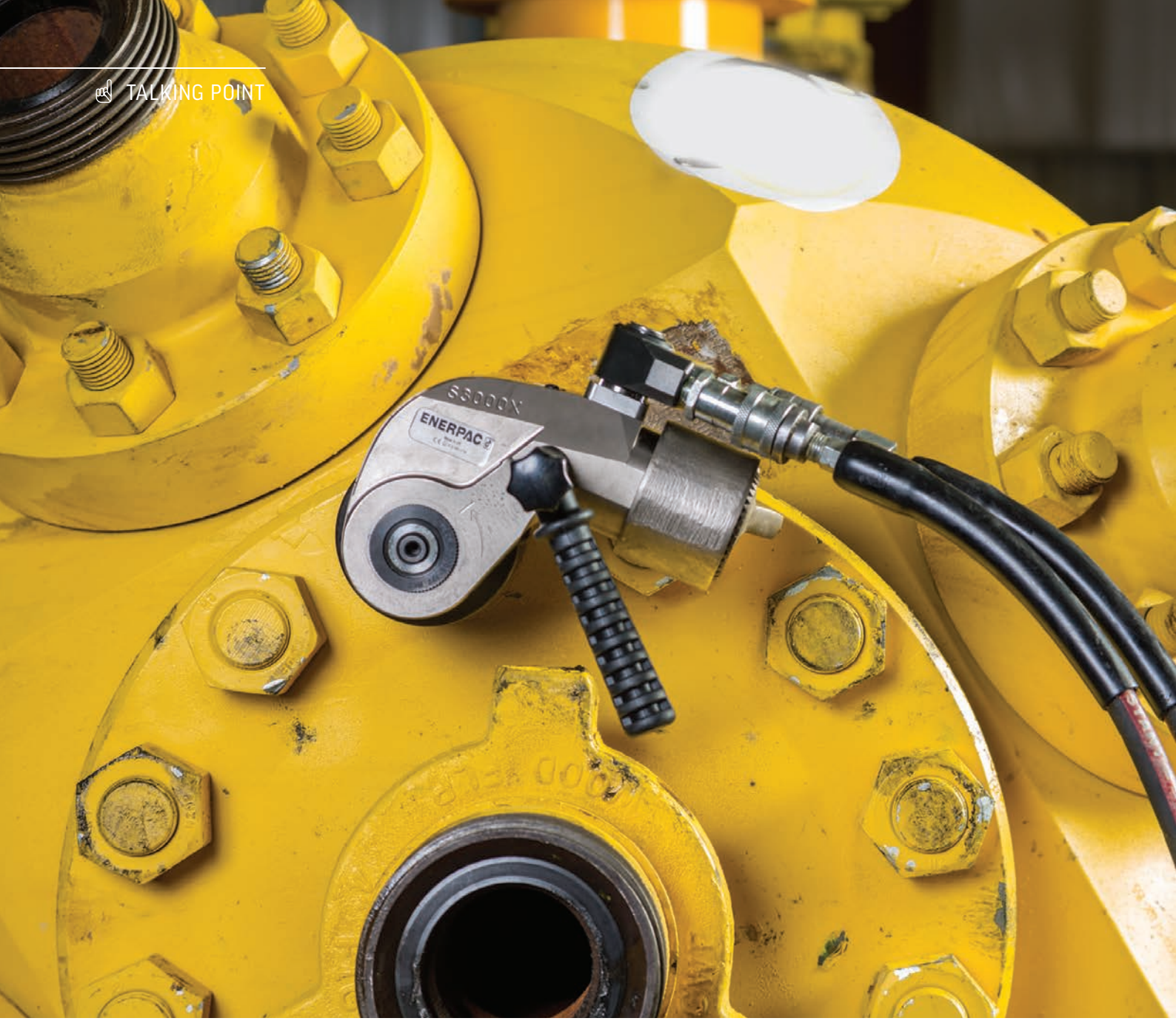

Wind turbine construction, installation and maintenance: torque vs tension

Torquing and tensioning are two very different ways to tighten a bolt. Each method has its own advantages and disadvantages. A wind turbine can contain as many as 25,000 bolts, with each one contributing towards either the turbine's structural integrity or how it functions. So, it's worth knowing how both torquing and tensioning work.

Before comparing torque vs tension, first, we should go back to basics and look at how a tightened bolt behaves.

Bolts that are correctly tightened make use of their elastic properties. To create a tight joint, they must behave like springs. When a load is applied by a torque wrench or tensioner, the bolt stretches and tries to return to its original length. The resulting tension produced by the load leads to a clamping force. It is this which works with the friction from the bolt's threads to produce a fully secure joint.

From this simple principle we then naturally progress to...

Understanding the difference between torque & tension

Torque is the measurement of the force that causes something to rotate, for example, the turning force needed to spin a nut around the threads of a bolt. Whereas tension is the stretch or elongation of a bolt that provides the clamping force of a joint.

Bolt torquing and bolt tensioning are both widely accepted ways to seal a joint. However, each method has different characteristics and suits different types of application.

Torquing with hydraulic torque wrenches

A Torque wrench works by applying the principle of Newton's law. This states that for every applied force there is an equal and opposite reactive force.

In practice, this means that as a nut is turned, the bolt material stretches. This creates tension within the bolt that acts as a clamping force over the effective thread length. The clamping force pulls the two bolted components together and retains a tension (load) within the bolt.

Torquing and friction

Friction plays a huge part in a torquing operation. An estimated 10-15% of the input torque stretches the bolt. The remaining 85-90% of input torque is used to overcome friction between the threads and under the nut or bolt head.

For the garage mechanic who needs to change a car wheel or dismantle an engine, a manual hand-held torque wrench is usually enough to get the job done.

But more powerful tools are needed for industrial applications – particularly for those in wind turbine applications. Considerable force is needed for applications such as securing pylons to their foundations, hubs to the generator nacelles, and blades to the hubs. Projects like these that require high torque output applied to many bolts make hydraulically powered torque wrenches a popular choice for these applications.

A hydraulic torque wrench works using high-pressure hydraulic power supplied from an air, battery, or electric-driven pump. The higher the pressure, the greater the amount of torque applied to the bolt. The unit of measure for torque is usually expressed in Ft.lbs or Nm.

A torque wrench operator can only tighten each bolt individually. So, working around a tower section during construction may take some time, unless more operators are available.

Tensioning with hydraulic bolt tensioners

Hydraulic tensioning dates back to the 1970s, and its use has become more widespread for critical applications throughout the wind, oil & gas, power generation, and subsea industries.

Within the wind power industry, specialized bolt tensioners are often used during both installation and maintenance checks on wind turbines - including the foundations.

Tensioning is a popular choice for attaching the base of the wind turbine to the footing. The advantage of this method is that it creates an accurate load – which is especially important on larger bolts.

Critical fastening applications for wind and other power generation applications are best served by single-stage and double-deck tensioners. These provide the speed and accuracy required for safe operation at the wind site.

There are tensioners designed specifically for wind tower foundations or base bolts, such as Enerpac's FTR-Series and FTE-Series tensioners. These elliptical and round tensioners provide an effective solution when a long bolt stretch is required, and if limited space between the stud and the wall prevents the use of standard tensioners.

The full hydraulic system

A torque wrench or tensioner does not do the work alone - it is part of a system that includes a hydraulic pump, hose, and accessories. Using components designed to work together will help to enhance operator safety and productivity. Doing this with products from a single brand makes this easier through common fittings, safety handles, and pendant controls.

Ergonomic features are important too. These make operation intuitive and ensure hand comfort when repeatedly operating the tools.

Torque vs tension: which is best?

The truth is that there is no simple answer. The decision should be taken per project, or even on a joint-by-joint basis. Considering these questions will help you arrive at the right decision.

1. **How critical are the joints?**
2. **What accuracy has been specified?**
3. **How accessible are the joint components?**
4. **What equipment is available?**
5. **How many bolts are there?**
6. **What size are the bolts?**
7. **How many joints are to be worked on?**
8. **What budget is available?**
9. **What are the skills of the people available to do the job?**

When making your decision, it is important to consider the specifications stated by the engineering team. If tensioning has been specified, then this is because they insist on accuracy, so there is no alternative. This is because tensioning can provide accuracy of plus or minus 10%.

By comparison, Torquing is accepted as being within plus or minus 30%. But there are exceptions. More accuracy can be

achieved by a very experienced operator through a combination of greater skill and effective lubrication.

If Torquing is specified there is more flexibility. Many torque specifications allow for a wider accuracy range – making tensioning unnecessary. However, in these cases, it may be acceptable to use tensioning if you already have the right equipment.

Hydraulic torque wrenches are flexible, versatile, and compared to tensioners – they're less expensive. But it would be wrong to make your decision based on budget alone. Dealing with an issue on a critical foundation joint in the future could incur significant costs. Also, if using the torque method, don't forget to factor in costs if extra manpower and more time is needed.

Tensioners offer more accuracy, and put simply, they're faster, they cost more, and they're more complex.

Also, it's worth knowing that if the clearance between studs is tight, some joints may need to be tensioned in stages – (instead of the preferred scenario where all bolts can be tightened simultaneously). This means the job will take longer and a suitable bolting pattern will need to be followed.

Wind turbines now and in the immediate future require bigger, more exacting equipment. This may result in larger nuts and bolts to be placed closer together than previously. Additionally, engineers are now designing foundations with a greater number of larger diameter rods which require greater tension. So, if you are currently planning to work on a large-scale wind turbine project, check in advance you have the right equipment to handle all the bolting applications you may be faced with.

Considerations for the future

If you're involved in wind-energy construction, operations, or maintenance, you will know that the goal of achieving greater KW output through larger turbines impacts how the turbines are manufactured, assembled, and maintained. Deeper pillars and new modular methods of on-site assembly all affect both the equipment needed, and the necessary procedures to achieve effective and precise results.

Increased demand for both bigger and repowered sites, both onshore and offshore is happening right now. To meet this need, contractors wanting to add to their inventory of tools may be tempted by the cheapest brands. But focusing on short-term cost savings could hurt them in the pocket further down the line. The adage 'you get what you pay for' certainly applies within the world of industrial tools.

So, if you are about to invest in the specialized tools and technology needed for wind power applications, a smart move would be to find a reputable manufacturer with a proven track record.

Enerpac and its commitment to build it bigger, build it better

Enerpac is a global market leader in high-pressure hydraulic tools, controlled force products, and solutions for the precise positioning of heavy loads. Our products have helped to assemble and move some of the largest structures on earth.

Backed by a global legacy of ultra-reliable quality and superior precision, Enerpac pushes industries forward with a wide range of advanced industrial tools and services. Our tools have become the industry standard in aerospace, infrastructure, manufacturing, mining, oil & gas, power generation, and more.

First and foremost, we aim to ensure our customers operate safely and productively every day.

It isn't about being compliant, or 'as good' as the next guy; Enerpac outpace the competition by delivering technically superior solutions that are easy to get, safe to use, and built to last.

Browse the Enerpac range of Torque and Tension tools: https://www.enerpac.com/en-us/products/USTorqueandTensionTools