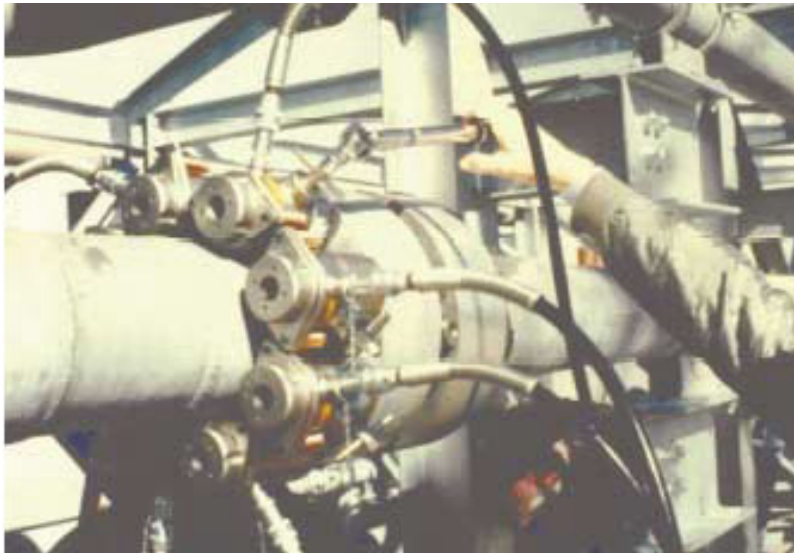


Tight nuts save studs

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Stud tensioning continues to gain acceptance as a preferred method for tightening many critical bolted connections and closures. This is because hydraulic stud tensioners apply loads that are both accurate and repeatable. Tensioning is a two-part process — load application and nut seating. Nut seating, though frequently downplayed, can often help establish proper stud load. Nut seating may not necessarily add significant load but it is key to maintaining residual stud (joint clamping) force after tensioner pressure releases.



Multiple hydraulic stud tensioners from Biach Industries, apply an even load to studs on this pipe flange. A torque wrench turns a bevel geared drive to seat nuts before releasing tension.

As a rule, shorter joints require higher tensions for a given residual load, and longer joints, lower tensions. However, only part of a load generates the desired clamping or residual pressure. The remainder is lost, typically to a phenomenon called embedment, as described by bolting expert John Bickford in the *Handbook of Bolts and Bolted Joints*.

Embedment happens when parts are forced together and is exacerbated by relatively rough mating surfaces. Surface high spots deform as stresses there exceed the material's yield strength. Embedment continues until the deformed contact area grows large enough to lower bearing stress and stabilize the joint. In studs, embedment typically takes place in the mating threads after the nut seats and is therefore independent of stud length.

The tensioning process rotates a nut without load so embedment begins when load transfers from tensioner to nut. Material creep further increases embedment and load loss over time. Stud and nut surface coatings, particularly thick galvanizing, crush and deform and can aggravate load loss. But

applying a relatively low torque to the nut during seating deforms the coating before load transfers to the stud, thereby minimizing the effect. Moreover, adequate seating torque helps reduce embedment when nuts and studs are not perpendicular to a flange face. Here, torque deforms the nut's seating surface before load transfer to help maintain proper stud load.

How much nut seating torque is required? That is estimated based on stud size, bolted joint length, thread surface condition, thread lubricants, flange anomalies, and other known conditions that could raise stud-load losses. Testing stud load with different seating torque helps define an optimal value. In general, apply at least 20 lb-ft of nut-seating torque to smaller nuts (stud sizes less than 1.25-in. diameter), 40 lb-ft to mid-size nuts (1.25 to 2 in.), and 50 lb-ft or more to larger nuts (2.0 in. and up).

As mentioned earlier, tensioning load is always somewhat higher than the required stud preload. Occasionally tensioning load meets or exceeds stud yield, particularly for short joints. Obviously, putting studs at their yield point is not a good idea. One approach overcomes the problem by applying a tension load that is close to, but doesn't exceed stud yield. Upon reaching the load, the nut is then torqued a predetermined amount.

This seating torque effectively "sneaks up" on the required tension load without applying significant torsional stress to the stud and without risking stud yield. In effect, the added torque lowers overtension yet gives the required residual preload. However, the procedure requires tensioners capable of supplying adequate seating torque, says Biach Industries, a maker of hydraulic stud tensioners.

Tests at Biach show that stud tensioners equipped with bevel-gear nut seaters adequately seat nuts to maintain load, and provide enough torque for additional stud loading, if necessary. For example, a 600 lb-ft torque applied to a 2-in.-diameter nut produced enough seating torque to reduce calculated over-tension by 75% for an application with a relatively short joint length. A 4:1 reduction ratio lowered input torque to just 150 lb-ft in this case. A calibrated torque wrench can precisely monitor input torque for added accuracy. The geared-nut seating system can also help remove nuts by overcoming accumulated rust, paint, and thread imperfections.