The importance of bolting in valves

Taking you through some of the considerations that should be taken into account when bolting valves, and why they are important.

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As everyone is aware bolts come in various shapes and sizes, and in different materials. They cater to a wide range of applications – their purpose to hold joints together.

The advantage of using bolts is that they are removable and re-usable. They also hold joints under tension because they act as a spring. It is, moreover possible to stretch the bolt within the elastic limit or the yield point of the bolt material. The bolt stretch or pre-load can be calculated by using torque or tension is retained by tightening the nut.

When talking about bolts in the valve industry, it is worthwhile considering that these could be anything from comparatively smaller valves used in the water mains of homes, right through to complex valves handling corrosive liquids and gases at high temperatures or very low temperatures as in cryogenic valves. The bolts specified for these types of valves could be made from a wide range of materials like A193 Gr B7, B16, ASTM A453-660 or even titanium depending on the application, service media, and operating temperature. Similarly, their shape could vary from stud bolts, to hex bolts, or neck down bolts.

Bolting tools are used during the manufacture of valves to pressure test them and to bolt bonnet bolts. Additionally, bolting tools are used in maintenance activities during the operation of valves in plants, for example, when changing gaskets or repairing valve seats. As such a successful valve bolting can be considered to be one that is used to maintain proper joint integrity so that leakages can be avoided where the joint consists of flanges, gaskets, and bolts & nuts.

Joint integrity

Any gasket joint assembly will have three major components namely flanges, gaskets and the bolts & nuts. All three components play their part in order to get a leak free joint. From this aspect there are two more components needed: calibrated tools of good quality and skilled/trained manpower working to laid down procedures. Often not enough attention is paid to tools and manpower, but a properly calibrated good quality tool, when operated by trained and tested manpower, will give consistent and verifiable results.

Bolts, nuts & washers

The type of bolts selected by valve designers and manufactures depends upon the required operating conditions such as temperature and total flange load. As the bolts are placed equidistant on the pitch circle diameter of the flange, each bolt carries a load equal to the total flange load divided by the number of bolts.

The load on each bolt should be such that the bolt stress generated is lower than the bolt material yield point. A lower specified bolt stress can extend the life of bolt. It is important to ensure that only bolts of the same grade are used on one flange, otherwise the bolt loads around the flange may vary, which can cause joint failure leading to leaks. The nut grades should also suit the selected bolts.

> *No matter how big and complex the machinery gets, at its heart, holding everything together, is the humble little bolt.*

If these are not matched to the bolt grade, it could lead to future thread stripping.

It is recommended to use washers when torque tightening as they protect the contact surface of the flange during the turning of the nut and also helps to convert the torque into bolt load according to *ASME PCC-1-2013 Guidelines for Pressure Boundary Bolted Flange Joint Assembly*. Washers should be made from through-hardened steel.

There are also special washers available on the market. For some the achievement of required load will be indicated whilst for others the design will eliminate any requirement of reaction arm of torque wrenches, improving the load accuracy and reducing side load damages drastically.

Bolt load/torque

Bolts are normally pre-loaded to a value between 40– 70% of the yield strength of the bolt material.

To achieve the required bolt load, the industry uses either torque wrenches or bolt tensioners, with the torqueing method being more prevalent than tensioning the bolts. As load is difficult to measure torque is specified as a way to approximate load. However, torque is dependent on many factors such as bolt diameter, bolt material, required pre-load, and lubrication, etc.

Lubrication, additionally, plays a very important role during torqueing as a proper lubricant can reduce the torque by as much as three times when compared to dry bolting or tightening the bolts without any lubricant. Choosing the appropriate lubricant can also reduce the torque and hence the size of the torque wrench selected.

If bolts are tensioned, then it is important to note that the applied load and residual load are not the same as in the case of torqueing. The applied load is the load applied using tools and the residual load is the load left or residing in the bolt after removal of the tools. The applied load and residual load are the same for torqueing, but there is a reduction in the applied load when using bolt tensioners. This reduction is dependent on the bolt diameter and the length of the bolt being tensioned.

Tightening sequence

The tightening sequence helps to achieve an even gasket load by increasing the bolt loads gradually, especially when using single tools like torque wrenches. The normal practice is to torque the bolts in increments of 30%, 70% and then to 100% of the torque value required. After giving the final round torque of 100% a check pass should be done in a clockwise manner to confirm that no bolts/nuts turn at the specified 100% torque value. This is important as in a flange with gaskets the initially tightened bolts can lose the preload when the next bolts are tightened.

Documentation

The records of bolt torqueing/tensioning should be maintained for quality purposes and will provide a guide for future disassembly and assembly. At a minimum the record should have the following data:

- Date of assembly
- Flange and gasket details
- Tightening torque/load
- Operator's name & sign
- Joint inspectors name & sign

There are new designs of documentation pumps available for hydraulic torque wrenches, which can give a complete report on the tightening activities on the flange. All data like operator ID, job ID, flange data, required torque, no. of steps, torque wrench model, are entered prior to the start of the job.

Training

It is important that before any bolting operation to ensure that the operator is skilled to safely operate the bolting tools and sufficiently trained to follow the quality and safety guidelines pertaining to the industry. It would be ideal if the operator is certified from an accredited agency providing structured training in bolting tools and the joint components although currently this is not mandatory with many industries.