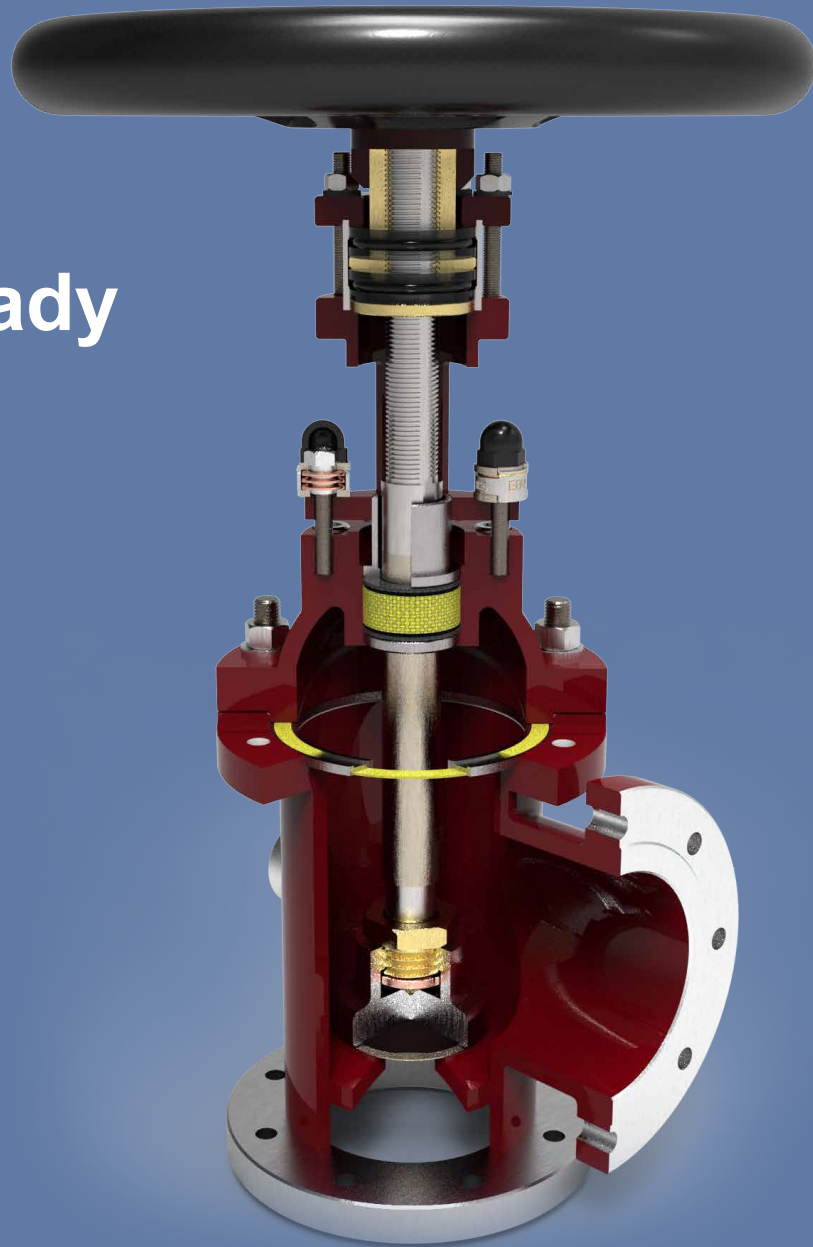


H2 ready



The new

TA Luft & live loading

spindle and flange sealing for fittings

H2 ready



Köthener Sepzialdichtungen GmbH

Dr. Ing. Jürgen Kästner

Dipl.-Ing Steffi Kästner

The new TA Luft

Technical instructions to keep the air clean

(draft stadium: 16.07.2018; Federal Ministry for environment, natural reserve and reactor safety; first general recast of the first general administration regulation to the federal emission control act)

The following passage of text is about a draft for adaption of the TA Luft:

„5.2.6.4 Shut-off devices (Shut off and control devices)

From the effective date plus 4 years shut-off or control devices like valves, slide or ball valves should be used which pressure of ≤ 40 bar at design temperatures ≤ 200 °C the tightness class BH ($\leq 10^{-4}$ mg/s*m) and with pressure ≤ 40 bar at design temperatures > 200 °C the tightness class CH ($\leq 20 \cdot 10^{-2}$ mg/s*m) of DIN EN ISO 15848-1 (edition November 2015) of the test medium helium. At pressure of > 40 bar and design temperatures ≤ 200 °C the tightness class CH ($\leq 10 \cdot 10^{-2}$ mg/s*m) have to perform and need to achieved at > 200 °C.

For sealing of stem implementation of shut-off or control devices, like valves or sliders, high-quality sealing with metallic bellows and safety stuffing boxes or equivalent sealing systems should be used.

Sealing systems count as equivalent if temperature specific leakage rates are respected according to the guideline VDI 2440 (for inspection and their pressure results and qualification should be used the DIN EN ISO 15848-1 edition November 2015).

For current shut off devices is number 5.2.6.1 paragraph 2 to be applied.

To ensure the tightness is constant, conditions for the inspection and maintenance of the sealing system in management instructions must be determined.”

What`s new in section 5.2.6.4 of the amended TA Luft?

With the stipulation that the European standard DIN EN ISO 15848-1 has to be used for the test as well as its assessment and qualifications, the legislature with the amended TA Luft clearly shifts its focus from falling below a required TA Luft leak rate under test conditions to compliance with its very strict regulations under operating conditions. This shift in the new focus underlined in the last paragraph, where legislators are required to provide suitable management instructions for testing and maintenance.

After the spring-loaded sealing system (called Live-Loading) for fittings was developed with the associated calculation program „TA Luft Expert“ in the early 1990s, the focus was required 30 years later.¹ To develop a sealing system that meets the requirements of TA-Luft under critical and constant practical conditions and at the same time indicates the required maintenance regulations. It is therefore not surprising that many of the test conditions defined at that time with TÜV Nord and TÜV Bayern reflected in the new DIN EN ISO 15848-1. This standard specifies a minimum test scope (C01) of 205 spindle actuations for two temperature cycles. The test program developed at that time was 400 spindle actuations and 3 temperature cycles at operating pressure pB with at least one start-up and shutdown process (depressurized state). Still a bit unclear is the compliance with a handwheel torques of the DIN EN Iso 15848-1. There is no reference to the definition of the permissible handwheel actuation torques. During the first certification of our spring-loaded sealing system, a question was formed by TÜV Bayern that has not lost any of its topicality until today.

What happens if:

- the gland packing is extruded by spindle movement
- the sealing system relaxes due to thermal alternating loads
- maintenance is required for the sealing system
- ...

¹ The development of spring-loaded sealing systems for spindle seals and their calculation bases began in early 1990 at MAW GmbH under the direction of the authors and has been further improved since KSD GmbH was founded in 1998

High-quality stuffing box sealing systems in the sense of TA-Luft regulation or a live loading application require an optimal interaction of all components that can influence the sealing system. We have been developing and manufacturing these systems for our customers for almost 30 years. That means 30 years of experience in the design and optimization of all these components. Use our experience, which shown in the result of the new TA-Luft system for the first time for all components of this sealing system in this new company standard.

**The new KSD Company standard 370:
"Gland spindle seals for fittings in the sense of TA Luft
and Live Loading applications"**

High quality stuffing box sealing systems in the sense of TA Luft or a live loading application require an optimal interaction of all components that can influence the sealing system. We develop and manufacture those systems for all different industry applications since almost 30 years. That's also 30 years of experience in design and optimization of all these components. Use our experience, which has been summarized for the first time for all components of this sealing system in the new company standard.

Our focus:

- assembly of the spring-loaded sealing systems with decentralized and central disc springs
- assembly and areas of application of spring columns
- Standard-, suction and locking glands, construction of areas of application
- Stuffing boxes, dimensions and tolerances
- Gland Followers, base and lanterns rings; Dimensions and tolerance limits
- Packing systems; Materials; Construction and installation guidelines
- Spindles; Surface quality; Tolerances; Shape and positional deviations
- Material selection to avoid spindle corrosion.

It would be a pleasure to share our knowledge with our customers to make this company standard available based on engineering nominal fee¹.

¹ The amount of the nominal fee can be found on the KSD website www.ksd-de.com.

The TA Luft EXPERT(+) Suspension system



(1)

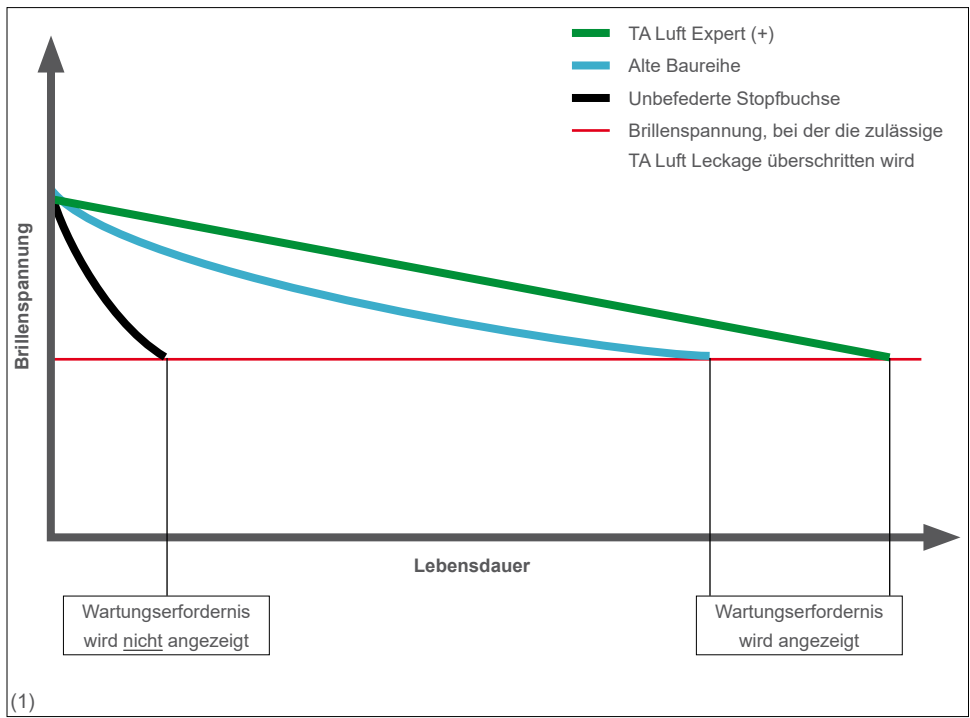


(2)

(1) The **TA Luft EXPERT (+) suspension system** no bolt extensions required. standardized for all metric and UNC 18 to UNC 9.

(2) The **TA Luft EXPERT (+) spring pillar** improved maintenance gap display because of a laser. Marking of the spring column size with a deep laser engraving. The label is retained even after the spring column has been colored. Tribally matted gloss surface. Spring column tube with base laser-welded. Optionally available with protective cap.

The applied marking of the spring column by laser engraving ensures an uncomplicated exchange, even after it has been used for a long time. No Bolt extensions are required for retrofitting. The standardized thread size from metric M8 to M24 and imperial UNC 5/16" to 7/8" have been retained. Compared to the old series, the spring assemblies made of galvanized spring steel were extended around the austenitic spring steel 1.4310. Through the new cranked design, the guide of the spring pillar could be moved into the housing tube, additional space gained for the conveyor package. This allowed the spring characteristics of the new „TA Luft Expert (+)“ series to be optimized compared to the old series without changing the previous dimensions significantly. The result increased significant in-service life and functionality.



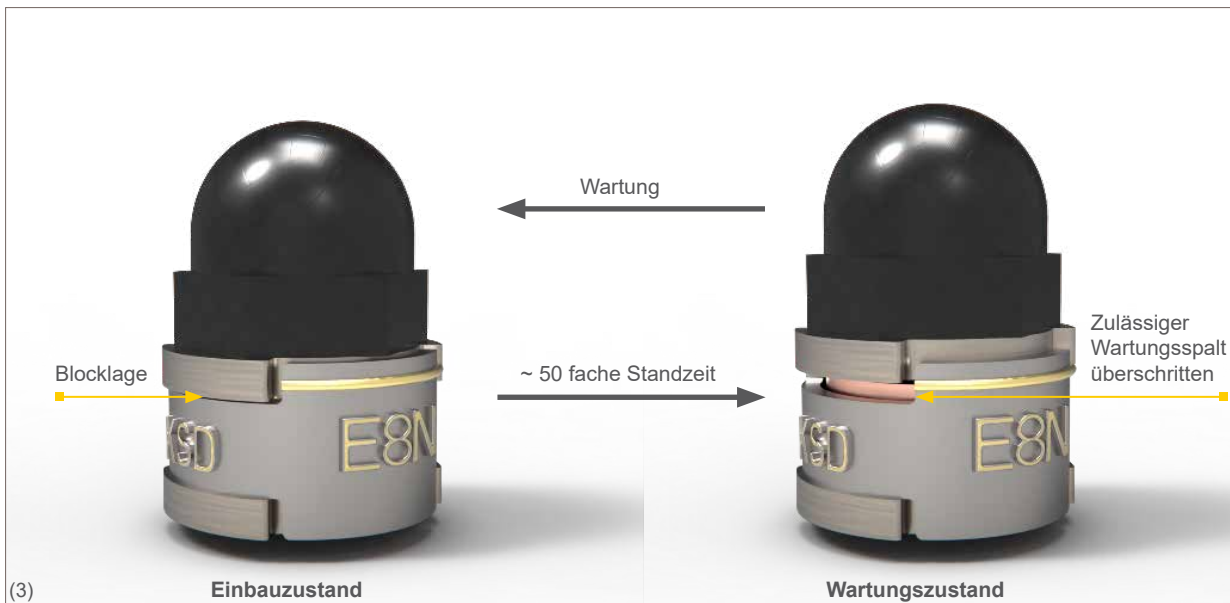
The TA Luft EXPERT (+) spring pillars are built as a completely standardized system and are therefore equally interesting for OEM and service companies. The suspension system TA Luft Expert (+) is very easy to assemble and can be precisely pre-tensioned without additional measuring equipment.

After the necessary pre-compression of the packing, assembly is carried out by tightening the spring column up to the block position of the cover (installed condition). In the operating state, the system signals a need for maintenance when the lower edge of the cover has reached or exceeded the laser line of the spring column (maintenance state).

Compared to unloaded fabric bushings, the extended service life can go up to 50 times. The prerequisite for this is compliance with all the conditions required in KSD company standard 370.



(2) Einbau- und Wartungsanleitung



(3) functionality of the spring column Expert (+)

An application overview by the use of this New TA Luft system with spring pillar is shown in the below graphic. KSD select all relevant data an Disc springs for any requested application automatically as long as we know correct application area (TA Luft or Live Loading), fluid temperature, the nominal pressure and the stuffing box dimensions.

Datenaufnahmeblatt Armaturenbefederung

		Hersteller Armatur / Typ	<input type="text"/>
		Anzahl	<input type="text"/>
		Befederungsart	<input type="text"/>
		TA-Luft 2000 / VDI2440	<input type="text"/>
		Live-Loading	<input type="text"/>
		Stopfbuchse	<input type="text"/>
		s Spindel	<input type="text"/> mm
		r Stopfbuchsräumeußendurchmesser	<input type="text"/> mm
		t Stopfbuchsräumtiefe	<input type="text"/> mm
		Deckeldichtung	<input type="text"/>
		di Innendurchmesser	<input type="text"/> mm
		da Außendurchmesser	<input type="text"/> mm
		h Höhe	<input type="text"/> mm
		Werkstoff	<input type="text"/>
		Stopfbuchsschrauben	<input type="text"/>
		Gewindegröße (metr. / Inch. °)	<input type="text"/>
		Freiraum	<input type="text"/>
		a axial	<input type="text"/> mm
		b radial	<input type="text"/> mm

Datum:
 Kunde:
 Händler:

Betriebsparameter
 Nenndruck (PN):
 Nennweite (DN):
 Betriebsdruck (Pb):
 Betriebtemperatur (Tb):
 Medium:

(4) KSD GmbH • Deltaplatz 1 • D - 08369 Kleinwilkauitz • Tel: +49 3496 5080-0 • Fax: +49 3496 508020

(4) Data form sheet for valve suspension

Optional, customers can make the assignment themselves using the examples overview of TA Luft applications shown below.

	≤ PN2,5	≤ PN6	≤ PN10	≤ PN16	≤ PN25	≤ PN40	≤ PN63
M8 UNC18	E8N (M _{FS} =7 (10) Nm; WSzul=1,0mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E8NV (M _{FS} =11 (12) Nm; WSzul=1,0mm) bp<1,6*√dsp			bp≤1,25*√dsp			
M10 UNC16	E10N (M _{FS} =9 Nm; WSzul=1,0mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E10NV (M _{FS} =15 Nm; WSzul=1,0mm) bp<1,6*√dsp			bp≤1,25*√dsp			
M12 UNC13 UNC14	E12N (M _{FS} =16 (17) Nm; WSzul=1,0mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E12NV (M _{FS} =32 (34) (26) Nm; WSzul=1,0mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E12NVA (M _{FS} =55Nm; WSzul=1,0) bp<1,6*√dsp			bp≤1,25*√dsp			
M16 M14 UNC11	E16N (M _{FS} =20 (19) Nm; WSzul=1,5mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E16NV (M _{FS} =37 (35) (38) Nm; WSzul=1,5) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E16NVA (M _{FS} =59 (55) (62) Nm; WSzul=1,5mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E16DV (M _{FS} =76Nm ; WSzul=2,0) bp<1,6*√dsp			bp≤1,25*√dsp			
M20 M18 UNC10	E20NV (M _{FS} =72 Nm; WSzul=1,5mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E20NVA (M _{FS} =105 (102) (106) Nm; WSzul=1,5) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E20DV (M _{FS} =143 (140) (144) Nm; WSzul=2,0mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E20DVA (M _{FS} =251 (244) (257) Nm; WSzul=1,5mm) bp<1,6*√dsp			bp≤1,25*√dsp			
M24 M22 UNC9 (1)	E24N (M _{FS} =81 (75) (79) Nm; WSzul=2,5) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E24D (M _{FS} =162 (148) (158) Nm; WSzul=3,0) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	
	E24DA (M _{FS} =218 (200) (213) Nm; WSzul=3,0mm) bp<1,6*√dsp			bp<1,25*√dsp		bp≤1,0*√dsp	

(1) Overview of the use of the "Expert [+]" and Expert [4.0]" spring pillars for applications in the sense of TA Luft

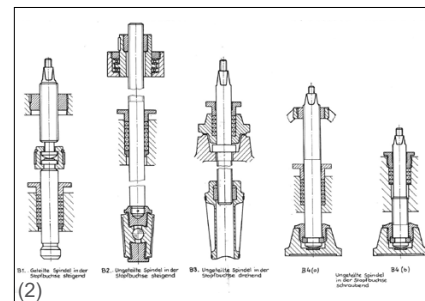
- Optimal working range of the spring columns
- Impermissible working area of the spring columns
- Not optimal working range of the spring columns (exceeding the permissible spindle actuation torques)

These application overviews, created on TA Luft and Live Loading applications, apply to glands with a packing depth / packing width ratio of 4.0 to 6.0 and for valves with fewer than 5 actuations per day. Overlaps, such as those used for the E16N; E16NV and E16DV occur, are about checking the maximum permissible pack width.

$$b_p = 1,0 \text{ (1,25) (1,6)} \sqrt{\text{Spindeldurchmesser } d_{sp}}$$

The value 1.0 stands for very narrow package widths, the value 1.25 for narrow package widths and the value 1.6 for medium package widths. Factors more than 1,6 should be avoided for fittings. For the areas marked in red or for operating conditions deviating from the scope of application, it is necessary to use our certified calculation program "TA Luft EXPERT".

Especially for valve manufacturers in conjunction with the use of our disc spring-loaded sealing systems for the construction principles listed under (2), we also offer the calculation of the hand wheel actuation torques for the unpressurized installation and for the test condition.



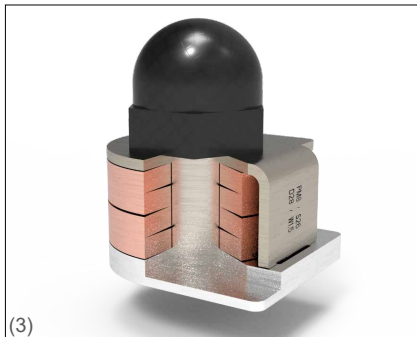
(2) design principles

The TA Luft PROFEKT (+) Spring loaded system

The predecessor system Profekt Life Loading was developed for applications in the live loading area. The design as open spring column, can be flexible adapted for special solutions. This also applied to applications that can no longer be covered by the standard TA Luft Expert system.

With the development of the new TA Luft Expert (+) series, the flexibility was further taken into account for special solutions at the same time, the TA Luft requirements for maintenance notifications were met. No bolt extension of the stuffing box design is required for this series. The TA Luft Profekt (+) spring column partially standardized for thread and spring sizes to M36 or UNC 1 1/2". This means that those spring columns are always individually adapted to the application conditions using the „TA Luft EXPERT“ calculation and design program.

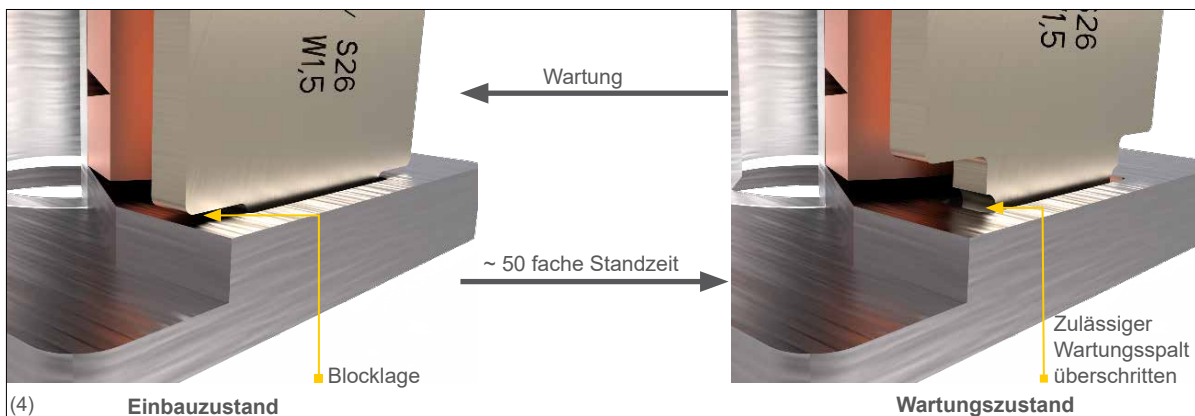
Spring pillar Profekt (+)



(3) spring pillar Profekt (+) in installed state

The spring pillar is identified by filigree laser marketing, as coloring of the pillar is not permitted

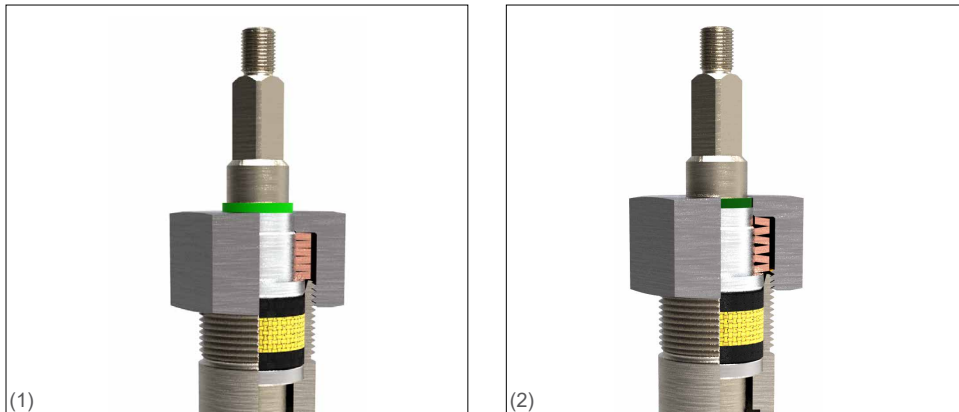
(4) How the spring pillar Profekt (+) works



The central spring system for screw glands TA Luft Central (+)

Screw glands are preferred in valve construction where there is a risk of freezing and the stem seal is deliberately separated from the critical area by extension tubes. Preferred applications of the TA Luft Central (+) system are combustible liquid gases such as hydrogen and methanol in the Live Loading application area and Liquefied Natural Gases (LNG) in the TA Luft application area, which are liquefied at minus 165 ° C. When developing the system, we decided against an internal spring system in order to avoid direct media and temperature contact in terms of high reliability.

The central springing system for screw glands developed by KSD has a maintenance indicator and thus fulfills the requirements of the amended TA Luft in Section 5.2.6.4, "Ensuring permanent tightness by means of suitable measures for testing and maintaining the sealing systems"..



(1) **The TA Luft Central (+) in installation and operating conditions.** The sealing system is in a maintenance-free working mode as long as the green, contrasting maintenance ring is visible.

(2) **The TA Luft Central (+) reports maintenance needs.** The green, contrasting maintenance ring is no longer visible. Need for maintenance.

The TA Luft Central (+) is designed for specific applications and customers using our certified calculation program TA Luft Expert.

Stopfbuchse Eingabe der Prozeßparameter

Firma / Institution:

Bearbeiter:

Anlage / Armatur:

Prüfdruck: bar

Prüftemperatur: °C

Betriebsdruck: bar

Betriebstemperatur: °C

Betriebsmedium:

Betriebsmedium

stark chloridhaltig

stark oxidierende Säure

Fluorverbindung

Anzahl der Spindelbetätigungen pro Stunde

weniger 5 weniger 50 50 und mehr

(3)

Ausführung

Stopfbuchsausführung

Normalstopfbuchse mit Federsäulen

Absaugstopfbuchse mit Federsäulen

Sperrstopfbuchse mit Federsäulen

Spermedium:

Stopfbuchsschrauben

Klappschrauben

Augenschrauben

Hammerschrauben

Stiftschrauben

Tellerfedersäule

zentral (Spindel)

dezentral (Schrauben)

Leckrate

TA-Luft-Ausführung

LIVE LOADING --> Gasleckrate: [cm³/min]

(4)

Normalstopfbuchse

Umrüstsatz

- Druckring
- Scheibe mit Führungsring
- Tellerfedersäule
- Brille mit integriertem Federtopf
- Verlängerte Stopfbuchsschrauben
- Grund- bzw. Distanzring (sofern erforderlich)
- Stopfbuchspackung (TA - Luft - Zertifiziert)

Vorhandene Stopfbuchsengeometrie

Wartungsspalt SW

Einstand 2mm bis max. Packungsbreite b

Ø · D

Ø · d

b

t

Konstruktionsdaten

Stopfbuchsengeometrie

d: mm

D: mm

t: mm

vorh. t unbekannt

Schraubenabmessungen

M: mm

L: mm

Anzahl:

Schraubenwerkstoff

Spindelwerkstoff

(5)

(3), (4), (5) calculation program TA Luft Expert

In addition to the packing system (see the modular solution „time live “and the spring package with pressure ring, the scope of supply of the centrally spring sealing system also includes the hexagonal cap nut. All elements are drilled by stainless steel A2 or similar. In order to ensure optimal guidance between the spindle and the pressure ring, it is armored at the ends with a modified Stellite 6 alloy. Explanade surface hardening is also possible for larger quantities.¹

The hexagon cap nut, made in 1.4034 material, its protected against surface damage in the threaded area by laser surface hardening. For larger quantities, material exports in A2 or A4 with an Explanade surface finishing are also possible.



¹ Expanite® is a protected name for a stainless steel surface hardening process.

The view in the future

The integration of digital solutions in the new series of spring-loaded sealing systems has started. It is not just about the continuous recording of the maintenance gap and the wireless information via wifi, but about a completely new quality of the maintenance forecast. The systems developed by KSD is already being tested not only measure the maintenance gap of the spring pillar by means of appropriate distance sensors but can also calculate the tension state of the stuffing box. In this way, a relatively precise assessment can be made of the period that remains until the next maintenance. If these systems are used on specially selected shut-off devices can also be used as control systems for our conventionally spring-loaded sealing systems. As a result, scheduled maintenance of large dash panels can be based on an Industry 4.0.

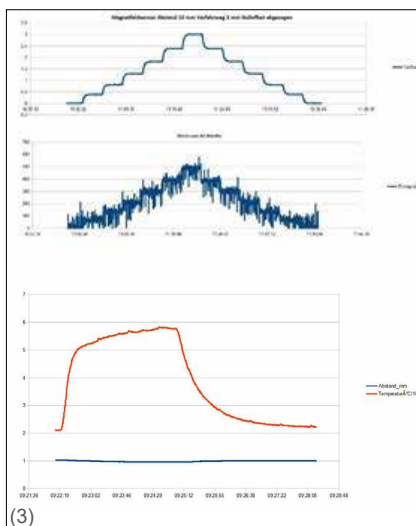
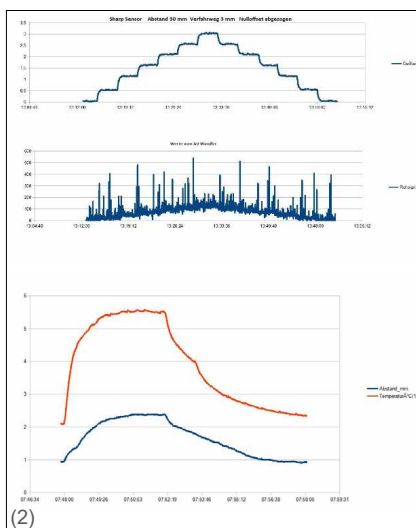
Extended applications arise in connection with suction glands through the integration of special gas sensors in the system. The selection of special gas sensors is still limited, but will be changed. Our systems should be upgradeable with an additional module. The sensory detection of special gas concentrations then serves as a permanent control. The parallel determination of the tension state of the stuffing box using a scheduled maintenance approach. In combination, an optimal and cost-efficient solution for testing and maintenance, as required in the last paragraph under point 5.2.6.4 of the amended TA Luft.

Many obstacles still have to be removed for this new generation of intelligent seals:

- Restricted temperature range for the sensors
- High costs for sensors and evaluation electronics
- Supply security with energy if no power connection is available or in the event of a power failure
- Explosion protection and protection against atmospheric disturbances.
- Data privacy
- Reliability of the electronic components and quality of the sensors, with regard to raw signal evaluation,
- Repeatability and temperature drift

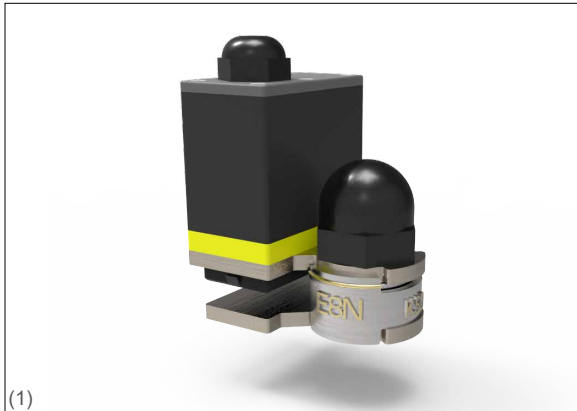
But this can't stop them.

Repeatability, raw signal evaluation and temperature drift comparison



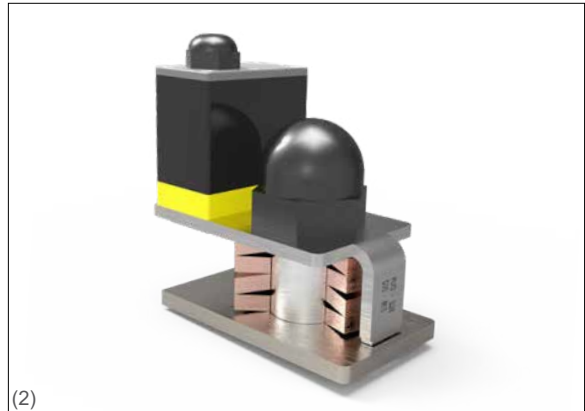
- (2) Infrared distance sensor
 (3) Hall Sensor

The spring-loaded sealing systems TA Luft Expert 4.0 and Profekt 4.0



(1)

(1) spring column TA Luft EXPERT 4.0



(2)

(2) spring column TA Luft PROFEKT 4.0

Aktiviert mit dem Handy in drei Schritten

Federsäulentyp ▼	Federsäulengröße ▼	Federwerkstoff ▼	Start
TA Luft Profekt 4.0 TA Luft Expert 4.0	E8N E10N E10NV E12N E12NV E16N E16NV	Standard 1.1211; 1.1248; 1.8159 Austenit 1.4301; 1.4310; 1.4401 Warmfest 1.4923; 1.4122 Inconel 2.4632; 2.4669; 2.4668	

After pressing the START button, the system permanently determines the length increase of the spring column by measuring the distance, calculates the voltage state of the spindle sealing and predicts the maintenance date.

Beginn der Aufzeichnungen	Prognostizierter Wartungstermin
20.09.2019	02.10.2022

The maintenance gap size, voltage condition of the stuffing box and forecast maintenance date for the spindle seal can be picked up via wifi after a short period of use of the system. Of course, the quality of the forecast increases steadily with an increasing number of measuring points.

This generation still relies on a conventional power supply with 24 V DC or 220 V AC and the maximum permissible temperature of the system is still limited. Power outages are buffered. If the permissible maintenance gap is suddenly exceeded, e. g. B. by faulty or manipulated loosening the eyeglass screws, the system goes into an error mode with an optical signal and must be reactivated.

The spring column must be re-tensioned up to the block position. If the measured distance of the newly activated spring column matches the stored control value when restarting, the system is reactivated. The system is programmed in C ++ industry standard. The system works in the low-voltage range of <5 V and is designed to be explosion-proof. In order to avoid damage to the distance sensors during installation, the measuring systems can only be used after the spring columns have been tightened or removed during maintenance work.

The software architecture is designed as a modular system, different sensor systems can be integrated. The interface of the data evaluation is designed for our customers across platforms.



(3) Intelligente Spindelabdichtung für Armaturen

Innovative TA Luft and Live Loading packaging system for original equipment manufacturer and service companies

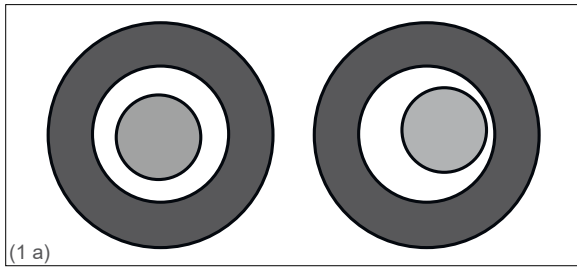
The packaging system (seal ring sets) used by KSD Gmbh for the TA Luft area are based exclusively on the materials PTFE or pure graphite. Only these materials guarantee that no serious changes in properties occur even in the event of ageing and media influence. The calculation results can also be transferred to the operating condition. The material PTFE also has the property of self-healing. That means that the cold flow inherent in the material can close leakage channels again. This requires, however, the maintenance of a necessary minimum pressure in the stuffing box. Either from the self-sealing effect of the internal pressure to be sealed or by measures that reduce the stress counteract the stuffing box. Many of these possibilities are often unknown or insufficiently known. But it is not uncommon for these possibilities to be translated into products that, as in the case of package packs, reduce costs and enable the possibility of automated attachment assembly.

Compact package *Time Live* as a modular

Compact pack <i>Time Live</i>	Kompaktpackung <i>Time Live</i>	Kompaktpackung <i>Time Live</i>	Kompaktpackung <i>Time Live</i>
Teflon	Slip	Universal	Mica
Braided Packing Set with PTFE, chambered with Glas-fiber reinforced PTFE rings	Pure Graphit bush ring with PTFE coated Treads, chambered with Carbon fiber rings	Pure Graphitbush chambered with reinforced smooth metal RGF discs	Pure Graphit bush, chambered with metal reinforced Mica disc
$T_{max} \leq 250\text{ °C}$	$T_{max} \leq 300\text{ °C}$	$T_{max} \leq 450\text{ °C}$	$T_{max} \leq 650\text{ °C}$

A deliberate, slightly eccentric punching of chambering discs results in highly effective functionality terms of chambering, spindle guidance and sealing behavior. The interception of the pack extrusion in the fractured stratification indirectly results in an amplification factor which contributes significantly to the stabilization of the sealing effect. [1]

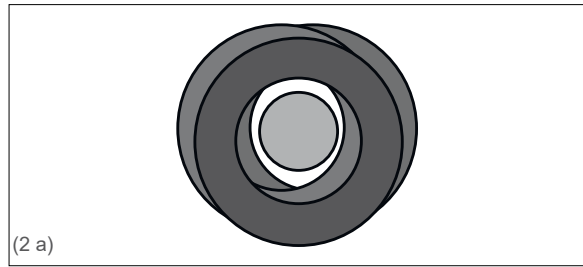
Solid base rings (1)



(1 a)

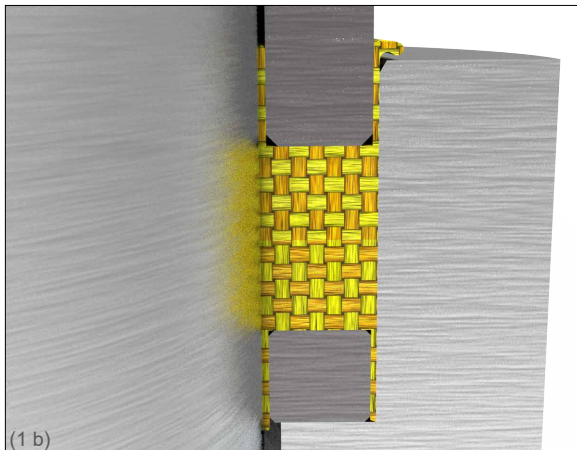
(1 a) Possible extrusion gaps solid base ring

Compact packs (2)



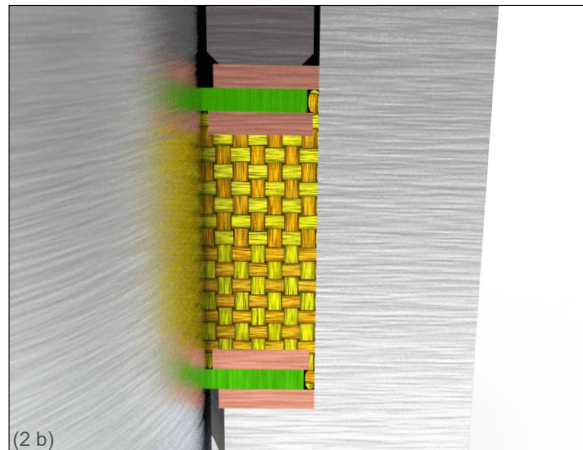
(2 a)

(2 b) Minimization of the extrusion gap



(1 b)

(1 b) Unchecked pack extrusion with solid base rings



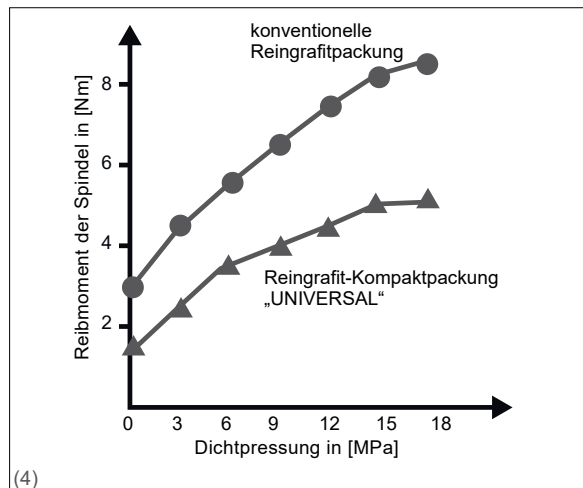
(2 b)

(2 b) Effective stop of the package extrusion through the multiple layering in compact packages



(3)

(3) Pack extrusion stuffed in the eccentric layering of the compact pack



(4)

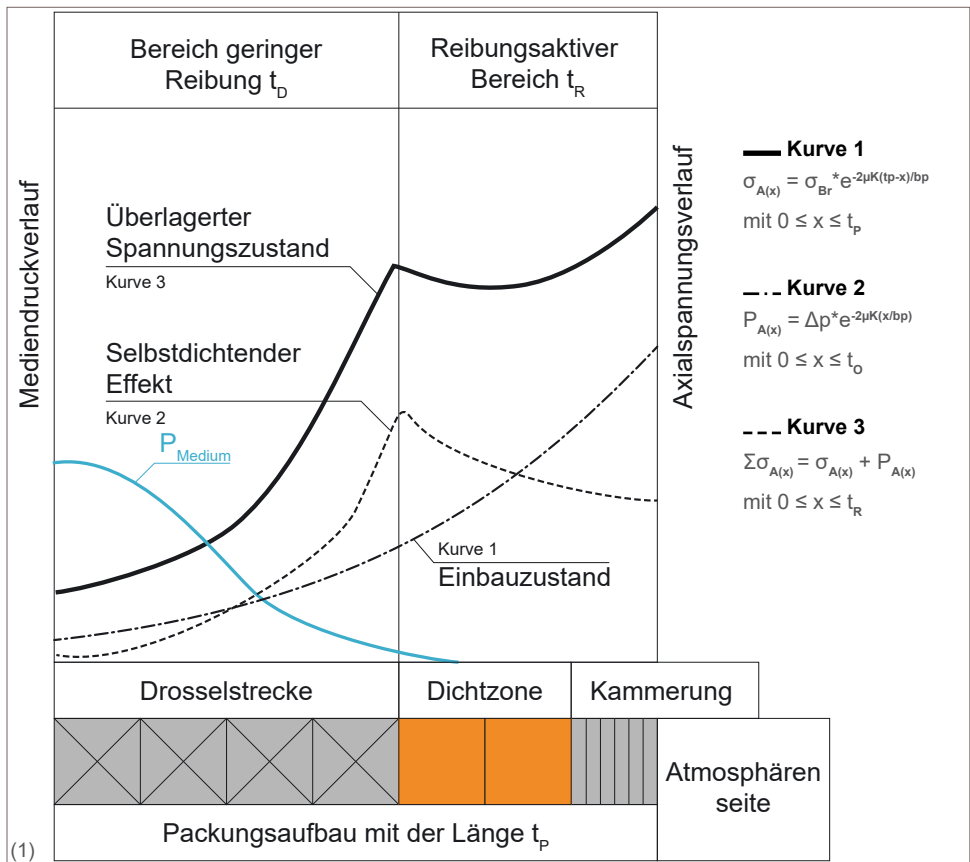
(4) Comparison of the spindle friction torques between an RGF compact pack and a standard pure graphite pack

Combination packs with throttle line

A further possibility to increase the efficiency of stuffing book packs are combination packs with an integrated throttle section. This structure brings together the theoretical approaches of Thomson [2] and Danny & Turnbull [3]. Such a packaging structure is particularly lacking where a horizontal mounting position of the valves occurs with frequent spindle movement at the same time. Such conditions can be found on feed water control valves in power plants. High pressures, along with a one-sided wear load in the stuffing box, can quickly lead to the blow out of standard pure-graphite packs. In the past, the feed water emitted under high pressure and high temperature was repeatedly the cause of serious accidents in power plants.

This can be avoided by the onbay of a combination pack with throttle section shown below.

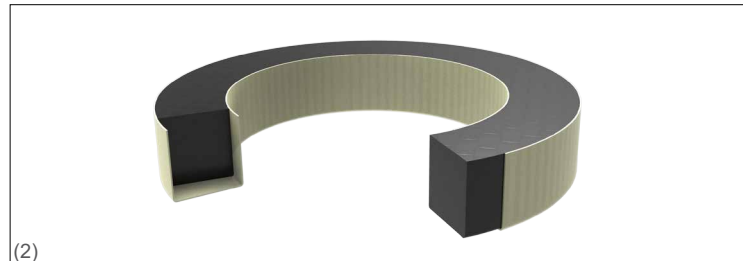
Principle structured off the combination pack with throttle section:



Packing elements

- dense zone:** ≤ 200 °C PTFE packages
- ≤ 300 °C PTFE coated pure graphite rings
- ≤ 450 °C (500 °C) Pure graphite rings

(2) PTFE coated pure graphite ring



Throttle section: Braided rings z. B. carbon fiber
chambering: layer ring z. B. Pure graphite Federing

The effect

The media pressure has already been greatly reduced in front of the sealing zone. However, the self-sealing axial tension P_A is fully effective. According to [2], each packing ring generates a pressure difference Δp , which in turn derives a resulting force $F_{\Delta p}$. This force is generated on the first product-side packing ring and acts as a gradient in the direction of the next ring: The process is repeated for each packing ring up to the sealing zone. This self-sealing force from the internal pressure builds up exponentially and acts practically from the inside on the sealing zone in the upper third of the stuffing box. This sealing zone is regarded in [3] as a compact, impermeable mass. It is compressed on the one hand from the outside via the force of the glasses and on the other hand from the inside using the principle of the throttle section by means of a self-reinforcing gradient force. The fabric book packs constructed according to this principle have a pressure relief exponent of $n \approx 0.35$ (see p. 25). This means that a large part of the internal pressure p_i is used for the self-sealing effect, see Table (3). If this efficient tension state is supported by a matching stuffing box spring system, even very complicated applications can be mastered safely.

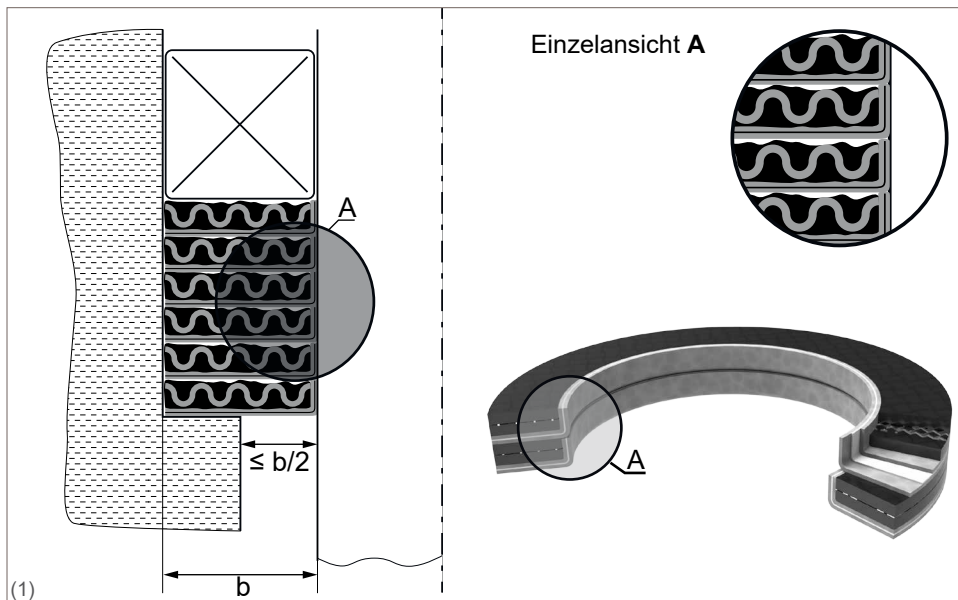
Internal pressure p_i [bar]	Selbstdichtender Effekt [%] ¹
10	~ 75
50	~ 90
(3) 100	~ 95

(3) Self-sealing effect of a KSD combination pack with throttle valve

¹ The values refer to a pressure relief coefficient of $n = 0.35$.

The pure graphite springing

The further development of our TA Luft and Live Loading packaging system has always been closely linked to the search for new chamber solutions. With the patented pure graphite springing, a product has been created that a new standard with regard to its functional properties. Can be used as a chamber and base ring, it counteracts relaxation symptoms of the pack with its permanent behavior. Extreme applications, such as the chambering of packages in high pressure fittings up to 2500 bar, as well as the use as a base in PN40 stainless steel fittings, are just as important for its field of application. Its special structure of expanded metal, pure graphite and smooth sheet enables the reliable bridging of gap widths of up to half a package width in its function as a base ring. The spindle is perfectly protected by the internal stock exchange of the smooth sheet graphite insert. The high strength expanded metal lining gives it an extremely high shear strength and at the same time a high permanent elasticity. As a result, our spring packages in TA Luft and Live Loading applications can be optimally supported. .



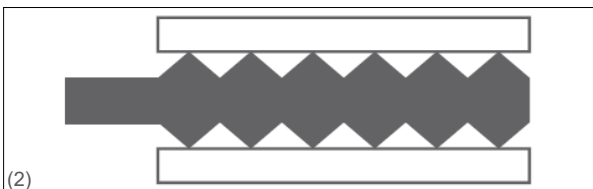
(1) Patented structure of the pure graphite spring ring

The new TA Luft and Live Loading attachment and flange sealing system

So far, KSD GmbH has successfully used Camprofile and Spiral wound gaskets for this application. Here too, the soft materials to be used had to consist exclusively of PTFE or pure graphite (> 98% purity). Camprofile gaskets in the main power end (KHS) were used specifically for sealing the valve attachments, which usually have limited space. Thanks to the concentric, linear sealing tapes, high process reliability could be achieved even with low contact forces.

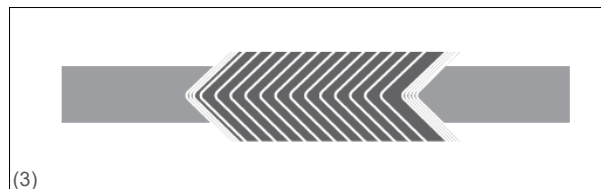
This is important for valve attachment flanges, since the number of screws often limited. Disadvantages of using this sealing solution are low elasticity and the risk of the sealing strip being damaged by the sharp teeth.

For valve pipe flanges with a smooth sealing strip, Spiral wound gaskets in the main power gasket (KHS) were preferred, and for non-smooth sealing strips, Spiral wound gaskets in the secondary force gasket (KNS). The high blow-out safety and the high elasticity of this sealing system against thermally induced pipe forces were decisive. Disadvantages when using Spiral wound gaskets, the relatively high sealing pressures σ_{Krit} for adaptation to the flange strips and the maximum load limited in the KHS.



(2)

(2) Cambrofile gaskets

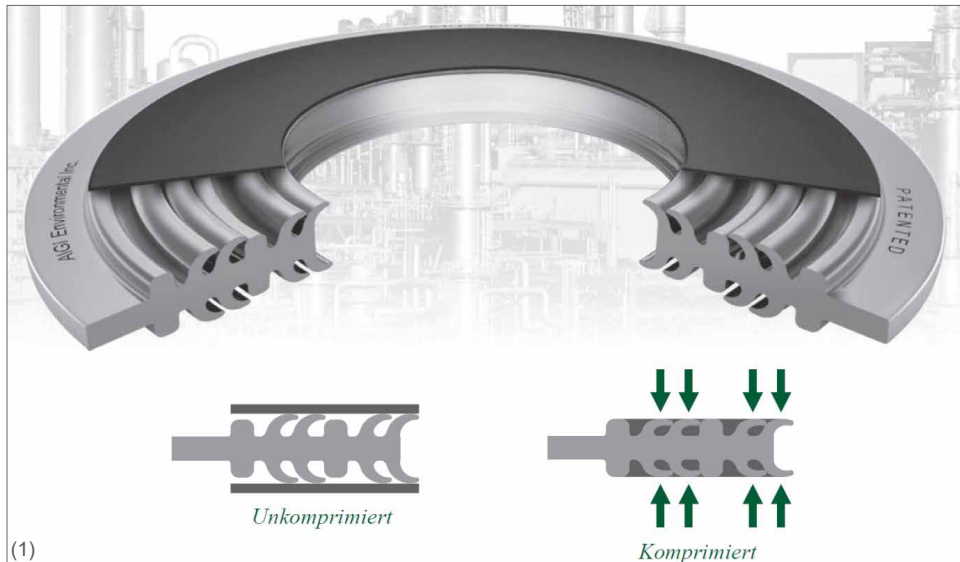


(3)

(3) Spiral wound gaskets

The Fishbone® sealing system, the best of two worlds

With the introduction of the new TA Luft and Live Loading stopper suspension system, we are also able to introduce a new innovative and high quality flange sealing system, the Fishbone sealing system.

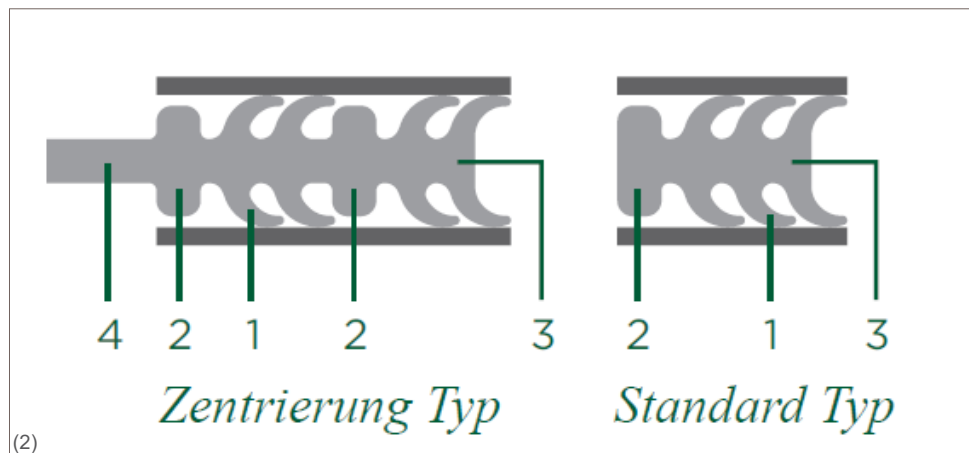


(1) The Fishbone® gasket is a patented product from AIGI Environmental INC.

This new sealing system combines the best of two worlds, the world of Camprofile gaskets forming seals and the world of Spiral wound gaskets. The two fields of application for high quality flange seals on fittings can be unified in the future. The standard type is intended for valve attachments and the centering type is intended for valve flanges.

Fishbone® Types

- 1 Concentrically beveled slats
- 2 stoppers for an integrated force next to the end (KNS).
- 3 Efficient use of media printing for a self-sealing effect.
- 4 Uniform design with or without centering ring



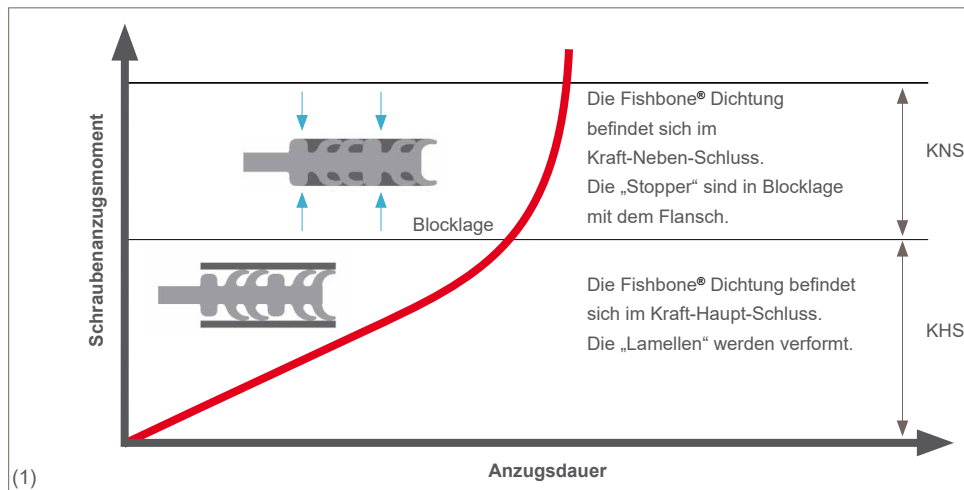
(2) Fishbone® Types

(2)

The concentrically rotating lamellas (Bones) form closed, linear sealing tapes with a high defined pressure, so that even very low contact forces are sufficient to make the system reliable. With the deliberately created deformation of the lamellas (Bones), the soft material covering is enclosed, thus ensuring a high blow-out safety. The special shape of the lamellas (Bones) practically rules out any damage to the flange strips. And a high degree of flexibility and elasticity is achieved.

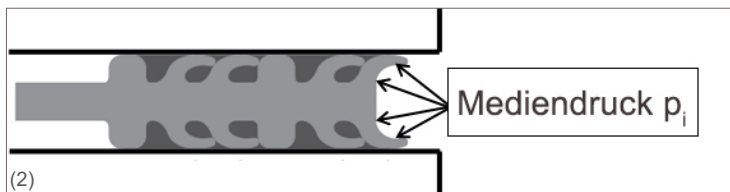
The stoppers integrated in the Fishbone® sealing element always ensures the inner force-side-kiss (NS) of the sealing elements it guarantees a very high-pressure resistance. Possible overloads of the sealing element are thus avoided. When reaching the inner block position, the tightening torques increase remarkably.

This simple but very effective control mechanism, when assembling this sealing system, is an outstanding feature of the Fishbone sealing design and helps to effectively avoid assembly errors.



(1) The control mechanism of the Fishbone® seal during assembly

Another outstanding feature is the use of media printing for a self-sealing effect.



(2) Use of media printing for a self-sealing effect

A functionality that is unfortunately not considered in the current calculation documents for flange seals. This is not the case with the authors of this brochure, who developed a general calculation model for static and quasi-static contact seals in the early 1990s, which has lost none of its relevance to this day. This calculation model puts exactly this functionality at the center of the consideration. [1]

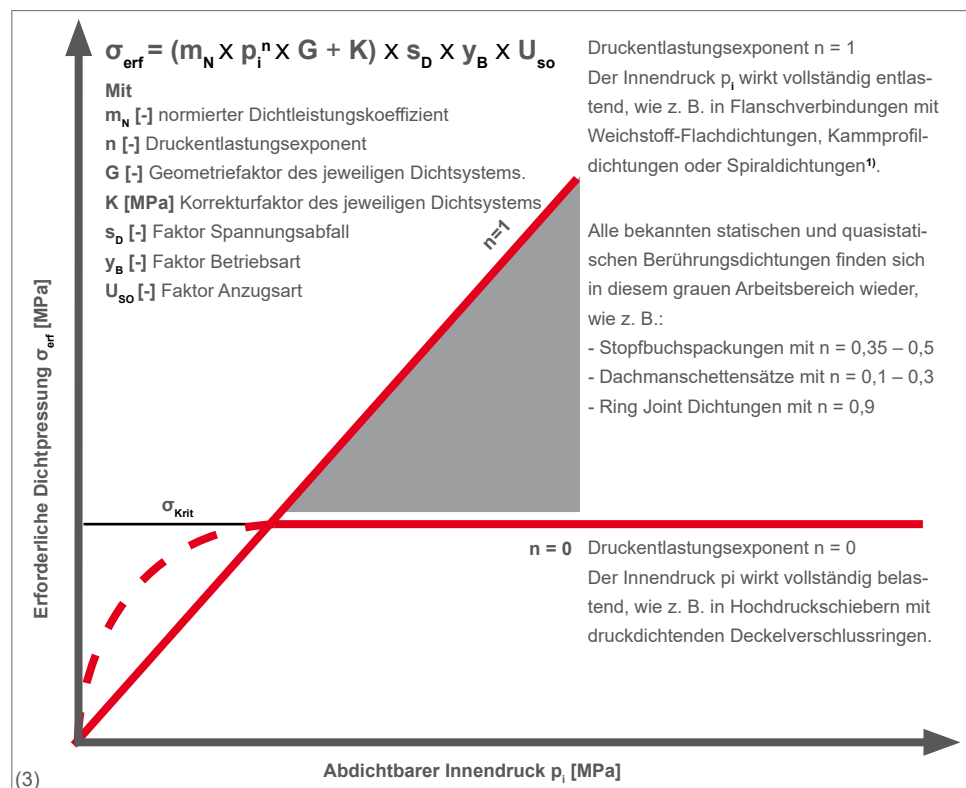
The working area of all contact seals is limited by two extremes:

a) The internal pressure p_i is completely relieving.
This limit value is present in almost all flange gaskets when soft flat gaskets, Camprofile or Spiral wound gaskets¹ used.

b) The internal pressure p_i is completely resilient

We can find this limit in high-pressure gate valves with a pressure-sealing lid closure.

(3)) General calculation model for static and quasi-static contact seals in the valve industry



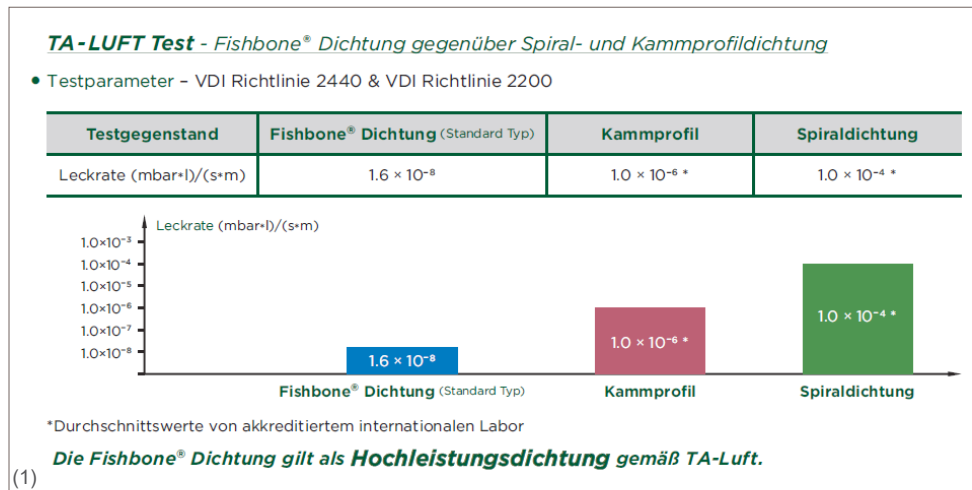
¹ With Spiral wound gaskets, the self-sealing effect is also given by the lamellas, but the multiple winding for stabilization and the additional inner support ring prevent this effect as far as possible.

²With Ring joint gaskets, the self-sealing effect is caused by minimal expansion of the seal due to internal pressure. [4]

Although most commonly used, flange gaskets with soft material flat gaskets, Camprofile gaskets or Spiral wound gaskets are the most inefficient sealing system within the group of static or quasi-static contact gaskets. Like other sealing systems, they were unable to use the internal pressure p_i , fully or partially as a sealing aid.

The Fishbone® sealing system with a pressure relief exponent of $n = 0,8$ sets a new mark, it's the first metal composite gasket that breaks the blemish of a completely relieved flange sealing system and shows how the media pressure p_i can be used for a partially self-sealing effect

The comparison results with other known sealing systems speak for themselves.



(1) TA Luft Test
Fishbone® gasket

Our goal to introduce a flange sealing system that not only achieves an impressively low leakage in the test state, but can also maintain it for a very long time in the operating state through a self-sealing effect, was achieved with the Fishbone gasket.

Our TA Luft and Live Loading Flange spring load system

For extreme loads, such as B. changing thermal conditions, superimposed with pulsating media pressures or systems with frequent start-up and shutdown processes, we also offer our flange suspension system.

(2) flange suspension system



For this purpose, front clamping washers are used, in various material variants that are matched to the process temperature. These clamping elements are standardized for all common metric and imperial screw sizes. By concentrating on the new Fishbone® flat gasket, we have also optimized our flange suspension system.

The two material variants listed below are our preferred series:

Tensioning Discs Material	Yield strengt [N/mm ²]	E-Modul [N/mm ²]	Temperatur-Limits	Corrosion-Protection
1.2344 (H13) X40CrMoV5-1	423	210	-150 °C bis +450 °C kurzzeitig short time up to 500 °C	nickelbeschichtet
1.4568(17-7PH) X7CrNiAl17-	280	180	-200 °C bis +300 °C kurzzeitig bis 330 °C	

As a result, today we can offer solutions that significantly exceed the service life of the previous system or low-cost solutions either that are based on the proven results but manage with significantly fewer or lighter spring elements.

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ISBN –Nr.: 3-88432-002-5

Publisher

Köthener Spezialdichtungen GmbH
OT Kleinwülknitz
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