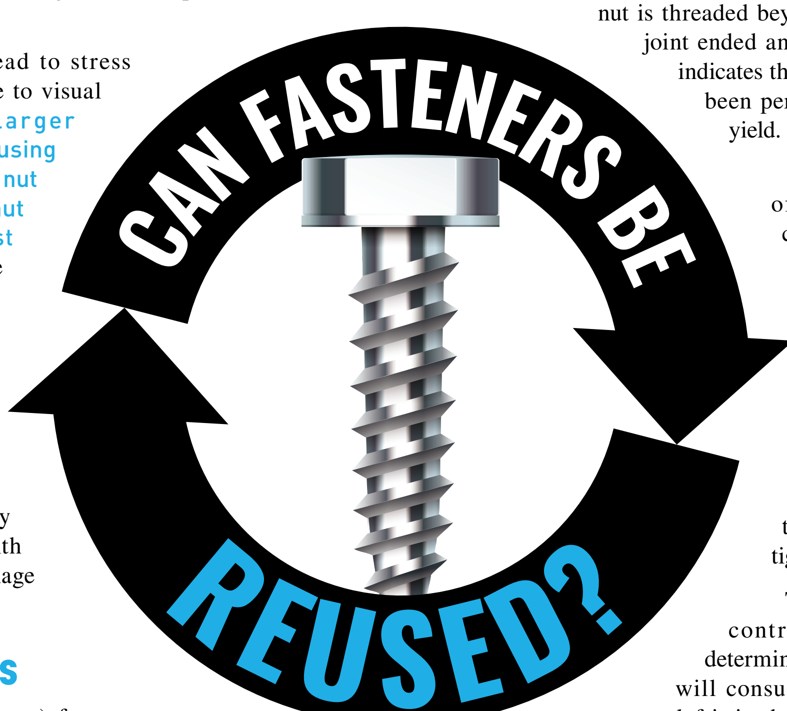
The term 'Fastener' is used so often to describe anything that will hold something together that we neglect the actual function of the individual parts used and the joint they connect. A fastener connection usually involves two or more components used to fasten the joint, such as a bolt and a nut or washer.

Basically, we need to define how a fastener is to be used and under what type of conditions it experiences in order to determine if it can be reused.

Critical Applications

A critical application is one that can cause physical harm or damage. Such as: amusement rides, pressure vessels, motorized vehicles, nuclear power plants and so forth. These applications apply cyclic stresses to the fastener in the form of dynamic loading and heat expansion and contractions.



These types of stresses lead to stress raisers that are mostly invisible to visual inspection. However, the larger problem here is not with reusing the bolt, it is with reusing the nut because the threads of the nut have deformed with the first tightening application. The threads are damaged to the point that reuse of the nut, even at the same torque, will not produce the same clamp load as before causing the joint to lose clamp load and further promote fatigue stress cracks.

Fasteners are relatively inexpensive when compared with the associated liability and damage that could result. Replace it.

Normal Applications

This applies to steel (ferrous) fasteners that were installed under controlled conditions. The operative word here is 'controlled' because the fasteners must be installed to produce a clamp load greater than the service loads and there has been no damage to the joint surfaces, such as embedment or warping. If the conditions of use are not known, then do not take any chances: Do not reuse.

Non-ferrous fasteners (stainless steel, nickel alloys, silicon bronze, titanium, etc.) will all work harden once placed under a tensile load. Here, one needs to apply discretion; if it is a small fastener, 5/16" or less, chances are it may be reused. But, once a fastener has work hardened, its mechanical properties become severely compromised.

Therefore: if any threaded fastener, ferrous or non-ferrous, has experienced any loading beyond its proof load or yield strength, that fastener should never be reused again in any application as it no longer safely represents its intended mechanical or physical properties.

Nut Applications

If maintenance logs are not kept, there is no way of knowing how many times the bolt and nut have been removed and replaced for scheduled maintenance. Replace it.

When the nut is tightened against the threads of the male fastener, the threads of the nut become compressed. The threads of the nut do not return to its normal pitch dimensions when unloaded. Unlike tensioning, when a material is compressed, it will remain slightly compressed, thereby permanently changing the thread pitch of the nut.

This change is usually not noticeable. That is, most likely the nut can still be freely threaded along the mating threads of the fastener. However, if the nut is threaded beyond the point where the joint ended and resistance is met, that indicates the threads of the bolt have been permanently stretched into yield.

Torque is a function of friction. Friction is caused by the deflection of the threads of the nut when tightened. Therefore, when the nut is tightened again, the extra thread friction between the bolt and nut threads from the thread deformation of the nut will prohibit the same amount of tightening from occurring.

Tests conducted under controlled conditions have determined a new nut and fastener will consume approximately 90% work friction between the mating threads and at the nut interface when tightening. Therefore, only 10% wrenching energy is applied to tensioning the fastener after the 90% friction has been overcome. If the threads of the nut deflect enough to increase the friction between the threads by only 2% when the nut is reused, then the amount of wrenching energy available to tighten the nut decreases to 8%. The overall torque output still adds up to 100% but the fastener is tightened 2% less.

A nut can be used safely a maximum of four times. Exceptions would be using an impact gun to install the nut, which would decrease the life of the nut, or by using a lubricant, which would increase the life of the nut.

Friction and Torque

Decades ago, the plating of choice was zinc. At that time, zinc plating solutions were made with a cyanide electrolyte. This was about 40-60% efficient, promoted hydrogen embrittlement and produced a rough, porous surface. Hence, the 'k' factor (commonly referred to as the coefficient of friction) was higher than the products plated with the newer non-cyanide zinc alkaline and zinc acid plating solutions in the mid 70's. These new electrolytes were over 90% efficient, reduced hydrogen embrittlement problems and produced a much smoother deposit. This changed torque values and the 'k' factor. Yet many torque value tables, and the 'k' factor, were never changed.

For decades, we have had fairly stable torque tables for plated zinc fasteners. Until now. The torque world has changed since the adoption of RoHS (Restriction of Hazardous Substances) Directive 2002/95/EC which banned the use of hexavalent chromium, Cr+6. The valence number is its oxidation state and the Cr+6 has been found to be a carcinogen. The Cr+6 has been replaced with trivalent chromium (Cr+3), a non-carcinogen coating.

The Cr+6 produced an iridescent yellow color which provided better corrosion resistance than the clear chromate conversion coatings, primarily due to its thicker coating. The Cr+3 coatings are thinner than the +6 and therefore have a much lower corrosion resistance rating in a standard comparative neutral salt spray test. To compensate, the coatings need to be thicker or have a supplemental top coat or sealer applied. The hexavalent coating was self-healing whereas the trivalent coating is not.

It is the variation with the thickness of the Cr+3 conversion coatings produced by different plating companies that is producing a wide variation in torque values on fastener products with the Cr+3 conversion coatings. Notably, recent torque experiments have shown that with many of the Cr+3 fasteners, previously stated torque values had to be increased by 7-10%.

Adding any form of lubricant will alter the torque-tension relationship. Primarily, the torque will be lower than the dry torque values. Again, this is because by reducing friction between the threads the applied torque must also be reduced. The lower the k value, the lower the friction and the greater the torque needs to be reduced.

Common lubricants are:

Lubricant	Torque Reduction
Metallic Anti-Seize	40–45%
Molylube	28–35%
Graphite	30%
White Lead	25%
Anaerobic Chemical Patch Lock	28–35%
Thread Locks (LocTite®)	10–22%
Oil	15–30%

Some examples of common k factors are:

k = 0.30 Black, non-plated fasteners.

k = 0.235 Socket Head Cap Screws, as received.

k = 0.23 Stainless Steels (300 series)

k = 0.21 Zinc plated, trivalent chromium

k = 0.20 Zinc plated, hexavalent chromium

k = 0.17 Phosphate and oil

k = 0.15 Zinc plated locknut with wax (also depends upon the wax)

k = 0.134 Some Organic Dip-Spin Coatings with Top Coats

k = 0.12 Metallic Anti-Seize (copper, nickel, aluminum with wax)

k = 0.09 Cadmium plated locknut with wax

k = 0.08 LPS Anti-Seize

Standardizing products, vendors and platers can help control variables and reduce potential customer problems. ■