPa (a typical value for "DIN-flanges" according to EN1092-1) the tightness level will be roughly at L0,0001 (see green arrows, Figure 1) – that means 100 times lower than required by the VDI 2290. This reduces the leakage 100 times meaning less lost products, low emissions etc. as well as improving the overall safety of the joint; due to the residual stress in service being higher.
The minimisation principle is shown in Figure 2. The minimum bolt force is given

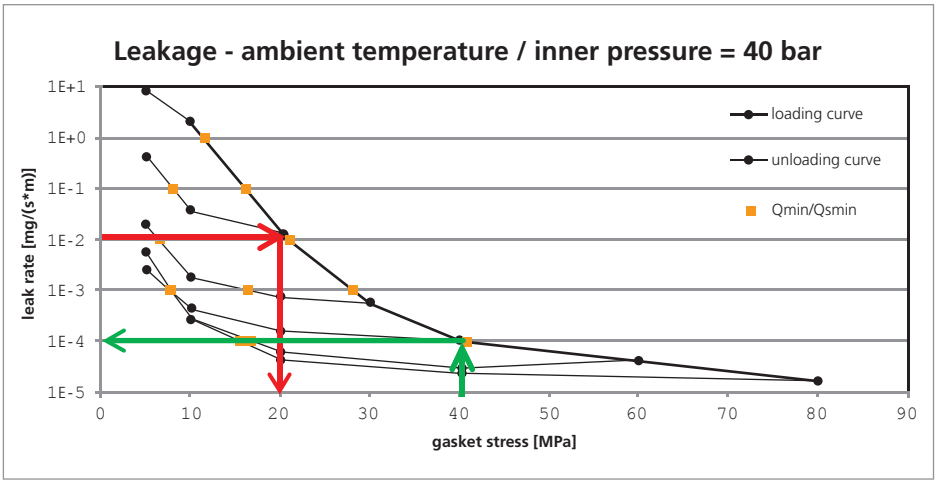

Figure 1: PTFE gasket (example)

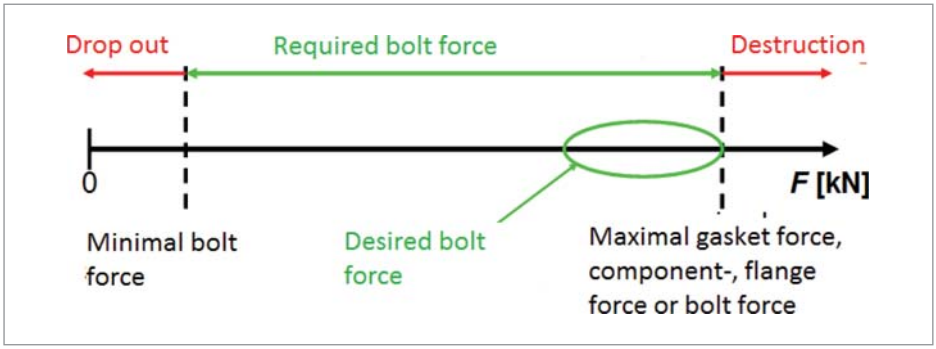

Figure 2: Minimisation principle, by maximising the available bolt force

by the tightness requirement and it is therefore mainly depending on the quality/ sealability of the gasket. The maximum bolt force is normally given by the stress limits of the flanges and bolts as gaskets can normally withstand relatively high stresses. The minimisation principle requires, as mentioned above, a stress as high as possible, so is shown as the "desired bolt force" in Figure 2.

High quality assembly

Minimum leakages, maximum safety and highest performance of processing units can only be reached by a high quality assembly. It requires the "best" (= highest possible) bolt torque with subsequent random quality inspections, as well as the use of qualified and competent fitters (e.g. trained according to EN1591-4).
A correct installation is a must as a flange connection with expensive high quality components is only as good as the quality of the installation.

Used calculation codes: stress and tightness approval

Traditionally, flanges were calculated by using the standards AD2000, EN13445-3 (ASME-Code) or FEA to prove the stability of the flange connection see figure 3.
In addition to the calculation, the gasket material was certified according to TA Luft by a separate laboratory test in accordance to VDI2200 without giving attention to the behaviour of the tightened bolts or to the whole flange system. This lead to many calculations not being right for their systems. Additionally installation errors caused by many fitters not having proper training levels, not using the right tools (e.g. torque wrenches) and/ or not having access to any information on the required bolt forces added to the problems.
As the "old" calculation codes AD 2000 and EN 13445-3 (ASME code) do not

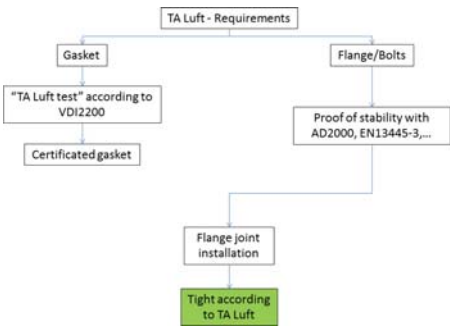

Figure 3: Reaching TA Luft requirements before VDI 2290

offer tightness calculations, they can't be used any longer under VDI2290. Instead they are replaced by EN1591-1. This calculation code requires gasket material test data according to EN13555. EN13555 gasket values are to be provided by the gasket manufacturers, they are often published www.gasketdata.org. The new codes now reduce calculation errors via the newer calculation codes and reduce installation errors by requiring correct training and making gasket data more available.

Figure 4 overviews the new methodology. Here are a few points of interest:

1. A "TA Luft" (VDI 2200) test is still mandatory to prove a gasket material is a high enough quality.
2. EN13555 data needs to be given out by the gasket manufacturer.
3. A calculation according to EN1591-1 has to be carried out, for each flange/ bolt/gasket combination.
4. Torque values (or bolt forces) have to be provided to the fitters.
5. Only trained fitters are allowed to install gaskets.
6. A quality management system has to be implemented to record the whole process.

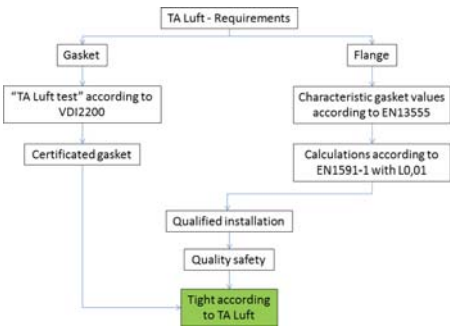

Figure 4: Fulfilling TA Luft requirements with VDI 2290

In Germany many companies have had very good experiences after implementing VDI2290.
The following additional advantages have been seen:

1. Reduced down time at shut downs due to significantly reduced leakages during the re-start of the process units.
2. Reduced overall costs due to less leakage in service.
3. Higher safety and efficiency of processing units.

So, why not implement these systems outside of Germany?

Summarising consequences for gasket manufacturers and users

- Gasket data (EN13555) must be measured for each gasket type and each thickness.
- After calculations according to EN1591-1 a certain gasket fits only to a specific flanges/bolt/gasket type, and cannot be used any longer as a "generic" gasket type.
- The number of (certified) gaskets will be reduced because of the higher performance required e.g. Minimum tightness.
- Existing Pipe-codes must be re-calculated by the gasket user/operator according to EN1591-1 Torque values (bolt stress) have to be listed in the pipe codes of the joint. The values have to be checked and documented after assembly.
- The assembly must be done by "qualified" fitters, e.g. according to EN1591-4.
- Quality management has to go along with the complete process of calculation and assembly.
- Low stress bolt qualities like 5.6 will be withdrawn in many cases and replaced by higher qualities e.g. 25CrMo4, because low stress bolts can no longer generate enough load to reach the required gasket stresses to obtain lower than the VDI2290 leakage limit.
- Comments like "our gasket type xyz goes with VDI 2290" or "certified to VDI2290" are nonsense, as VDI 2290 considers the whole system which incorporates flanges, bolts and the gasket – not the gasket as a single part.

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