flangevalid

● Technical Philosophy of „flangevalid“

Detachable flange connections are complex systems that can give rise to significant costs and damage in the event of malfunction. As stipulated in the Pressure Equipment Directive (97/23/EC PED) and the Industrial Safety and Health Ordinance [*Betriebssicherheitsverordnung* – BetrSichV], it comes down to creating “connections with a permanent technical seal.” Flange joints are detachable connections. Flanges, gaskets and bolts should be tensioned so that the flange connection then behaves as an individual component. The weakest component in the flange connection determines the permanent function of the system. A secure sealed connection can only be created if minimum criteria are observed for the individual components.

Gaskets

In general, the bolt forces to be installed are calculated in line with the gasket requirements (image), meaning that the possibilities of placing the flange connections under greater tension, thereby rendering them more reliable, are often not exploited. We rightly assume that the highest possible seating stress results in the smallest possible leak rate. Soft gaskets made from laminate material, with the exception of GR graphite gaskets, can only withstand relatively low seating stress. In comparison with gaskets made from laminate material, soft gaskets made from metal, such as corrugated, spiral and grooved gaskets, have a leak rate that is three or more orders of magnitude lower and can withstand very high seating stresses. The component test in accordance with the Technical Instructions on Air Quality Control [*TA-Luft]* (VDI 2440) is carried out with a seating stress of 30 MPa (N/ mm^2). In order to ensure a lower leak rate, the seating stresses on the gasket during assembly should significantly exceed this value.

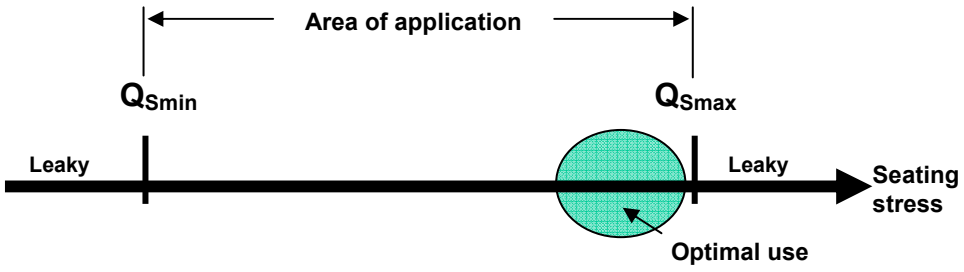

Figure 1: Conventional depiction of how gaskets function

The flange properties are often not included in the considerations. In addition, gaskets with a high settling/yield potential, such as those made from FA material (elastomer-bound fiber gaskets) and TF material (PTFE gaskets) show an increase in leak rate over the long term.

As a result of yielding/settling of the gasket, the seating stress applied at assembly is reduced. In order to give an impression of the settling properties of flanges, the value P_{QR} denoting bolt relaxation was introduced in EN 13555.

When ascertaining the P_{QR} value, values between 0.25 and 0.50 are found for elastomer fiber material (FA) and values of between 0.25 and 0.75 are found for PTFE gaskets (TF). Graphite gaskets (GR) and metal soft gaskets have better values, from over 0.85 to 0.99, and therefore hardly show any settling losses. The P_{QR} value gives the ratio of the bolt force between assembly and end of the measurement after approximately 5 hours. The value 0.25 shows that 75% of the bolt force is relaxed. It is important to use gaskets with high P_{QR} values.

Bolts
Relaxed bolts increase the risk of the connection failure. (Figure 2)

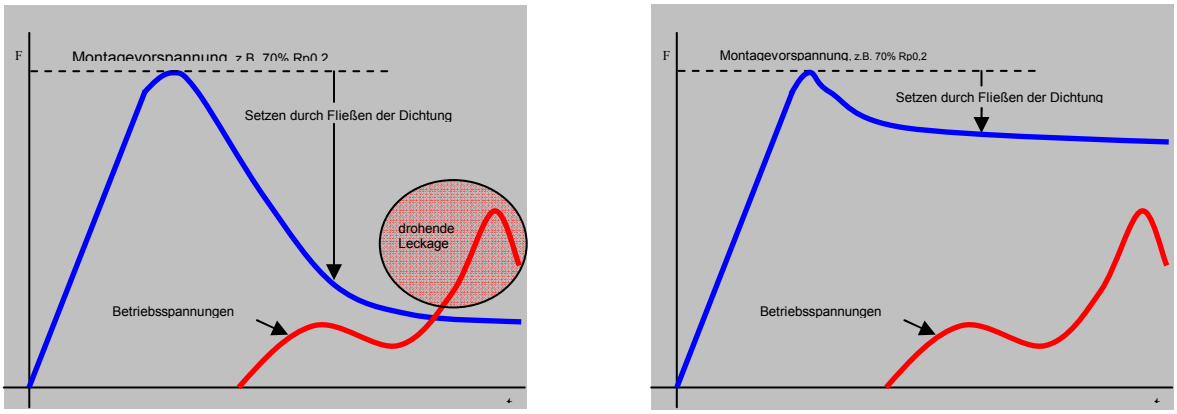

Figure 2: Risks posed by the gasket material settling/yielding

The maximum possible tension should be applied to the bolts (Figure 3); they determine the maximum force to be introduced into the systems (S_{max}). The maximum possible bolt force is calculated from all the components and should be set at the highest possible level (S_{opt}), i.e. is based on the weakest component in the joint. Here, the system tension should safely exceed the seating stress required for the stipulated minimum leakage of the gasket.

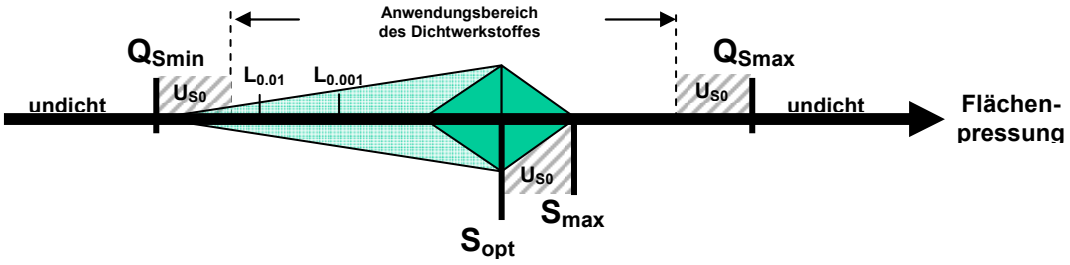

Figure 3: Lannewehr + Thomsen's depiction of the gasket system

In many cases, it is sufficient to provide proof of the components with regard to the optimal attainable bolt force (70 to 80% $R_{p0.2}$). In the event that the bolts cannot be fully loaded due to a weaker component, the weakest component (flange or gasket) must be

modified so that a higher system tension and thereby a lower leak rate can be attained, while simultaneously raising the operational safety.

Flanges
When tensioning the system, the flange faces are bent (rotation). The inclination of the flange face should not exceed 1º and is even limited to 0.5º or 0.2º in some operating specifications. Frequently, in order not to exceed the values, the load on the bolt is limited/reduced and/or only a very low load is placed on the bolt. The bolt bears only limited responsibility for the elasticity of a conventional flange connection. Where there is no rotation, or only slight rotation, the bolt is the elastic component and must be placed under as much tension as possible, for this reason alone.

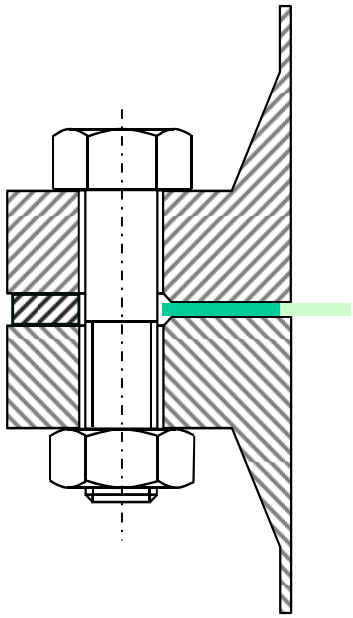

Figure 4: Flange with supporting ring

System by „flangevalid“
In order to avoid unacceptably high degrees of settling and or creep, no plastic or quasi-elastic elements (gaskets) should contribute towards maintaining the tension under any circumstances (*Schraubenverbindungen* [Bolt joints], Wiegand, Kloos, Thomala). Only gaskets with low settling properties are used. A gasket that cannot withstand the seating stress will either be broadened or replaced by one that can withstand higher seating stresses. In the event that the inclination of the flange face is too great (rotation), this can be remedied through the use of supporting rings (Figure 4) or gaskets with support elements (Figure 5), e.g. Kempchen type W1A/A1 (Figure 6).

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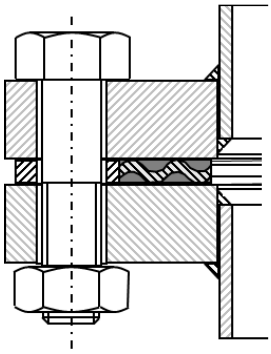

Figure 5: Gasket with support element

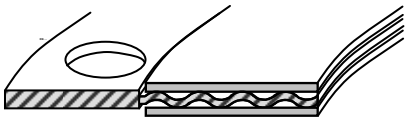

Figure 6: Gasket of Kempchen type W1A/A1

The following criteria apply to a sealing connection under the **„flangevalid“** system (values in parentheses are the minimum values):

- Minimum seating stress on the gasket 50 MPa (30 MPa)
- Bolt relaxation through gasket (P_{QR}) > 0.90 (> 0.80)
- Load on bolt $R_{p0.2}$ s70–80% (> 50%)
- Seating stress on nut support plate < $R_{p0.2}$ of the flange material
- Gaskets must not restrict the maximal load of flanges and bolts

Contrary to many calculations, any liners present are taken into account and the assembly pre-tensioning force and/or torque is stipulated.

High bolt force = low leakage = secure connection = lower costs

Correctly designed sealing systems bring an improvement in legal safety with regard to health, safety and the environment – by increasing the assembly safety, environmental safety and operational safety – lowering your costs and reducing your yield.

flangevalid **is your profit!**