Triple offset butterfly valve meets the stringent requirements of TA-Luft and ISO 15848

Advanced environmental protection – the ZETRIX way!

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Introduction

Both TA-Luft [1] and DIN EN ISO 15848-1 [2] [3] aim to mitigate or reduce fugitive emissions which are harmful to the environment and human health. TA-Luft is a comprehensive German regulation which specifies binding technical requirements for classified installations in accordance with the 4th Federal Immission Control Act.
EN ISO 15848-1 [2] [3] is an international standard which provides users with evaluation criteria for classifying valves (isolation and control devices), to enable different designs or brands to be compared.
Although compliance with the requirements of TA-Luft is considered to be proof of a sealing system's quality –not just in Germany but in many other countries too – EN ISO 15848-1 [2] [3] is playing an increasingly important role in the chemical, petrochemical and process industries.

Test standards

Section 5.2.6.4 "Shut-off devices" of TA-Luft [1] refers to a metal bellows with a downstream packing gland or sealing systems of similar effect as the latest technology for sealing shaft bushings for isolation and control devices. The more expensive bellows option would often be the better choice for technical reasons; however, the proven packing gland is still regularly chosen for stem seals. Sealing systems "of similar effect" are defined as systems which are capable of maintaining the temperature-specific leakage rates during the proof procedure pursuant to VDI Guideline VDI 2440 [4].

Proof pursuant to VDI 3.1.3.3 must be furnished for a test sample which is representative of the sealing system at temperatures, pressures and stem or shaft movements corresponding to the actual operational conditions. The equivalence of a sealing system is deemed to be demonstrated if a leakage rate of 10^{-4}mbar*l/(sec*m) or 10^{-2} mbar*l/(sec*m) is maintained at a temperature of <250°C or >=250°C respectively.

EN ISO 15848-1 [2] [3] specifies the test conditions and requirements in much greater detail in that the valves are generally grouped according to tightness, endurance and temperature classes. The test specifications take account of the significant requirements for isolation and control valves by means of different mechanical cycles and lift movements. In contrast to TA-Luft [1] a tightness criterion is specified for the static body seal (<=50 ppmv). This allows users to evaluate the expected fugitive emissions from the valve as a whole.

The valve qualification or classification must be demonstrated by means of a type test; provided the design is identical, the results can also be transferred to other types with a stem or shaft ∅ between 50% and 200% of the test sample.

Leakage rates of stem and shaft seals – EN ISO 15848-1 [2] [3] and TA-Luft compared

The leakage rate which is achieved under the test conditions is also decisive in the standard. A total of three tightness classes are specified independently of the temperature: class A implies equivalence for the sealing systems of rotary valves with a bellows, for example. In the 2015 edition, which came into force in November 2015, the leakage rate for class A has been increased, bringing it closer to TA-Luft [1].

	Class A		Class B		Class C	
	$\frac{mg}{sec \cdot m}$	$\frac{mbar \cdot l}{sec \cdot m}$ 1.)	$\frac{mg}{sec \cdot m}$	$\frac{mbar \cdot l}{sec \cdot m}$ 1.)	$\frac{mg}{sec \cdot m}$	$\frac{mbar \cdot l}{sec \cdot m}$ 1.)
2006 Edition	**$\leq 10^{-6}$**	**$\leq 6.1*10^{-6}$**	**$\leq 10^{-4}$**	**$\leq 6.1*10^{-4}$**	**$\leq 10^{-2}$**	**$\leq 6.1*10^{-2}$**
2015 Edition	**$\leq 10^{-5}$**	**$\leq 6.1*10^{-5}$**	**$\leq 10^{-4}$**	**$\leq 6.1*10^{-4}$**	**$\leq 10^{-2}$**	**$\leq 6.1*10^{-2}$**

*1.) The room temperature-specific volume leakage rate must be reduced by the factor $\frac{2*d_i}{d_i+d_a}$ to permit a direct comparison with TA-Luft because it refers to the mean seal diameter (d_i = inside ∅ of packing; d_a = outside ∅ of packing). Example: The factor for a 58x42 packing would be 0.84 while the class A criterion for TA-Luft would be $5.1*10^{-6}$ or $5.1*10^{5}$ mbar*l/sec.*

It can be seen from the table that tightness class A always satisfies the TA-Luft criterion; in the case of classes B and C the temperature-dependent criterion must be verified.

Zetrix triple offset butterfly valve in practice – qualification according to DIN EN ISO 15848-1:2006-04 [3] and classification of the results according to TA-Luft [1]

A test sample of the butterfly valve (rotary valve with 90° travel), fitted with a high-grade graphite packing without a spring for sealing the shaft bushing and a serrated seal as a static seal for the bottom flange, was tested and certified in two different temperature classes at Amtec's accredited laboratory in accordance with the standard.

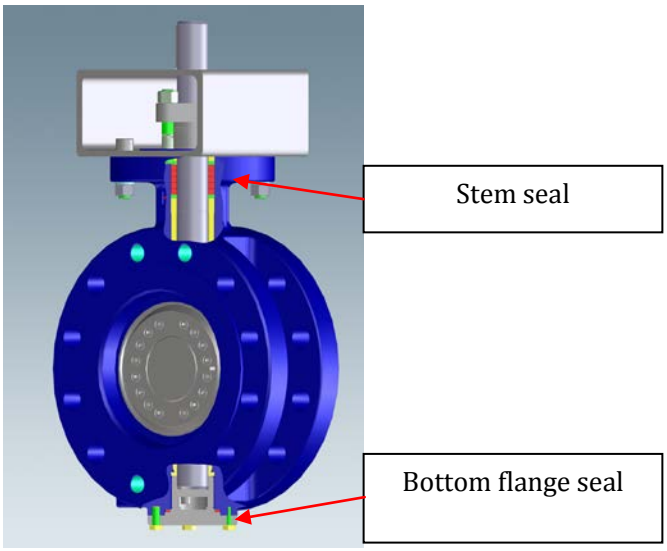

Fig. 2: Zetrix triple offset butterfly valve with high-grade sealing systems

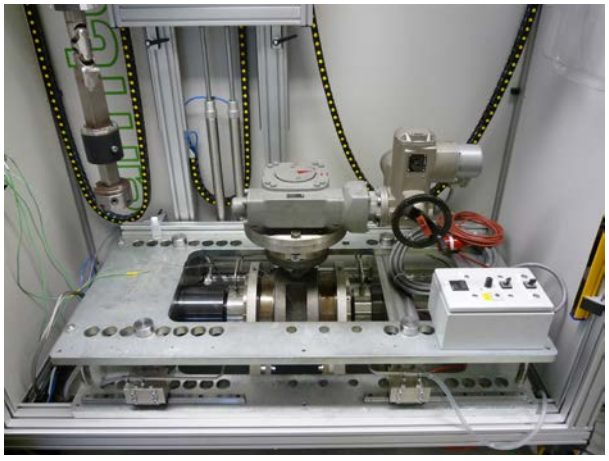

Fig. 1: Amtec test report no. 302 586 2/- Supplement 16 – Testing procedure and results EN 15848-1 [3] [5]

Results for temperature class 1 (max. RT 200°C) [5]

ISO FE AH – CO3 – SSA 0 – t(RT,200°C) – (40/35 bar) – ISO 15848-1 [3]

FE	Fugitive emissions
AH	Tightness class A, test fluid = helium
CO3	Endurance class CO3, 2500 mechanical cycles in 4 thermal cycles, max. RT 200°C
SSA 0	Number of stem seal adjustments = 0
t(RT, 200°C)	Temperature class max. RT 200°C
(40/35 bar)	Pressure rating at test temperatures

Classification of results according to TA-Luft [1] [5]

The leakage rates measured during the test were always less than the 10^{-4}mbar*l/(sec*m) criterion; this is also confirmed by the class A tightness which was achieved. The sealing system can thus be deemed high-grade as defined by TA-Luft under the test conditions described.

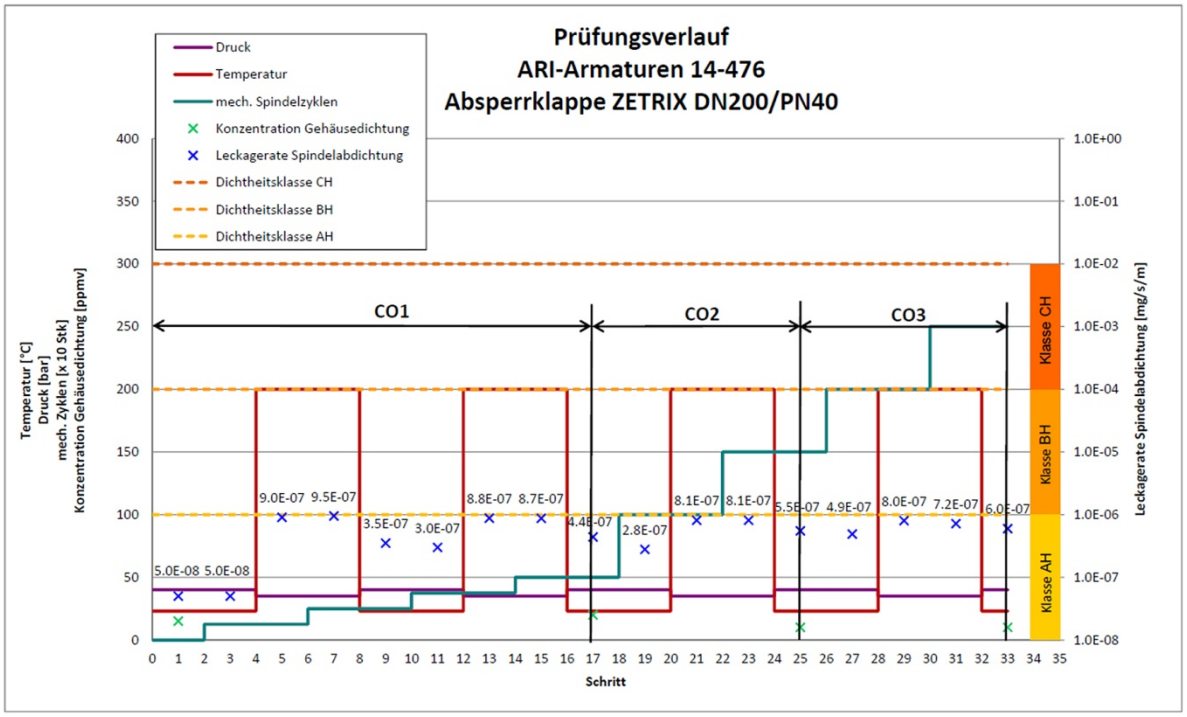

Fig. 3: Amtec test report no. 302 586 2/- Supplement 15 – Testing procedure and results EN 15848-1 [3] [5]

Results for temperature class 2 (max. RT 400°C) [6]

ISO FE BH – CO3 – SSA 0 – t(RT,400°C) – (40/23.6 bar) – ISO 15848-1 [3]

FE	Fugitive emissions
BH	Tightness class B, test fluid = helium
CO3	Endurance class CO3, 2500 mechanical cycles in 4 thermal cycles, max. RT 400°C
SSA 0	Number of stem seal adjustments = 0
t(RT, 400°C)	Temperature class max. RT 400°C
(40/23.6 bar)	Pressure rating at test temperatures

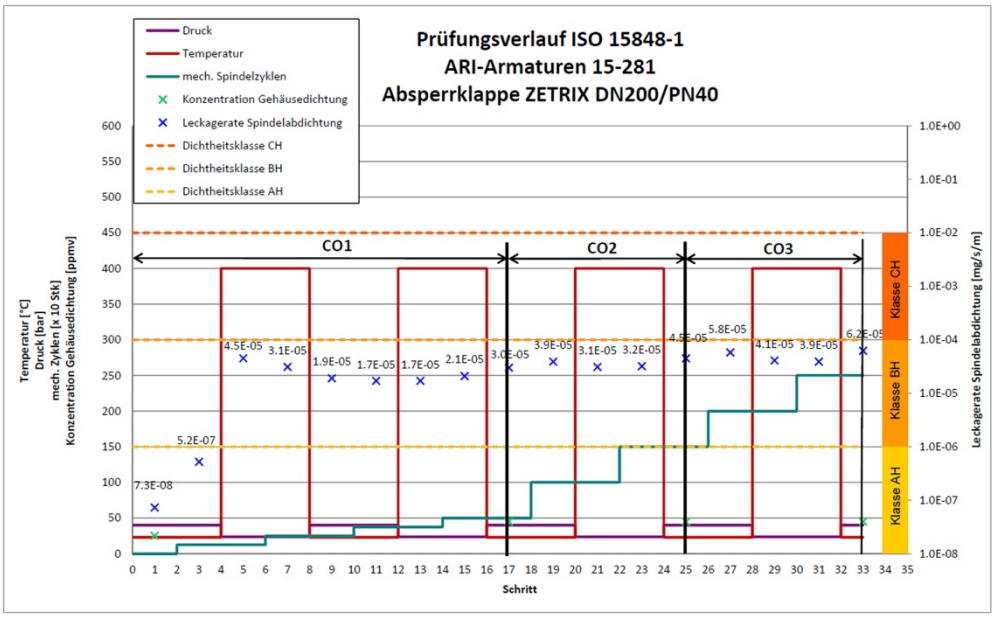

Fig. 4: Amtec test report no. 302 586 4/- Supplement 9 – Testing procedure and results EN 15848-1 [3] [6]

Classification of results according to TA-Luft [1] [6]

Up until the end of the second thermal cycle and 500 mechanical cycles the leakage rates measured during the test were always in the region of the TA-Luft 10^{-4}mbar*l/(sec*m) criterion at RT and 10^{-2}mbar*l/(sec*m) for 400°C. The sealing system can thus be deemed high-grade as defined by TA-Luft under the test conditions described .

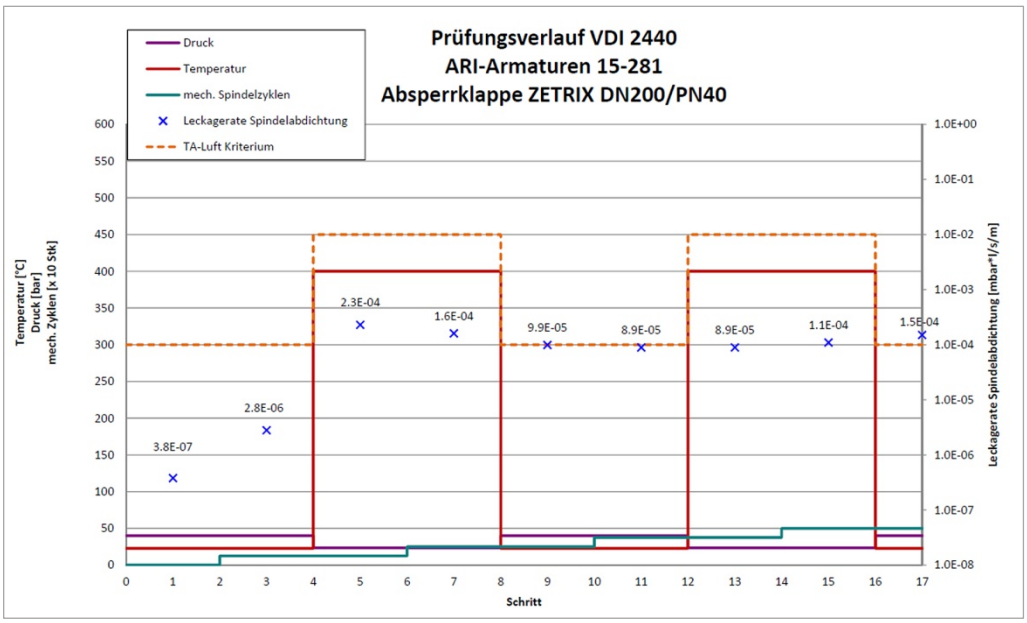

Fig. 5: Amtec test report no. 302 586 4/- Supplement 9 – Testing procedure and results EN 15848-1 [1] [6]

Conclusion

The stem seal of the Zetrix triple offset butterfly valve is fully compliant with the TA-Luft criterion in the temperature class up to 200°C under the conditions described in DIN EN ISO 15848-1 [3]. In the temperature class up to 400°C the criterion is fulfilled up to 500 mechanical cycles in two thermal cycles, in other words equivalence with a bellows seal is proven.

Since a specific classification is possible according to DIN EN ISO, a valve's performance can be classified in terms of its ability to reduce and mitigate fugitive emissions, as demonstrated by this example. Different designs or operating parameters can thus be directly compared.

The manufacture and installation of the valve entails considerable challenges and requirements in order to ensure conformity with these two technical regulations. The stipulated leakage rates can only be achieved by observing narrow limits with regard to the stem surface finish and the gland hole and by utilising a high quality bearing with a precisely tensioned gland.

In-service examination

A Zetrix triple offset butterfly valve with a nominal diameter of 350 mm was subjected to an endurance test lasting approximately 3-months with synthetic thermal oil at the in-house test facility. The valve completed 11 thermal cycles and 10,000 mechanical cycles between RT or 100°C and 350°C at approximately 10 bar fluid pressure. Any leakage at the stem seal is drained off and collected by means of a lantern ring underneath the packing box flange. No leakage whatsoever occurred at any time during the test. The high quality of the stem seal described here was thus proven under realistic operating conditions – offering further confirmation of the results obtained in the laboratory.

Bibliography

[1] TA-Luft, *First General Administrative Regulation Pertaining to the Federal Immission Control Act (Technical Instructions on Air Quality Control – TA Luft) of 24 July 2002.*

[2] DIN EN ISO 15848-1, *Industrial valves - Measurement, test and qualification procedures for fugitive emissions - Part 1: Classification system and qualification procedures for type testing of valves (ISO 15848-1:2015); German version EN ISO 15848-1:2015.*

[3] DIN EN ISO 15848-1, *Industrial valves - Measurement, test and qualification procedures for fugitive emissions - Part 1: Classification system and qualification procedures for type testing of valves (ISO 15848-1:2006); German version EN ISO 15848-1:2006.*

[4] VDI 2440, *Emission control - Mineral oil refineries - November 2000.*

[5] Amtec, Test Report-302 586 2/-, 2014.

[6] Amtec, *Test Report-302 586 4/-,* 2015.

List of figures