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1/2026

IndustrialValves

International Edition of IAD – Germany's leading trade magazine IAD Industriearmaturen & Dichtungstechnik

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Improving Valve Reliability in Critical Applications – Adhesive-Free Technology for Triple-Offset Valves

STEFAN SCHULZ

Hydrogen infrastructure, oxygen service and demanding process conditions place increasing requirements on valve sealing systems. Adhesive-free laminated seals offer a robust solution for metal-seated triple-offset valves used in critical applications.

Metal-seated triple-offset valves (TOV) are among the most important valve types for demanding applications in the process industry. They are used wherever aggressive media, high temperatures, large pressure differences or challenging operating conditions must be reliably controlled – for example in the chemical, energy and gas industries.

Source: IDT

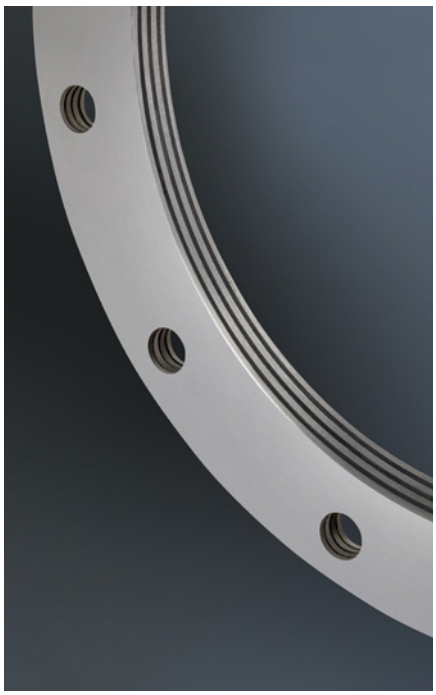

Figure 1: *Adhesive-free seal with IDT's LE-Safe technology for metal-seated triple-offset valves.*

A key component determining the performance of these valves is the sealing system. In metal-seated butterfly valves, laminated butterfly valve seals have proven particularly effective, as their metal-elastic structure enables reliable seat tightness even under demanding operating conditions.

A Seal that Adapts

Laminated seals consist of several layers of expanded pure graphite combined with metallic interlayers. This sandwich construction combines two important properties: the elasticity of graphite and the mechanical stability of metal. The specially machined sealing surfaces ensure that the lamella adapts precisely to the valve seat and housing geometry, guaranteeing reliable sealing even at high shut-off pressures.

"Laminated seals are a central component of metal-seated triple-offset valves. Their geometry and material combination are decisive factors in determining the achievable tightness and the service life of the valve," explains Jörg Skoda, Technical Director at IDT.

Safety-Critical Reactions

Traditionally, the individual layers of a laminated seal bonded together with adhesives during manufacturing. This bonding primarily serves to stabilize the lamella package during handling, transport and assembly. However, once the seal is installed in the valve, the clamping ring takes over the mechanical fixation. In this condition, the adhesive no longer fulfills any structural function. In critical applications, adhesives may even become a potential risk factor. At elevated temperatures, decomposition products may occur, while at low temperatures adhesives can become brittle. Applications involving oxygen are particularly sensitive.

"In oxygen service equipment and plant components, certain organic substances can lead to safety-critical reactions. Therefore, seals used in such environments should be as free as possible from potentially reactive components," explains Norman Richter from Product Development at IDT.

Development of the LE-Safe Technology

Against this background, IDT collaborated with a valve manufacturer to develop an adhesive-free laminated seal specifically designed for triple-offset valves. With the LE-Safe technology, the metallic carriers and graphite layers are connected purely mechanically. The stability of the lamella package is ensured by the seal design itself and by its clamping within the valve assembly.

"Our goal was to completely eliminate adhesives without compromising the mechanical properties or sealing performance," says Jörg Skoda.

To achieve this, a multi-stage development process was carried out, including extensive laboratory testing and practical validation.

Advantages for Demanding Applications

The adhesive-free design provides several important advantages:

- No delamination of the material layers
- No ageing of organic components
- High long-term stability
- Reduced contamination risk
- Temperature-stable material combination suitable for cryogenic applications

At the same time, the mechanical properties and leakage performance remain comparable to conventional laminated butterfly valve seals. Even extreme operating conditions can be reliably covered. "Metal-graphite seals without adhesives cover a very wide temperature range – from cryogenic applications to high-temperature processes," explains Norman Richter.

Relevance for New Energy Applications

In addition to classic process industry applications, laminated butterfly valve seals are gaining increasing importance in emerging hydrogen infrastructures. Due to its very small molecular size, hydrogen places particularly high demands on the tightness of valves and flange connections. At the same time, hydrogen electrolysis pro-

Source: IDT

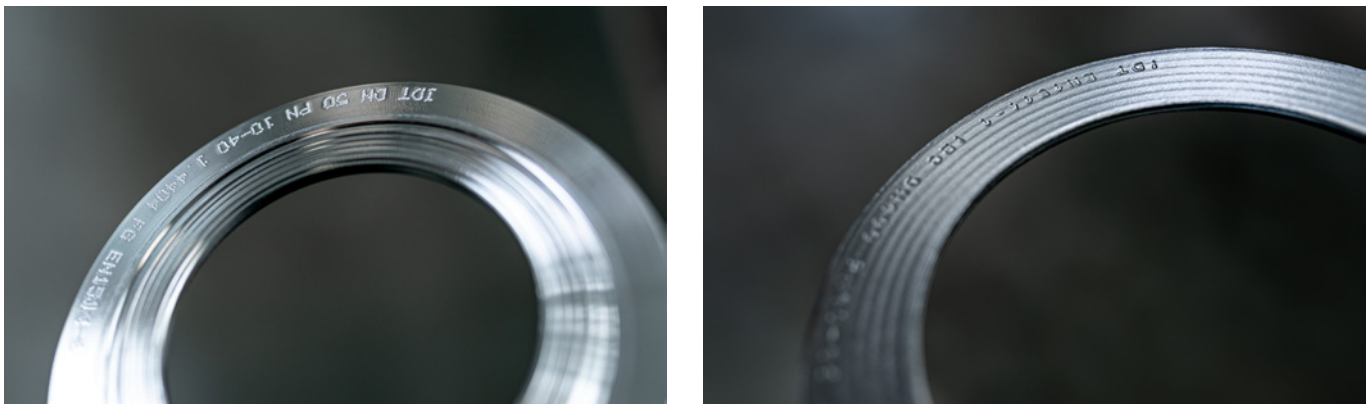

Figure 2: *Cammprofile carrier and graphite layer for IDT's adhesive-free LE-Safe technology used in demanding applications in hydrogen and oxygen service.*

duces oxygen as a by-product, which imposes additional requirements on material compatibility and cleanliness. Adhesive-free metal-graphite sealing systems can therefore contribute significantly to operational safety in hydrogen-related applications.

Extending the Technology Beyond Laminated Seals

The LE-Safe technology originally developed for triple-offset valves has meanwhile been transferred to other sealing systems. These include camprofile gaskets and corrugated metal gaskets, which are mainly used in flange connections for pipes, pressure vessels and process equipment. This creates a consistent sealing concept that can be applied across different components within industrial plants.

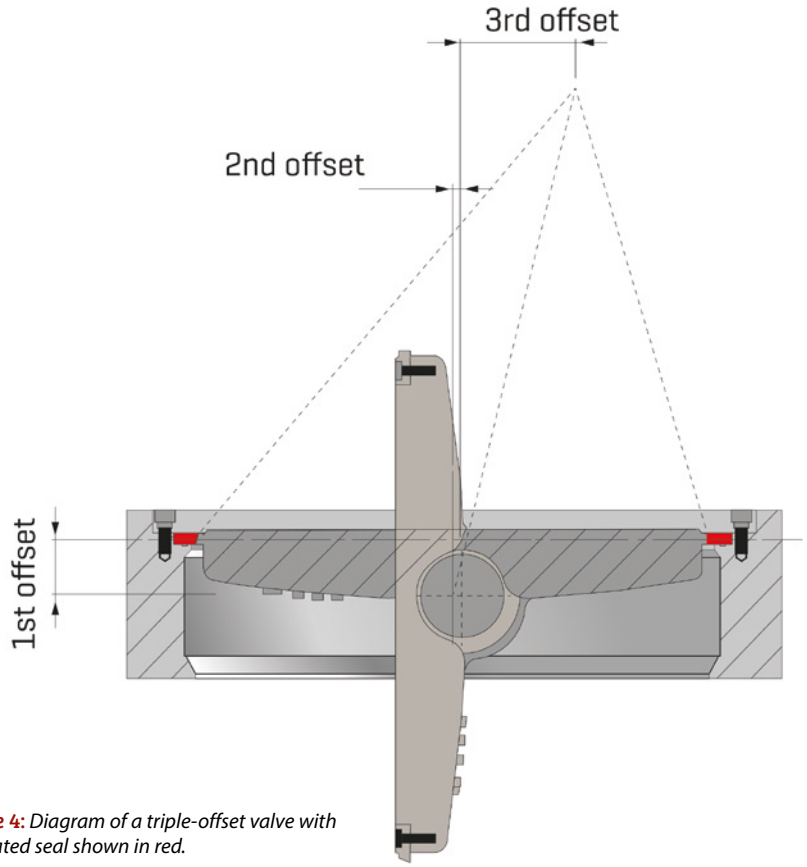

Figure 4: *Diagram of a triple-offset valve with laminated seal shown in red.*

Conclusion

Increasing requirements for process safety, emission control and plant availability are placing growing demands on sealing technology. Adhesive-free butterfly valve seals demonstrate how targeted improvements to established sealing concepts can enhance both safety and long-term reliability of industrial valves. Especially in demanding applications such as hydrogen infrastructure, adhesive-free laminated seals provide a robust and reliable sealing solution for metal-seated triple-offset valves.

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