Fugitive emissions: guidelines for successful valve upgrades

Due to the upcoming emission legislation in Europe, most chemical and process industry plants will have to adhere to strict legislation when replacing sealing elements during shut-downs. In addition to the need for proper sealing solutions there are requirements with regard to the correct installation and condition of the equipment, i.e. valves or flange connections. All aspects have to be covered to ensure a tight and minimal emission performance. In this environment, seal manufacturers strive to not only supply packing sets to the customer but to give additional support for a problem-free upgrade of existing valves to IPPC/ TA-Luft requirements. This work includes the provision of the right products, working with the customer and helping with (or managing) the transition work, training and educating maintenance staff about the requirements and consequences of the I.P.P.C. and TA-Luft legislation.

Ralf Vogel, Engineering Manager, Burgmann Packings Limited
Stefan Danner, Applications Engineer, PSS Division, Burgmann Industries GmbH & Co. KG.
Bob Smith, Product Marketing Manager, PSS Division, Burgmann Industries GmbH & Co. KG

1. Sealing solutions for TA-Luft

A range of packing sets and gasket solutions to specifically cover the refurbishment and upgrade of used valves to meet the new regulations has been developed following testing of a wide range of packings and gaskets; the testing phase included field tests with selected customers.

For the retrofit of valves there are two main solutions - one for temperatures up to 250°C and one for temperatures exceeding this limit.

2.1. Sealing valves for temperatures up to 250°C

The new BuraTAL 9560 T3 packing set, shown in Figure 1, has been developed using very dense and gas tight patented materials [4]. The set is made of three intermediate rings of PTFE impregnated meta-aramid non-woven material. The end rings consist of non-woven carbon material with a PTFE/graphite impregnation. The set has very good thermal stability and reduced cold flow compared to pure PTFE packings due to the fibre reinforcement. The strong but flexible end ring material counteracts gland pressure losses and protects against gap extrusion.

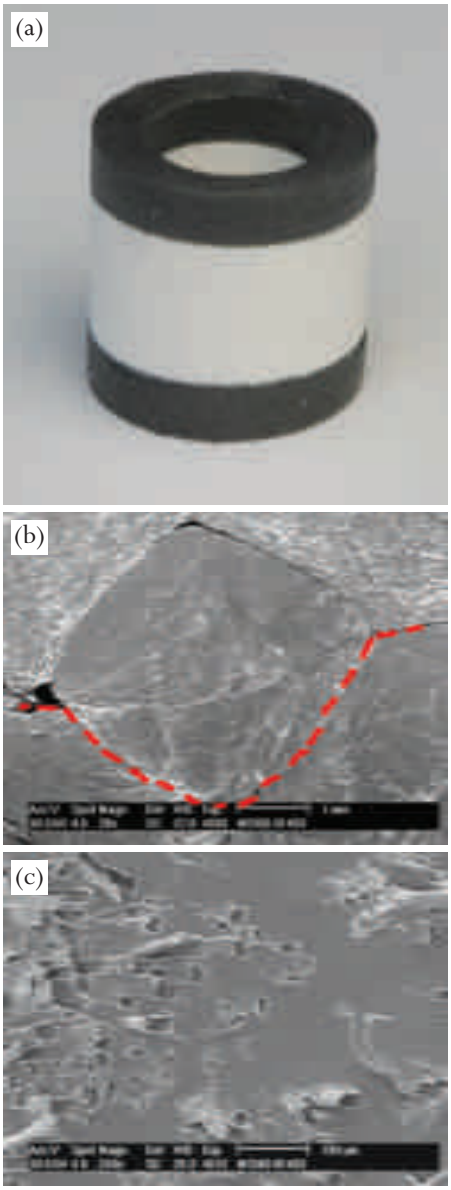


Fig. 1(a) Packing set - BuraTAL 9650/T3. (b) Magnified view of typical PTFE braided packing. High-density packing - but leakage paths between yams still visible. Cold flow of PTFE under working load leads to poor resilience and gap extrusion. (c) Magnified view of non-woven packing ring. ● No leakage paths. ● Cold flow of PTFE impregnation inhibited due to interlocked, randomly oriented, fibres.

The set is suitable for standard on/off valves as well as for control valves due to its low coefficient of friction. The graph in Figure 2 shows the results of testing the packing set at 40 bar with helium according to VDI 2440 [5] at room temperature. Over 100,000 cycles with a stroke length of 10 mm the leakage rate was lower than the TA-Luft limit throughout the test.

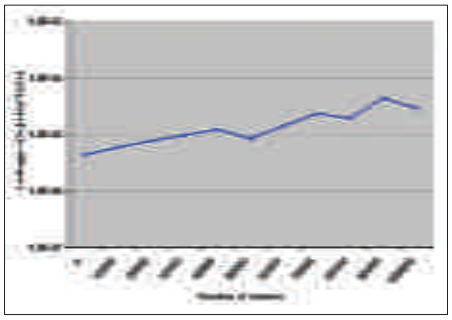


Fig. 2. Leakage rate of non-woven set over spindle cycles.

A field-test with the BuraTAL 9650/T3 set in a control valve in a gas refinery (26.4 bar, ambient temperature, mixed hydrocarbons, 4 spindle cycles per day) showed no detectable leakage after 30 months of operation. The leakage was measured on-site by sniffing with a FID (Flame Ionisation Detector). The measurement of previously packed graphite-sealed valves showed leakage values of up to 5,000 ppm.

2.2 Sealing valves at temperatures above 250 °C

The BuraTAL 9650/HT packing set, shown in Figure 3, has been specially developed for the sealing of older valves to meet fugitive emission standards. This set consists of four components, each with their own specific function, to guarantee good performance in less than ideal, re-worked conditions. The end rings are made from braided expanded graphite with carbon filament yarn corners giving protection against gap extrusion even when valve clearances are large. Next are high density expanded graphite discs which act as a permeation barrier. The middle part of the set is made of coated high density expanded graphite adapter rings and a low density expanded graphite sealing ring with a special friction reducing impregnation.

The conical inner ring can adapt to the spindle surface easily even in reworked valves where the actual dimensions differ significantly from nominal stuffing box dimensions.

Fig. 3(a). BuraTAL 9650/HT packing set.(b) Exploded view of BuraTAL 9650/HT packing set.

Figure 4 shows the leakage performance of the BuraTAL HT set during tests against alternative packing sets at 40 bar pressure and helium. The HT set was the only packing set, which consistently performed within the TA-Luft limits, without additional spring loading over 1000 spindle cycles. All other packing sets showed higher gland pressure losses and failed to meet the TA-Luft limit.

2.3. Life cycle cost of high performance sealing sets

The products described above are 'high grade' products, and require a higher initial outlay in comparison to standard packings supplied in length form. The purchase decision must be based upon the operating costs because of the on-going requirement for emissions monitoring which will exceed the initial packing purchase cost. These costs combined, with the disposal costs, represent the life cycle cost of the product.

The on-going operating costs associated with a packing set are related to issues such as:

- Product leakage
- Maintenance, Leakage monitoring (LDAR), and retightening regime
- Environmental pollution and resulting costs/fines
- System downtime due to seal failure

If a customer considers the full extent of each product's life cycle cost, the 'high grade' sealing product is no longer considered over-priced compared with any low grade solution.

3. Experience-based guide lines for valve refurbishment

Over the past few years we have gained much experience from working with large chemical and petrochemical plants, both in Germany and throughout Europe, during shut-downs and upgrade projects to meet the IPPC and TA-Luft standards. The co-operation between relevant departments and companies involved is critically important in the successful completion of the upgrade. In many cases, the End customer's own maintenance department manages the project and sub-contractors carry out the valve and pipeline refurbishment work. A third party should also be involved - the seal supplier/manufacturer who will work closely with the valve repair contractor and with the customer's maintenance department in the planning phase.

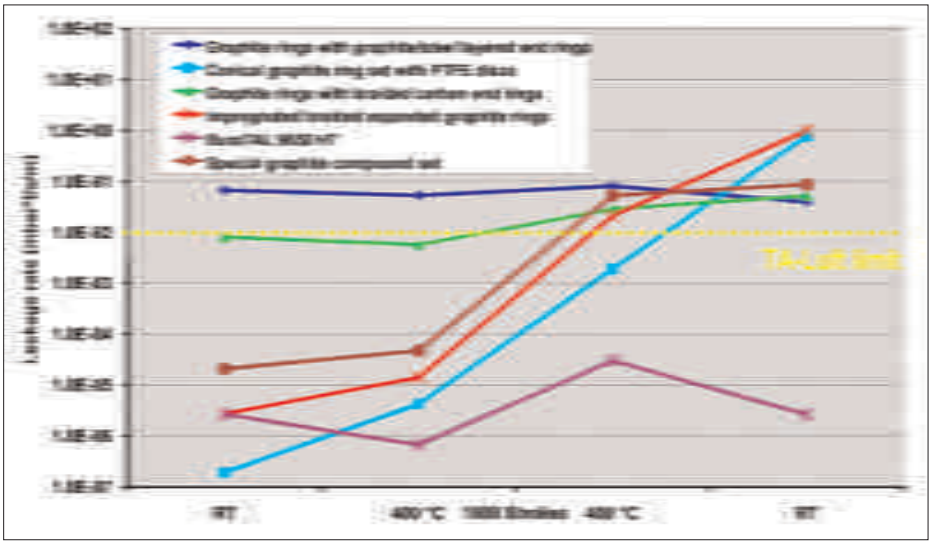


Fig. 4: Leakage rate over test cycle for different packing sets.

3.1 Site assessment and valve survey

The first requirement is to see if the valve documentation and data is correct. Normally the maintenance department has detailed documentation like inventory lists, drawings and spare part information. In many instances the data is incomplete and therefore a physical survey to establish the stuffing box dimensions has to be undertaken either by the customer or by the seal supplier's personnel. In some cases the valve is not accessible during plant operation so assumptions have to be made based on valve OEM information or from similar valves in the plant. The unique identification and marking of the surveyed valves is essential for the installation of the replacement packing sets. If the valve is accessible but still in operation the spindle diameter is measured. For the stuffing box dimension the gland dimension is taken and a slight addition is calculated. The third unknown factor is the stuffing box depth. If it is not known how many rings are used the Maintenance Company must be able to turn adapter rings on-site during installation.

3.2 Reworking of valves

If a valve has to be re-worked the principle component will be the spindle which may have to be replaced or machined slightly smaller to give the appropriate surface finish. In the case of a spindle with such a reduced diameter the

packing set should be able to adapt to these changed dimensions from the nominal.
If this is not possible, new sets made from appropriate tooling have to be manufactured. The permissible clearance dimensions should be also checked so that they are not exceeded after rework. If this is the case, metal disks should be used which can bridge these bigger clearances. Similar measures apply for an enlarged stuffing box bore caused by corrosion problems.

3.3 Determination of spring loading of valve bolts

There should always be a cost evaluation to see if spring loading is necessary. It is recommended if the valve is hard to access for re-tightening or if long maintenance-free periods are required. Also if there are a high number of spindle movements or larger temperature fluctuations during operation a spring-energised system can guarantee a more sustained and consistent sealing performance.
If the valve is to be fitted with discs springs at the gland bolts, all the dimensions for the spring assembly have to be measured. In some cases longer gland bolts are needed to accommodate the disc spring solution. An additional cover bushing is also recommended to guide the spring stack and to protect the springs against contamination. Figure 5 shows a spring-loaded gland arrangement, which is supplied by Burgmann. The gland bolt

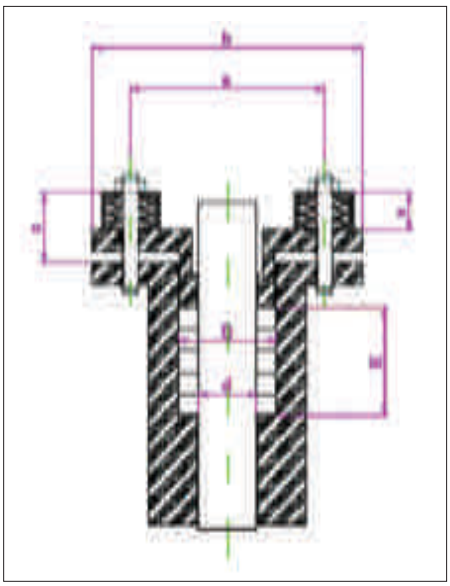


Fig. 5: Spring loaded stuffing box arrangement.

should be tightened until only a one-millimetre gap is left between the gland and the bottom of the bushing. This set-up is very user-friendly because it is virtually impossible to over- or under-tighten the set. Additionally, this gap gives a visual indication when the volume loss of the packing set has increased and the springs have to be re-tightened.

4. Installation of sealing sets

4.1. Maintenance plan

The supply of detailed installation information and maintenance plans with all sealing sets is very important. All installation forces have to be specified to achieve the best sealing performance. If torque measurement is not possible, a specific diagram for the compression-related tightening should be supplied. Our experience shows that the maintenance information needs to be easy to understand. Diagrams are more informative than formulae or tables. If the instructions are too complicated they will not be followed and errors can occur, resulting in poor seal performance.

4.2. Delivery of sets

The correct packing sets can be supplied at an agreed schedule for the upgrade as a result of the initial valve survey. But it is not always possible to check every valve and there will even be unexpected dimensional variations when some of the valves are opened. To react quickly in this event, a designated engineer from the refurbishment company should liase with the upgrade co-ordinator at the seal supplier who can ensure that missed or modified seals can be manufactured in time for the plant re-start.

4.3 Differences and problems

In situations where there are problems or dimensional deviations the experience and skill of the maintenance personnel is crucial. In addition to the specific maintenance and installation instructions, thorough theoretical and practical training must be given to all staff beforehand covering standard situations and also potential problems.

It is also important that there are project leaders in all the related companies involved in the upgrade who can organise a quick response and seal replacement in emergencies. End customers should ensure that the chosen seal supplier is able to supply new and/or modified packing sets within 24 hours.

4.4 Re-work or new valve?

In many instances it is questionable if an old and worn valve should be re-worked or replaced by a new one. Experience has shown that most valves can be upgraded to fugitive emission requirements if the work is carefully done. However, for smaller valve sizes there is always an economic decision which has to be made and a general rule is: Existing stainless steel valves smaller than DN 50 and carbon steel valves smaller than DN 80 should be replaced with new valves for fugitive emission service. In general replacement proves to be more economical than refurbishment.

5. Management Strategy for Fugitive emission upgrades

Based on experience there is an simple strategy for valve upgrades which has been proven with large and small end users in all process industries. The following steps outline the process:

(1) Select a seal supplier who has previous upgrade references, can provide technical site support and staff training.
(2) Make a thorough site survey, agree the technical and logistical requirements and order sets from the selected supplier.
(3) Maintenance or contractor personnel must be trained in the correct installation techniques.
(4) The Customer, Seal Supplier, and Service company should all appoint dedicated upgrade engineers to liaise with each other.
(5) Sealing sets should be installed by the customer or service company under the supervision of the seal supplier.
(6) The seal supplier should have sufficient resources to be ready to respond rapidly to unforeseen problems ensuring that the Plant can be restarted on schedule!

6. Conclusion

Experience to date has shown that with a carefully planned approach the upgrading of existing plants according to to meet the requirements of the TA-Luft can be fulfilled without problems. In most of the cases, valves can be refurbished without creating excessive costs using the best available technology (BAT). The co-operation between all partners involved in the revision upgrade is important.
Additional measures like planned continuous LDAR programs can provide further benefits by directly monitoring and controlling emission reductions after revisions.
The use of suitable packing rings or packing sets is important to guarantee a problem-free operation according to TA-Luft or IPPC guidelines during the lifetime of the valve. The seals should be approved by a recognised acknowledged test institute to guarantee their technical capability.
The proper condition of the valve, as well as the correct installation procedure, is vital. Additional measures, like spring loading of the gland, ensure additional performance for trouble-free sealing. Despite the increased engineering costs to fulfil the legal requirements there will be subsequent cost reductions due to longer service live and increased maintenance intervals. Also, reduction of product losses will give benefits in regard to the increased efficiency of the plant.

7. Literature

[1] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control, Official Journal L 257, 10/10/1996, P. 0026 - 0040
[2] Erste Allgemeine Verwaltungsvorschrift zum Bundes-Immissionsschutzgesetz (Technische Anleitung zur Reinhaltung der Luft - TA Luft) Entwurf 23.11.2001
[3] Sealing Technology - BAT Guidance Notes, ESA Publication No. 014/05, June 2005
[4] Klenk, Th., Vogel, R.: Special nonwoven materials for sealing technology - Alternative to braided packings, BHRG Sealing Conference, York, 2003
[5] VDI 2440, Emissionsminderung Mineralölraffinerien, Kommission Reinhaltung der Luft (KRdL) im VDI und DIN - Normenausschuss, 2000-11

About the authors

Ralf Vogel

Ralf Vogel is an mechanical engineer who has worked for more than twelve years with Burgmann Packings Ltd. in Dublin, Ireland. His main experience is in produce development, especially for fugitive emissions and TA-Luft sealing solutions. Additionally, he provides help and assistance for customers worldwide in packings application engineering. He is currently chairman of the Packings Working Group for the European Sealing Association.

Stefan Danner

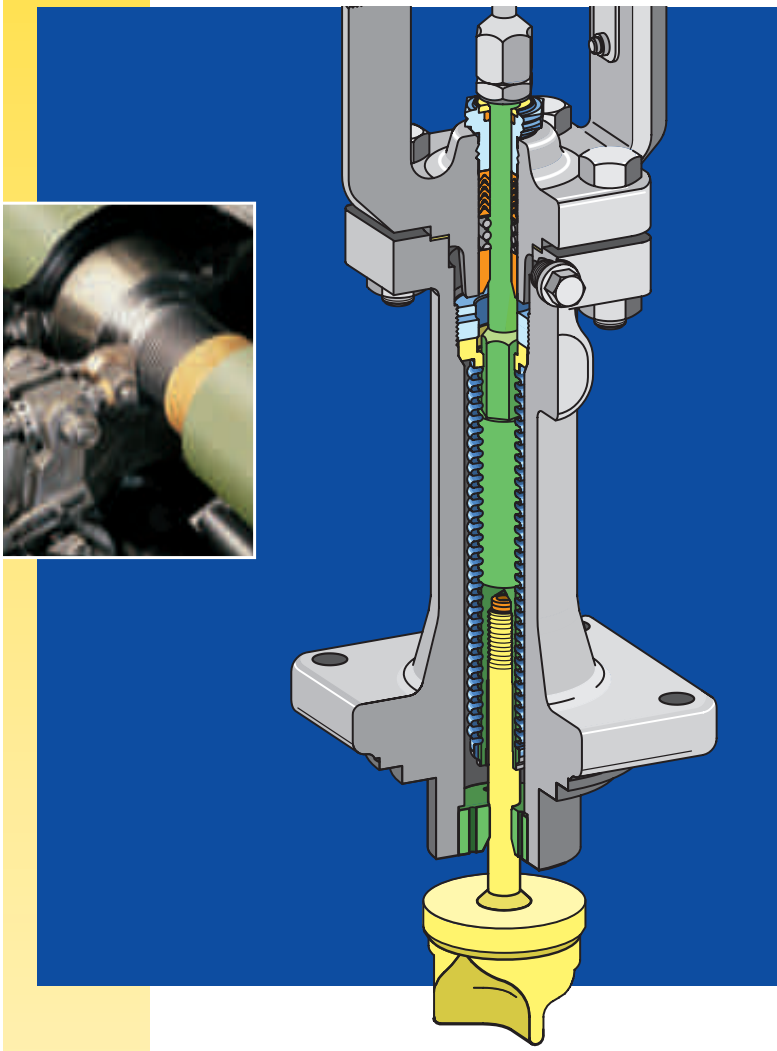
Stefan Danner is currently Applications Engineering Specialist for fugitive emission packings for Burgmann Industries in Germany. He has over fifteen years experience with Burgmann Industries, working for a considerable time in the R&D Department on valve packing development. His experience in recent years has been in the development on site with customers of upgrade projects to meet the upcoming TA-Luft legislation.

Bob Smith

Bob Smith has worked within the Valve and Seal industry for over twenty years. He is a professionally qualified mechanical engineer with his early career being in metal refining and chemical plant engineering. Working for several international valve and seal manufacturers in a technical sales and marketing capacity, he has considerable knowledge of end user maintenance practices and is currently concerned with service activity developments for fugitive emission upgrades.

SAMSON

100 YEARS SAMSON



Sealed for life

Our maintenance-free, hysteresis-free bellows seals guarantee zero leakage over the entire service life of the control valve. With SAMSON's environmentally friendly bellows seals, you are always on the safe side and plant downtime required to replace the valve packing is a thing of the past. What's more, they reduce your total cost of ownership while yet still keeping your emissions considerably below the stringent limits specified in the Clean Air Act and the TA-Luft. See for yourself by monitoring the control chamber between the bellows and the backup packing system. You can trust our bellows seals. We manufacture the entire bellows seal assemblies ourselves to ensure top quality.

A01029EN

SAMSON AG · MESS- UND REGELTECHNIK
Weismüllerstraße 3 · 60314 Frankfurt am Main · Germany
Phone: +49 69 4009-0 · Fax: +49 69 4009-1507
E-mail: samson@samson.de
Internet: http://www.samson.de