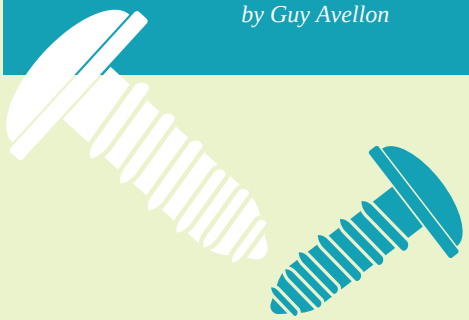
Locking Fasteners -Part 1-

by Guy Avellon



There are many reasons why a fastener may become loose, all of which involve loss of preload, such as: not initially achieving a desired preload during assembly, tightening the bolt head instead of the nut, embedment into softer materials, extreme temperature variations, severe vibration, nonparallel joint surfaces, inconsistent application of torque, shear forces, heavy load impacting, or a host of other reasons. It is for these reasons that supplemental locking devices have been developed and used: to keep the parts together.

Using the term 'lock' or 'locking' in our present litigious society can present some legal problems if the product fails to perform as expected. This is because 'lock' implies some type of permanency and we literally hang on that word to feel that the connection is going to be safe forever. As with any connection, performance includes the selection of the correct product for the application and the proper installation technique.

Basically, we have two choices: lock the nut or lock the bolt.

While there have been a multitude of designs for the locking feature of the nut, the bolt is limited to having its threads distorted, using a nylon insert or by applying an anaerobic or cyanoacrylate chemical to the threads. These methods are used to help prevent the bolt from backing out of a tapped hole.

Nylon:

Nylon is a favorite material to use with any type of fastener to provide some prevailing off torque resistance. Used with bolts, the nylon is applied either as a round plug in the threads towards the end of the threads or as longitudinal patch. Nylon is relatively soft and will not damage the internal threads of softer materials. The nylon patch and plug have been found on bolts of all different strength levels, except it would not be as effective on a higher strength Grade 8, 10.9 or socket head cap screw.

There is a minimal amount of metal removal that neither method would affect the performance of the bolt. It may be argued that the patch would provide more surface area and hence more drag than the plug but again, it would depend upon the application needs and mating materials. Both would be suitable for use with a standard nut especially if there was a clearance problem with using a higher dimensioned all-metal locking nut.

The problem with any nylon product is that they will begin to lose their prevailing drag upon multiple reuses. Since the female threads will cut into the nylon, it will begin to lose its shape and loosening resistance. Temperature is another concern. Standard products are not recommended for use above 250° F (121° C). However, there are several US manufacturers that offer products which withstand elevated temperatures up to 550° F (288° C).

Chemicals:

There are many good 'locking' chemicals on the market. Perhaps that is the problem. With so many to choose from, the customer becomes overwhelmed. Then, because they are 'locking' chemicals, they are used from the small screws in eyeglasses to 1 ½" diameter bolts.

Some chemicals (mainly cyanoacrylates) are sensitive to contaminants, such as oils which may be found in tapped holes, but there are now compounds that will overcome slight contaminants. Many chemicals have a high shear strength, so if the materials are soft and disassembly is anticipated, better check the shear strength of the product.

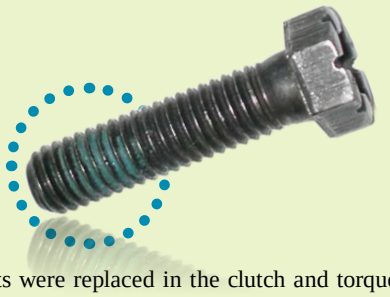
There are some types of thread locking chemicals will set up faster than others of the same brand. So, it is best to review all of the product specification sheets between the variety of chemical products. For example; when tightening six bolts into a connection, the six are laid out on the bench and the chemical compound is applied to the threads. When individually tightening each one, the chemicals begin to set up, changing the torque resistance as each bolt is installed at different times, especially if tightened in increments.

If a mechanic cannot expend over 1,000 lb-ft. of torque to tighten a 1 1/2" bolt, regardless of the grade strength, a 'locking' chemical won't help.

A true anaerobic works in the absence of air, or when it is being tightened. These will not change torque parameters by just sitting. But, every different product type has a different coefficient of friction or effect on the torque value and clamp load on the joint.

Many bolt manufacturers will not apply a microencapsulated epoxy to their bolts due to potential liability. It is up to the user to apply the product they need for their application; whether it is for use in a manufactured product or as an after-market aide. However, if used as OEM parts, the bolts may not be available with the same epoxy patch, if at all, to the user and may be replaced with a non-conforming product when performing maintenance. This will present load variables within the joint connection between the treated bolts and non-treated bolts.

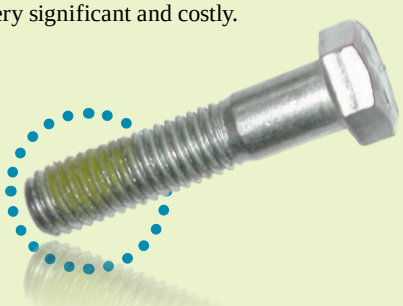
To illustrate a point, here is a case where this worked in reverse. The bolt below is a 'place bolt' which is used in clutch assemblies. The OEM bolt did not have the epoxy coating on the threads. However, when the bolts were purchased from a supply house, it came with the blue patch on the threads.



These bolts were replaced in the clutch and torqued into a tapped hole to the specifications given in the manual. The vehicle was placed in service, where a short time later, the bolts had head failures. No one thought to think that the epoxy would cause the failure.

Testing the place bolt with the epoxy determined that the epoxy acted as a very good lubricant. So good, in fact that the installation torque value needed to be adjusted downwards by 30%. Since most torque values have a 25% safety factor, this bolt was clearly taken into yield, as verified by checking the thread pitch, when the 'dry' torque was applied to the lubricated bolt. Thus, the heads failed during service.

The bolt below is a Grade 5 hex head cap screw with a yellow colored compound. This is also a very effective lubricant and, if torqued to the normal 'as received' recommended torque value, will cause the bolt to be stretched into yield where the over loading can become very significant and costly.



These epoxy type of locking aides are very good if used properly. Most users will not employ a torque wrench to tighten their fasteners, so these epoxy coated fasteners will work well. However, caution must be observed when using any air impact assembly tools, as these fasteners will not have sufficient friction to cause these tools to stall and the fasteners will be either stretched into yield or have their threads stripped.

Therefore, we have two basic types of chemical thread locking products. The liquid cyanoacrylate chemicals and the microencapsulated epoxy. The cyanoacrylate chemicals were originally designed for small screws. These too act as a lubricant but well below the 25% safety factor of a fastener's torque limit. But one must ask: is it because of the thread locking chemical or because the connection is now about 20% tighter than expected? Naturally a tighter connection will produce a more vibration resistant joint.

Due to the high loads placed on large diameter bolts, it would not be safe to place all your trust on using the liquid chemicals on very large diameters. The microencapsulated epoxy is capable of performing more efficiently with the larger diameter fasteners.

The caveat is, with any threaded fastener that has lubricated threads, lower the torque value, decrease the speed of assembly and don't use an unregulated impact wrench.

Unfortunately, the seller, or distributor, never knows where any of their products are used or how they will be assembled. Avoid costly liability; don't make recommendations about applications. Just be sure the customer has the information he needs to make an educated choice of products and grades that would be appropriate for his use.