Understanding and preventing

Improved plant reliability is key to optimising both safety and profits. In today's competitive global environment understanding the potential causes of asset down time is an important part of devising and implementing effective prevention plans.

By ESA member D Halkyard

Down time can be costly, therefore the management of strategic plant and equipment allows the identification of both real and potential problems to avoid down times as much as possible.

A good management system should define levels of connection criticality, allow the acquisition of appropriate data and include regular performance reviews attended by relevant personnel to identify trends, specific problem areas and continuous improvement strategies. This can only be successful if records are maintained as part of an integrated management control system.

By implementing a structured analysis of seal failure, important lessons can be learned and preventative maintenance programmes adopted to prevent future occurrence.

The bolted flanged connection is a complex mechanical assembly. A basic understanding of the mechanical components, forces at play, basic interactions and the factors that influence them can give insights into why they sometimes leak. Before looking in more detail into the possible reasons for seal failure and ways to prevent future occurrence it is useful to briefly review each of the mechanical components and their primary functions and the importance of correct assembly procedures.

Flanges

Flanges serve a number of functions such as load transference i.e. how the compressive force is transferred onto the gasket. They also provide a sealing face against which the seal is formed and maintained. Flanges need to be flat, parallel and stiff or rigid enough to allow the transmission of the compressive force without over bending or rotation. Flanges that deform can cause uneven load distribution on the gasket leading to gasket unloading and\or too much stress on the outer edges of the gasket. Important considerations that have a bearing on rigidity/stiffness are the flange thickness, facing configuration and the way the flange is designed to connect to the vessel or pipework. Material selection and temperature also play an important role as modulus, or stiffness are both temperature and material specific. Differences in the thermal expansion attributes between different flange materials and/or bolting can also lead to changes in the compressive load during process start-up, shutdown and under steady state operating conditions.

causes of down time

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Fasteners

Flange fasteners, by which we normally mean bolts, nuts and washers come in many materials and forms. The most common types used in the field of industrial sealing are usually stud or fixed head bolts with either one or two nuts with a coarse metric or UN thread form; typically UNC or UN8. The primary function of the fastener is, via direct or indirect bolt extension, to provide suitable clamping load within the connection. Ensuring the bolt is not subject to loosening and stress is maintained within acceptable (elastic) limits. Correct fastener selection is a key consideration in maintaining compressive load throughout the expected life of the connection. A good knowledge of different bolt types and materials and their mechanical properties under both assembly and working conditions will assist in this.

In elevated temperature or cyclic service conditions as with flanges, consideration to differences in thermal expansion characteristics with other metallic components within the grip length of the bolt should be given. Washers are often overlooked, however their use, particularly in problematic connections where torque is used to generate bolt load can prove useful. The nut material is generally harder than the flange material, which can result in localised deformation of the back of the flange making accurate torque\tension determination difficult, even under controlled conditions. The use of correctly sized and hardened washers can improve torque\tension conversion efficiency by providing a smooth hard surface for the nut face to slide over and spread the compressive force more evenly.

Gaskets

Gaskets come in many styles and materials they are generally classified into 3 main groups; non-metallic, semi-metallic and metallic gaskets. The primary function of the gasket is to create and then subsequently maintain the seal over the working life of the connection. This means the gasket must have the capability of forming into the sealing faces of the flange and react enough against the assembly and operational compressive loads without being damaged or undergoing excessive relaxation. Connections that utilise non-metallic gaskets can present particular challenges, such assemblies are sometimes described as floating connections. In general their load bearing capability is less than that of the other gasket groups. For more extreme sealing applications semi-metallic gaskets may be more appropriate as load bearing, blow-out resistance and relaxation properties are generally improved. Resilience of a connection can also be enhanced by selection of the appropriate semi-metallic gasket style for the application. Precision machined solid metal gaskets are generally used in high pressure service where available compressive forces are high. When using this type of gasket attention to mating surface finish and relative hardness are key considerations.

Installation

It should be pointed out that consideration of all the mechanical components and their potential for interaction is key to maximising seal performance. Correct hardware

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selection, however, is not a guarantee of seal success. Installation plays a major role, correct installation ensures that the relevant forces are appropriate in both magnitude and distribution for the intended service conditions. To achieve this with any accuracy requires the adoption of a managed or controlled assembly procedure. From a practical perspective this means adherence to proven best practice assembly techniques using trained and experienced personnel. EN1591-4 'Qualification of personnel competency in the assembly of the bolted connection of critical service pressurised systems' provides an excellent modular training syllabus and assessment regime for both management and technicians that have responsibility for the assembly and disassembly of pressurized bolted connections.

In the March issue of Valve World ESA will publish an in depth article on seal failure analysis and corrective actions.

The European Sealing Association (ESA) has produced this article as a guide towards Best Available Techniques for sealing systems and devices. These articles are published on a regular basis, as part of their commitment to users, contractors and OEM's, to help to find the best solutions for sealing challenges and to achieve maximum, safe performance during the lifetime of the seal. The ESA is the voice of the fluid sealing industry in Europe, collaborating closely with the Fluid Sealing Association (FSA) of the USA. Together, they form the key global source of technical knowledge and guidance on sealing technology, which is the basis for these articles.
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