A.W. Chesterton's advice sealing aging static equip

Staff at A.W. Chesterton Company are experts in advising owners of process plants, among many other things, on which factors they need to consider in order to optimally seal their static equipment. This advice helps companies on a number of levels. It not only ensures that the companies keep their equipment in compliance with industrial standards, but also that their plants remain cost effective in the face of the need to increase profit margins, that they remain resilient against ever more competition from emerging countries, and that they manage to keep ahead of progressively tougher governmental legislation. This is obviously no mean achievement and it takes many years at the forefront of industry to build up the knowledge to be able to provide such services.

We talked to Hans Dekker, Senior Applications Engineer at the A.W. Chesterton Company's Static Sealing Division, about these complicated issues and gained some very valuable insights into how useful and money saving such advice can be.

By John Butterfield

Setting the scene

"Process plants in Europe and the US are facing a number of specific challenges," begins Hans Dekker. "Both regions have plants and installations that have been in operation since as far back as the 50's and 60's of the previous century. In recent years, they have had to face increasing competition from overseas and as such have had to run their plants longer between maintenance stops. Furthermore, they have had to deal with higher profit expectations and with more stringent health, safety and environmental regulations".

Additionally, costs for maintaining plants are persistently rising and it is a continuing challenge to reduce these to ensure sufficient profit margins. To tackle recurring issues, it is therefore very important to identify root causes and understand equipment and their failure modes well. It is also crucial to comprehend what factors need to be considered with re-

Fig. 1. Steam leaking from a valve.

gard to sealing aging static equipment. "This is one of the reasons why we at A.W. Chesterton have used our expertise in these fields to draw up a series of guidelines, which if followed, will certainly help plants to make the right decisions about their aging assets."

Fugitive emissions and valves

"Around 50–60% of all fugitive emissions come from valves," says Hans Dekker. And data published by the European Industrial Emissions Directive and the U.S. Environmental Protection Agency are in agreement about this. Apparently, even though product loss is expensive, the real motivation drivers behind reducing plant leakages come from the need to comply with legislation and health & safety requirements. "Piping, vessels and heat exchangers are other assets that can cause major headaches with regard to reliability. Such equipment can account for a major part of a company's maintenance budget."

Around 50–60% of all fugitive emissions come from valves

There are techniques available to ensure that older static equipment complies with current emission regulations and performance expectations. However, pieces of static equipment naturally have their own specific challenges with regard to keeping them leak free, regardless of whether they are block valves, dynamic valves, pipe flanges, or pressure vessels.

Challenges with different valves

"Small valves that do not perform are usually replaced by new ones," says Hans. "For example, low-emission valves, certified according to API624, ISO15848-1, or TA-Luft, are readily available off the shelf and the cost of buying them often does not justify repair. With larger valves, however, replacements often require greater investments. Therefore the most cost-effective and regular solution used to ensure that they remain compliant with current regulations is to upgrade them. In order to make an older valve comply with the latest fugitive emission requirements, it is necessary to look more closely at the mechanisms that affect the seal as we will now go on to examine."

Valve packing and seals

Valve packing is a contact seal and its mechanism relies on maintaining a very small gap between two surfaces, just as with every other seal. In addition, a force is required to keep the surfaces together. In the case of valve stem packing, it is the packing that has the conformability and elasticity to adapt itself to the surface of the valve stem and maintain a narrow sealing gap. The gland bolts in combination with the internal elasticity of the packing material supply the force to maintain the seal. Failure of the seal is always due to the fact that one or both of the requirements cease to be met. "It is not just a matter of increasing the sealing force to improve performance," continues Hans "because the undesirable downside of this is that stem friction increases when the sealing force increases. The engineering challenge involved is to find the correct sealing force that forms the balance between having a good seal and acceptable stem friction."

Fig. 2. An emergency repaired shell and tube heat exchanger.

Deep stuffing boxes

Older valves sometimes have extremely deep stuffing boxes. Apparently, deep stuffing boxes were once thought to seal better but in reality they cause more packing relaxation, high stem friction, and low sealing performance. The ideal number of packing rings in a stuffing box is five. Deep stuffing boxes can be easily improved by installing a metallic or carbon filler bushing.

Deep stuffing boxes in reality cause additional packing relaxation, high stem friction, and low sealing performance

Gland bolts and studs

Gland bolts or studs are crucial in applying the right gland force on the packing set and therefore creating the seal. Old corroded and plastically deformed bolts cannot perform this function. Therefore it is of crucial importance to exchange the studs on an older valve at each replacement of the packing set.
Hans goes on to tell us that "gland studs and nuts need to be lubricated

Fig 3. Live Loading Assembly.

with a lubricant with a known K-factor or coefficient of friction. Unlubricated bolts have a coefficient of friction that can vary +/–40%. Lubricated bolts have a variation of +/–20%. Lubricants need to have a small variation between the wet K nut factor and the dry K nut factor to ensure that re-torqueing of the valve in the future will always happen reliably. Neither should they be easily washed off. Recommended lubricants are nickel anti seizes or some similar type.

Gland studs generally have very low elasticity. Thermal cycling, pressure surges, packing relaxation, wear, or extrusion may cause loss of gland force. In these cases "live loading" can be applied to majorly improve performance by assuring the right gland force over a longer period."

Valve stem and stuffing box

The valve stem and stuffing box condition is crucial to the correct functioning of the valve. Pitting corrosion can occur due to a galvanic reaction between the graphite packing and the valve stem. Good graphite valve packing contains a passive corrosion inhibitor to prevent these issues.

Stem run out should be within certain limits. Stems that are in bad condition should be either replaced or reworked. The stuffing box bottom should be flat and have no angles. The same applies to the bottom of the gland nose.

Valve stem packing

Increasing legislative requirements with regard to fugitive emissions have led to enormous improvements in the sealing technology available for valves over the past ten years. Packing emission testing standards are available so that packing can be compared.

Modern low-emission packing can bring even older valves up to the newest emission requirements.

Fig. 5. Modern graphite low-emissions' packing.

Flanges

A flange gasket needs a certain stress over a certain gasket width in order to be able to generate the pressure drop that is required to seal a flange. This gasket stress needs to stay between a certain minimum and a certain maximum value. The gasket stress is generated by tightening the flange bolts to about 30–70% of their yield strength. The failure that may occur and makes a flange leak has either to do with the fact that the sealing gap is not maintained or that the sealing force falls under a certain minimum.

"If the flange condition is sufficiently bad then the flange should be replaced or repaired," relates Hans. "Repair can be carried out by machining the flange or coating the flange with a special layer to bring its surface back to an acceptable condition. Large flanges can be machined in situ with special equipment.

Poor flange surfaces, poor bolts, or the improper tightening of bolts are common causes of flange failure

"Corroded bolts or plastically deformed bolts cannot perform properly and will not provide sufficient sealing force on the gasket. In these situations, it is recommended to replace the flange bolts at each gasket replacement.

Live Loading can help to increase the elasticity and compensate for the effects created by thermal cycling, loss of gasket thickness, and might compensate for some of the issues that are the result of bolts that have yielded, or bolts that have been poorly tightened as well.

The correct values for tightening flanges are derived from theoretical calculations. In the petroleum industry the method described in Section VIII of the ASME Boiler and Pressure Vessel Code is commonly used. In Europe, EN1591-1

Fig. 4. Stem corrosion due to galvanic corrosion.

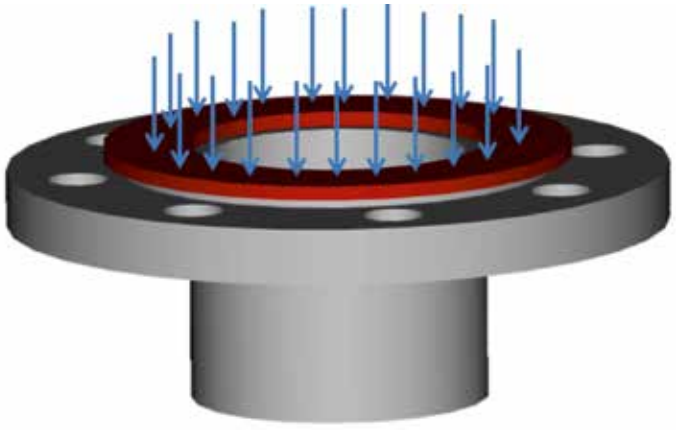

Fig. 6. Gaskets need stress over the entire surface of the gasket.

Fig. 7. The installation of flange Live Loading on a shell and tube heat exchanger.

has won ground to become a reliably accepted method for calculating the ideal bolt force on circular flanges. When a torque wrench is used during installation, it is important to use the lubricant with a K-factor or coefficient of friction that was used in the calculation."

"The correct stress should be established on the entire surface of the gasket. All bolts should thus be tightened simultaneously or successively by using a tightening method that gradually builds up stress in a cross pattern. This is done by applying sequentially 30%–60%, 60%, and 100% of the final torque in a crosswise pattern, and finally 100% in a circular manner.

Even if equipment is aging there is no need to be non-compliant with current industry standards. There are techniques available for valves and flanges to make them seal and perform well. This means that plants can be upgraded to meet current emission legislation without major capital investments but, in fact, by extending the life of the equipment that is currently in place," concludes Hans.

The A.W. Chesterton Company, in brief

The A.W. Chesterton Company operates in over 110 countries around the world and is recognized as a leading sealing solutions provider for rotating, stationary, and fluid power equipment reliability and efficiency. The company's sealing solutions are supported by a comprehensive line of protective industrial coatings, high performance industrial lubricants, and advanced MRO products designed to extend equipment life and improve productivity. Company staff provide practical, knowledge-based solutions for equipment sealing and efficiency, industrial process reliability, and environmental compliance to companies operating in some of the toughest industries around the world. See further their website at: www.chesterton.com

Is Chesterton's expertise only in the area of static equipment sealing?

"Oh absolutely not," says Hans ""the static sealing area happens to be my area of expertise but Chesterton's services are so much wider and diverse. For example, we help our customers improve the reliability and efficiency of their rotating and fluid power equipment platforms. Our rotating equipment solutions team has extensive knowledge that helps plants to operate their critical and non-critical equipment for long periods, reliably, cost effectively and safely. Examples are our split mechanical seal technology and our gas seal technology.

In the area of fluid power, Chesterton engineers and manufactures highly-reliable sealing solutions for heavy industrial process fluid power equipment including such as presses, cylinders, and valves.

In addition, we have a team dedicated to surface protection and lubrication. Industrial equipment and plant assets are often subjected to abrasion, erosion, impact, and chemical attack that can drastically impact reliability and overall plant profitability. Chesterton develops innovative industrial coating solutions for metal and concrete surfaces to protect storage tanks, pumps, containment facilities and fans. Furthermore, we have a broad range of comprehensive lubrication programs focused on friction detection, corrosion prevention, and equipment life extension. These programs often dramatically improve equipment reliability and reduce total cost of ownership."

Conclusion

Whatever the problems with aging equipment, Hans and colleagues like him at A.W. Chesterton have a solution at their fingertips. And the answers that they provide are extremely well thought out, cost effective answers, which take in a myriad of considerations to offer a company a tailor-made response to their often very specific needs. "What can be more pleasing," says Hans "than knowing that you have the expertise and knowledge within your company to solve a company's equipment headaches and Improve upon their processes whilst saving them money at the same time!"

Fig. 8: Correct bolt lubrication.

About Hans Dekker

Hans Dekker graduated with a Bachelor degree in Engineering from the Saxion Polytechnic in Enschede in The Netherlands. He has worked in the sealing industry for over fifteen years in various functions in both engineering and marketing. He works currently as a Senior Application Engineer for the A.W. Chesterton Company in the Static Sealing Division. Hans is an active member of the European Sealing Association and is the current Chairman of the Compression Packing Division.