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Total Integrated Solutions

Petracarbon (Thailand) Co., Ltd is a hi-tech company with their primary goal to promote advanced repair & maintenance techniologies for oil & gas, chemical, petrochemical, oil refining industries in Thailand and in neighbouring countries.

We are able to provide total integrated solutions for all your bolting requirements, including torquing, tensioning, flange management services and joint integrity QA/QC that go well beyond the accepted norms in terms of:

- Professional advice and planning
- Quality on-site workmanship
- Standard of Safety & Care
- Optimise the deployment of competent, multi-disciplined teams
- Customer Satisfaction from initial survey to completion of project

Contact us:

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Our reputation is your guarantee.

Petracarbon support clients to achieve their business objective safely and efficiently by providing appropriate management and control techniques.

The integrity of bolt and flange connection is key to minimizing production downtime.

Petracarbon's on-site machining & bolting division manages the entire joint integrity process from inspection through assembly, testing and completion.

Our experienced technicians are highly qualified and competent in operational procedures on the use of hydraulic equipment, which providing the confidence and professionalism which our clients can depend on us.

Joint Integrity Solutions

This is part of a Quality Management Systems to control the Joint Integrity Program to ensure a zero leak start up. This system will control and record gasket joints that have been parts and subsequently re-installed with new gaskets and re-tightened in a controller manner. At all stages of the Joint Integrity Program, work is executed within the agreed work procedures, standards and good engineering practices in order to achieve zero leaks on the equipment and guaranteed reliable plant operation until the next shutdown and/or rountine maintenance.

What does JIS includes?

Bolt Tensioning is accepted as the fastest and most consistent method of sealing bolted connections. These benefits include increased efficiciency with reduced operational and labour costs.

Hydraulic and Hand Torqueing are alternative solutions to bolt tensioning during flange installation or separation operations. They are frequently used for the removal of damaged or corroded bolts and are suited to difficult access areas.

Other extensive controlled bolting solution consists of ancillary equipment such as nut splitters, flange spreaders, flange alignment equipment and Joint Integrity Management software where it captures the joint indentification, bolt loading calculations and important parameters.

Ultrasonic Bolt Load & Elongation Measuring Instrument

This is a pulse-echol ultrasonic time-of-flight measurement device, where it measures, displays, stores and transfers bolt load and elongation data in a new, single purpose unit. It has a rugged, sealed colour 4.3" medical proven touch screen display. This unit is powered by 4 X 9V Li-on batteries.

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ASME PCC-1-2019

ASME is short for the American Society of Mechanical Engineers. PCC-1 stands for "Post Construction Committee 1". PCC-1 addresses "Guidelines for Pressure Boundary Bolted Flange Joint Assembly."

It's a consensus document, which means it was written by several experts across the bolting injury.

The document addresses many factors involved in bolting principles and the assembly of bolted flange joints. The scope of ASME PCC-1 states:

These guidelines for bolted flange joint assemblies apply principally to pressure-boundary flanged joints with ring-type gaskets that are entirely within the circle enclosed by the bolt holes and with no contact outside this circle.

These guidelines may be selectively applied to other joint geometries. By selection of those features suitable to the specific service or need, these guidelines may be used to develop effective joint assembly procedures for the broad range of sizes and service conditions normally encountered in industry.

This document uses the most up-to-date bolting principles for the integrity of bolted joints on pressure vessels. They discuss assembly, disassembly, quality assurance (documentation), bolting safety and tool handling, gaskets, torque, fasteners, washers, tensioning.

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Petracarbon offers Ultrasonic Bolt Load Management which provide assurance for all critical application and to ensure absolute joint integrity verification. By measuring, complex variables such as friction, temperature and machining tolerance that can dramatically affects the residual load in a bolt after force (Torque or Tension) has been applied, can be eliminated. Thus, resulting in improvement of bolted flange joint integrity.

5 ways to improve Bolted Joint Integrity

In a bolt flange joint, every component has a maximum allowable stress level. At this level, flanges may start to rotate or deform at a defined threshold. Stud bolts of a specific grade may start to give way and resulted to plastic deformation. Non metallic gaskets may start to yield under excessive compression loads.

PCC-1 suggests to have a minimum stress level on the gaskets and studs bolts at 40% of bolt yield strength. At this level, it's the minimum force that will provide a proper sealing. Similarly, ASME has suggested a target preload from range of 40% to 70% of bolt yield for most critical element in reliable flange joint assembly. At this preload, any elastic interaction between the flange, the fasteners and the gasket will be compensated for various forms of relaxation.

There are 5 ways to improve the bolted joint reliability.

1. Proper torque tightening and tightening sequence.

To obtain a leak-free flange connection, a proper gasket installation is needed, the bolts must be assigned on the correct bolt tension, and the total bolt strength must be evenly divided over the whole flange face.

With Torque Tightening (the application of preload to a fastener by the turning of the fastener's nut) the correct bolt tension can be realized.

Correct tightening of a bolt means making the best use of the bolt's elastic properties. To work well, a bolt must behave just like a spring. In operation, the tightening process exerts an axial pre-load tension on the bolt. This tension load is of course equal and opposite to the compression force applied on the assembled components. It can be referred to as the "tightening load" or "tension load".

Flange bolt torque sequence is extremely important to achieve the proper tightening of the flange joint.

Once all pre-checks are completed. You can go ahead with tightening the stud in the pre-define torque sequence mentioned here.

- PASS 1 Torque Sequence: Torque to 30% of the final torque value at criss-cross pattern. Check that gasket is getting compressed uniformly.
- PASS 2 Torque Sequence: Torque to 60% of the final torque value at criss-cross pattern.
- PASS 3 Torque Sequence: Torque to 100% of the final torque value at criss-cross pattern.
- PASS 4 Torque Sequence: Torque to 100% of the final torque value on adjacent bolts in clockwise direction until no further rotation of the nut is observed.

If time permit, wait for a minimum of 4 hr and repeat PASS 4. This will restore the short term creep relaxation/embedment losses. If the flange is subjected to a subsequent test pressure higher than its rating, it may be desirable to repeat this pass after the test is completed.

More details can be found in ASME PCC-1, Table 1, Torque increments for legacy cross-pattern tightening using a single tool.

2. Measuring the bolt load.

One of the most common method for determining fastener preload is by using an ultrasonic measuring instrument.

This is possible by introducing a sonic pulse at one end of the fastener and accurately measuring the time of flight (TOF) required for the echo to return from the opposite end. Using material constants, the instrument converts this TOF into an "ultrasonic length" of the fastener, providing a baseline from which future measurements will be made. When the fastener is tightened, the TOF increases and the instrument will again utilise material constants to eliminate the effects of stress and temperature variations on sound velocity, providing an accurate elongation or load

3. Lubricating threads & contact surfaces.

Friction is the undesirable variable in bolting applications. Significant variables exist between different types of lubricants and anti-seize compounds. Care should be used when selecting of lubricant to avoid contamination of the process system or oxidation to the hardware and flange assembly. Never apply any lubricants to the gasket contact area of the flange.

The benefit of pre-coated bolts is primarily to protect against oxidation. Such as PTFE coated bolts. However, when these bolts are reused, it should be lubricated.

Apply lubricants liberally after inserting the studs or bolts through the flange to avoid contamination. After assuring the nut rotates freely to the point of contact with the flange, apply lubrication to the stud threads and interface between the nut and washer.

By lubricating the fastener before use, not only can friction be reduced to improve torque to load ratio, friction scatter can also be reduced to improve preload accuracy.

When finding the torque value for bolted joint, we need the nut factor, also called the K factor. This is available from most manufacturers of anti-seize products. This factor has a large impact on the effectiveness of applied torque. However, this K factor is not the same as coefficient of friction (or friction factor). Refer to page 4 for more details on friction factor.

Applying the right amount of torque is essential for creating a good seal around the gasket. However, one must not forget that mating surfaces and bolt thread conditions are equally important and can vary widely due to factors such as:

- relatively loose nut and bolt thread manufacturing tolerances for threaded fasteners
- fastener thread condition issues that affect thread friction
- thread pitch
- new versus reused fasteners
- the presence of hardened washers versus nut rotation on the bearing surface
- variations in nut dimensions
- temperature and
- the presence of coatings and lubricants

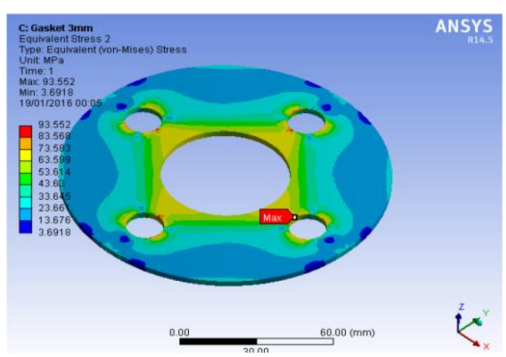
More details can be found in ASME PCC-1, Section 7, Lubrication of "working" surfaces.

4. Using through-hardened washers.

The function of the washer may consider as one of the most important component in bolted flange joint reliability. Overcoming friction through turn of the nut procedures is critical in terms of realized bolt load. The interface between the nut and the washer becomes a crucial bearing surface.

If a washer is not through-hardened, it is also susceptible to cupping, resulting in inaccurate torque readings versus actual bolt stress. Another benefit of using through-hardened washers is the prevention of the nut becoming embedded against the flange face, or with a nut flat embedded inside the bolt hole. This will result in a large variable between applied torque and actual preload.

Utilizing through-hardened washers also disperses the applied load of the fastener assembly across the face of the flange. This allows for more uniform stress applied to the gasket contact area and reduces potential leak paths of the contained media.



The above shows the effective gasket stress when no washers are used; potential leak paths or failure points are clearly evident at the midpoint between the bolt holes.

More details can be found in ASME PCC-1, Appendix M on washer usage guidance for through-hardened washers.

Determine the Target Torque.

For US Customary Units,

$$T = K D F / 12$$

Where T = Target input Torque or Applied Torque (ft.lb), K = nut factor, D = nominal diameter of bolt (in), F = target bolt load or preload (lb)

For SI Units,

$$T = K D F / 1000$$

where T = Target input torque or Applied Torque (Nm), K = nut factor, D = nominal diameter of bolt (mm), F = target bolt load or preload (N)

K is an experimentally determined dimensionless constant related to the coefficient of friction. The value of K in most applications at ambient temperature is generally considered to be approximately equal to the coefficient of friction plus 0.04. Based on the above, friction coefficients of 0.16 and 0.12 correspond approximately to nut factors of 0.20 and 0.16.

More details can be found in ASME PCC-1, Appendix K.

5. Inspection before bolt tightening.

Flange condition:

Poor flange condition, especially the gasket sealing surfaces can result in leakages. Thus, before performing any bolt tightening, it is a must to perfom pre-check:

- conditions of flange faces for scratches, dirt, and scale.
- corrosion pitting and tool marks.
- inspect the gasket seating surfaces.
- the areas on the flange where the nuts will seat, it should be flat & free from pitting and excessive wear.
- RTJ Grooves must be kept clean, corrosion-free & undamaged.

More details can be found in ASME PCC-1, Appendix D on Guidelines for allowable gasket contact surface flatness & defect depth.

Flange alignment:

Visually examine the flange alignment to ensure that an acceptable fit has been obtained. While aligning flanges, make sure that there are no residual stresses in the joint. The use of heat correction for alignment of flanges is not a good practice and should be strictly prohibited.

With proper alignment of flange joint assembly, it will result in maximum seating surface contact & maximum opportunity for uniform gasket loading, & it improves the effectiveness of all bolt tightening methods. The pre-check on aligning mating flanges should cover:

- Flange faces should be parallel and aligned.
- Flange with excessive spacing or gap
- The flange bolt holes should be in line so that the bolts will pass freely.

More details can be found in ASME PCC-1, Appendix E on flange joint alignment guidelines.

Studs / Bolts & nuts condition:

- Visually examine nuts & Stud/bolts before installation to assure they are free from defects such as corrosion, damaged threads.
- Check the length of the stud or bolt to avoid short bolting and excessive threads. Flange bolts shall be furnished with sufficient length to allow the use of bolt tensioning equipment or spades / spacers and the associated extra gaskets.
- Visually examine studs and nuts after cleaning to ensure free from burrs. Studs and nuts shall be cleaned using a wire brush to remove any dirt on the threads. Lubricant shall be applied on threads and nuts to flange contact surfaces.
- The bolt and nut material grades should be correctly identified before they are used. They can only be reused if it is known that they have not been overloaded or exceeded their yield point.
- When assembling the nut on the bolt, the nut identification marking must always facing outwards.

Gasket checking:

- Do not use sealing compound, grease, or other paste or adhesive on the gasket or flange faces.
- Visually examine gaskets, before installation, to assure they are free from defects.
- Color coding shall be maintained as per the rating and type of gasket provided by the manufacturer.
- Clean gasket seating face using appropriate wire brush.
- Make sure the material is as specified, look for any possible defects or damages in the gasket such as folds or creases.
- All soft material gaskets should be replaced with new ones whenever an opened joint is to be re-assembled.

Coefficient of Friction – Friction Factor

Coefficient of Friction

In basic terms, the coefficient of friction is measured experimentally. It describes the ratio of the force of friction between two bodies and the forces pressing them together, typically by using a incline plane with a block on it. The drawback is that this method does not look at bolt preload for a bolted joint. Its only addresses the coefficient of friction between a block and a incline plane. It's not representative of what happens to a nut and a bolt during fastening.

Friction Factor

Most friction factors are extremely complex. Certain aspects need to be determined experimentally. That is why we use recommend the simplified formula when calculating Target Torque using nut factor as presented in ASME PCC-1 Appendix K. In ASME PCC-1 of Appendix J, it also describes a mathematical model relating the applied torque and tension in bolt preload as:

$$T = \frac{F}{2}\left[\frac{p}{\pi} + \frac{\mu_t d_2}{\cos\beta} + D_e\mu_n\right]$$

- De = effective bearing diameter of the nut face, mm (in.) = (do + di) / 2
- d2 = basic pitch diameter of the thread, mm (in)
- di = inner bearing diameter of the nut face, mm (in)
- do = outer bearing diameter of the nut face, mm (in)
- F = bolt preload, N (lb)
- n = number of threads per inch, (applies to inch threads)
- p = thread pitch, mm (For inch threads, this is normally quoted as threads per inch). p = 1 / n
- T = total tightening torque, N·mm (in.lb)
- β = half included angle for the threads, degree
- μ_n = coefficient of friction for the nut face or bolt head
- μ_t = coefficient of friction for the threads

Determine the Bolt Load (preload).

Preload is the tension created in a fastener when it is tightened. This tensile force in the bolt creates a compressive force in the bolted joint known as clamp force.

For practical purposes, the clamp forces in an unloaded bolted joint is assumed to be equal and opposite of the preload. If proper preload and thus clamp force is not developed or maintained, the likelihood of a variety of problems such as fatigue failure, joint separation and self loosening from vibration can plague the bolt joint leading to joint failure.

Preload, F can be determined from

$$F = A_s \sigma_y P_{\%}$$

where A_s = tensile stress area of the thread, mm^2 (in^2), σ_y = minimum yield strength of the bolt material, N/mm^2 (lb/in^2), $P_{\%}$ = percentage utilization factor for material yield strength (default value typically 50%; i.e., $P_{\%}$ = 0.5)

More details can be found