Critical bolting demands innovative thinking

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The wind industry has a huge number of bolted joint connections and for the most part they are critical to both performance of the turbine and safety of those working on or around it. The primary installation method for assembly of equipment, construction of turbines and for maintenance is the tightening and checking of threaded fasteners, or bolts, because this is a standardized way to design joints which can also be repaired or replaced during the course of the turbine's entire life cycle. These joints provide structural integrity of the tower, nacelle or blades, they ensure correct performance of equipment, they ensure the safety of both the workers during assembly and construction, and if installed correctly can maximize the lifetime of the turbine.

All of this directly impacts the reputation of all stakeholders in the value chain, from turbine OEM, to service provider and the asset owners and importantly has a significant direct impact on the cost and efficiency of the industry.

Considering the continued ongoing focus to reduce costs and improve efficiency whilst at the same time securing safety throughout the industry you would expect that there is a high focus on bolting operations, however for the most part this is an area that seems to be often overlooked.

What is important to know is that the technology in bolting tools and solutions has accelerated forward in recent years, and the technology that was previously considered only applicable inside factories, can also now be applied in the field, meaning that sectors such as wind turbine construction, commissioning and maintenance work can really benefit with the same type of highly accurate, ergonomic and productive tools that had previously only been used in fast paced assembly lines.

Times have changed, tools must also

Since the birth of the wind industry, bolts have been used, and the primary method to install the fasteners has been torque tools. Historically, tools such as Hydraulic wrenches, often referred to as controlled bolting tools, had been used because they were believed to be the only tools capable of achieving the high torque levels required with some degree of accuracy.

This resulted in these types of tools being specified in as the approved tools for use in construction and maintenance work. Due to the long service life of a wind turbine, this meant that these tools remained, and indeed remain today in many cases as the tools specified on many applications.

However, the use of hydraulic wrench systems presents some challenges. Firstly, the torque is achieved by applying oil pressure via a hydraulic pump. This pressure is then correlated to a torque output so is not a true measurement. This can be very repeatable but has an extremely slow speed of operation because to tighten a bolt, the operator must repeatedly activate the pump so that the pistons in the wrench will move forward and retract repeatedly back until the bolt is secured. Furthermore, to use a hydraulic wrench you also need to have a hydraulic pump, which can be heavy to lift, or to transport, and then of course there is the risks involved with working with high pressure hydraulic oil.

Also, because the powerhead or cassettes on hydraulic wrench systems are relatively small, during operation it often results in hands being placed in areas where the torque reaction force is being generated, and so finger injuries, are not uncommon.

The main alternative to hydraulic torque tools, is to use what is known as continuous rotation tools. These are tools that are typically in pistol configuration and are powered by a motor, electric or pneumatic and have gear box which transmits the force directly from the motor to the output shaft and applies the turning force in a continuous manner to the fastener.

This type of tool has several significant advantages but perhaps the most notable is tightening speed. As the tool is powered by a high-performance motor, and the gearbox turns continuously at high speed upon the pull of the trigger, and there is no ratchet

mechanism, then the output speed is multiple times faster, even up to 100 times faster than a hydraulic tool. If you have a lot of bolts to tighten, as you do in a turbine this can save a huge amount of process time and can literally translate hours of work into minutes.

The most common type of continuous rotation tool, also called nutrunners, in the wind industry is electrically powered and so you have a tool with an electric motor, and that is connected to a controller or drive unit which connects directly to a power source such as a generator or to the tower. The controller can be programmed with different parameters to control how the tool operates. For example, increasing or decreasing tool speed, counting the number of fasteners, and setting up different programs for different bolt sizes, flanges or even turbines. What this does is take a lot of the decision making away from the operator of the tool and puts it in the intelligence of the tool system itself. This can really add a lot of value for example when contractors are hired for bolting work, and they may need training. Rather than relying on operator expertise for the good result as you do with hydraulic wrenches, instead the training cycle can be reduced and even minimized as with nutrunners the tool will have pre-programmed tasks, and so is easy to use, even for a novice.

Besides, the tools, and controllers can provide feedback to the technicians, with information such as torque result, batch counting, or even error messages which can help the technicians to identify faults in the bolted joints as the work is being done. This improves quality by reducing the need for rework during service checks which also saves time and cost.

With electrically powered continuous rotation tools, there is no high-pressure oil. There is no heavy hydraulic pump to carry. There is no twisting set of hydraulic hoses on the floor. There is no noisy pump being activated, and the tool itself is typically designed for comfortable use by the operator. All of these aspects make the tools significantly more ergonomic and safer to use than traditional hydraulic systems and so can reduce work related accidents, and injury.

Although many nutrunner systems have similar benefits, there is one area that has a distinct difference that is extremely important and must be understood well. This is the difference between 'transducerised' tools or 'current controlled' tools. With current control, the tools torque measurement is a calculation based on the correlation between voltage, current and temperature during the tightening.

Therefore, the output torque is a calculation which in consistent conditions such as a test lab the results are extremely accurate and repeatable. However, in the field when temperatures can vary quickly, or power fluctuations in the system can be present, then the output calculated torque will also change. This can be unpredictable, and dangerous, as a tool tested on a test fixture, may not perform the same on a flange in a tower.

The alternative type of tool is a transducerised tool which instead has a transducer inside the tool to measure the output torque. This is much more secure as it is a measurement rather than a calculation. How you can think about this is, it's like using a current control

tool, but then checking it afterwards with a calibrated torque wrench. The transducerised tool simply combines both of these process in one operation as it tightens the bolt, thereby reducing the need for after checks and providing security that the right result was achieved first time. Of course, it also has the ability to save that data as a digital record which is then fully traceable.

A manufacturing heritage of quality and precision

Atlas Copco are the world leader in intelligent nutrunner systems and have been supplying them to factories in automotive, white goods, heavy machinery for many years. Around 15 years ago a tool was developed for higher torque applications such as the construction of excavators, cranes or mining trucks. It used the platform of highly intelligent and accurate nutrunners used in automotive but redesigned for higher torques and more robust use cases.

This was called the Tensor Revo tool and it really revolutionized high torque bolting in factories due to its ergonomic design and extremely fast tightening speeds. Around 7 years ago, the Tensor Revo was further optimized for use in field applications such as flanges, by making it even more compact. The result was a tool that is at least 3 times faster than anything else on the market making it ideal for applications such as wind tower construction with lots of bolts and where speed is really critical, but joint quality and worker safety are a priority.

The Tensor Revo HA nutrunner system not only reduces process time, but the inbuilt intelligence, that it brings from its heritage in factory use means that it has very high torque accuracy with inbuilt transducer, fully programmable tightening strategies, error detection, bolt counting and of course data collection which can be collected at the point of tightening without any additional work required, thus it saves time, provides security and gives full transparency on all bolting work that has been done.

Additionally, by using a secondary trigger, the tool becomes free from the risk of finger pinch points, one of the most common injuries in a wind turbine.

To say the Tensor Revo is unrivalled is no overstatement, as when put in head-to-head tests with any other tool of its type, the tightening speed, torque accuracy and level of error proofing available is superior making it best in class solution for any critical high torque bolting application.

Ongoing innovation

It is clear that continuous rotation tools can delivery benefits in operation that translate directly into savings on the bottom line for operators, OEMs and service providers, in particular if they have been or still are using hydraulic tools, and Atlas Copco's Tensor Revo is best in class when it comes to tools, but Atlas Copco are a company driven by innovation and working closely with customers.

The 'voice of the customer' was clear on how the system could be improved further and this led to the development of a new drive unit to power the tools which is designed specifically for use in field applications such as wind tower construction or maintenance to maximize robustness, and minimize complexity.

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PES talked to Axel Lycke, Global Product Manager at Atlas Copco to learn more about how the new Power Focus XC, can help Tensor Revo deliver even more benefits to the wind industry.

PES: Axel, can you tell us about the latest developments with Tensor Revo tools?

AL: Yes, sure. The Tensor Revo tools were developed around 15 years ago, but remain best in class for performance even today, however during 2020, we introduce some new gear box designs to make the tool even more compact and lightweight, which is important with tools that can deliver up to 8000Nm in torque. This reduces strain on the technicians, resulting in less absence, higher productivity, and less errors due to fatigue.

We also implemented a new design of dual trigger into the Revo tools, which can eliminate finger pinch points which is a major issue across the industry. During late 2019 we had launched a battery tool to the market, SRB HA, which had an ergonomically designed and fully integrated dual trigger meaning that operators hands were safe when the tool was in use. This has been a huge success, and so we took this design and have applied this to our Tensor Revo tools also. Safety is always our priority and this design is unique in the market

PES: What can you tell us about the new drive unit, Power Focus XC which we understand is currently in the launch phase?

AL: Yes, that's right. It's really exciting. The Tensor Revo tools have been working together with our PF6000 tightening controller up until now, which is the most advanced and most widely used tool controller in the world. However, the PF6000 controller was designed to be used inside a factory environment, and indeed all major wind turbine OEMs are using these in their factories today. Although it is extremely advanced in terms of functionality, we felt it was not optimized for the robust environment for example in the construction industry. When we talked to our customers, they told us the loved the Revo tools, but they did not love the controller, as it was perhaps not robust enough, it was seen as complex to program and offered too much functionality than was required in the field. Taking this feedback onboard, we completely redesigned the drive unit with the applications in the field in mind. The result was the PF XC which is truly optimized for high intensity work, in the field on critical high torque applications.

PES: What were the main changes that were made in the new system. Where is the value for the user?

AL: Well, where to start?... we have done a lot!

Firstly, we removed the large display on the front of the drive. This meant there was less risk of damage, and we also felt it wasn't necessary because when using the tool, the tool is in the technician's hand, but the drive is located somewhere else, perhaps even behind him.

Therefore, by having information on the tool housing instead, like torque result,

Axel Lycke

target, error status this means the information is exactly where the user is working. This creates a simpler housing for the drive, which is much more robust.

However, we also realized that there was a need for more detailed information to be available to some users, for example tightening strategies during set up, or data logs for analysis. This however was only needed by supervisors or engineers, and not by the actual bolting technicians. With this in mind we developed an integrated web server inside the drive, so that any device: phone, tablet etc. can connect directly to the system by simply scanning a QR code on the drive and without the need for any additional app to be installed.

This effectively means that any person with

a phone can access the drive information, programming, configuration, and torque data even when there is no mobile signal on site. Moreover, because this can be accessed on a phone, it can also be sent to any other location instantly.

We also increased the capacity of the drive itself. We had seen that in some applications when operators use the tool on many bolts consecutively and in extreme weather conditions, the tool could heat up and this could reduce the time between service intervals. To overcome this, we have redesigned the drive to work more efficiently reduce any temperature build up. This results in a tool that can harder for longer and will mean less service and maintenance is needed.

Lastly, we also created a unique frame design to house the drive itself. The frame not only means transportation, and movement within the turbines, or to sites is easy, but it also provides an extra protection to the drive from damage. This makes the work of the technicians easier, and of course reduces the risks of costly damage.

PES: It sounds really great, and it's clear the needs of the wind industry have been addressed specifically with this product. However, in recent years there has been a trend to more battery tools, due to having no cables for example. Wouldn't these be a better option than tools with a drive unit?

AL: This is true, that is a real trend, however its essential to use the right type of tool on the right application where it delivers the most value. In construction for example, time is critical, and speed of work is crucial, so using a tool with a drive unit, will mean much higher performance due to higher tightening speeds.

Furthermore, with an electric tool with a drive, the work can continue without batteries requiring to be replaced or charged, again saving time.

However, for service work, or for maintenance checks, this is where Battery tools really have an advantage as the flexibility and ease of movement is much more important than the tool speed.

In Atlas Copco we have a full range of tools, such as continuous rotation tools, and high torque battery tools, and now intelligent hydraulic tools, including bolt tensioners, and all of these are needed inside a wind turbine.

What we have done is to make all these tools compatible so that the user experience is the same regardless of tools, the safety focus is the same and of course data can be gathered from all to ensure traceability of process results.

Most important is to select the right type of tool for the right application

PES: Do you feel that continuous rotation tools such as nutrunners or battery tools can be used on all applications in future, such we see in factories?

AL: No, this won't be the case, and this is because of 2 main factors. The first being accessibility on some applications means that hydraulic wrenches may be needed due to their compact nose radius which is sometimes the only thing that can physically fit onto a bolt. Particularly in cramped spaces.

And secondly, we see that as turbines become larger, and there is a drive to reduce weight and cost of turbines, we see an increased demand for bolt tensioning due to the much higher loads required to secure the bolts.

This means that all of these different tool types will continue to be used in the construction and maintenance of turbines for some time to come. What we do see however is a demand for data being a common factor for all types of tooling, and so the implementation of integrated sensors and data capture on hydraulic products such as wrenches and tensioners just as we see on nutrunners and battery tools is really important and is happening right now.

PES: Finally, Atlas Copco are an innovative company, with a strong industrial heritage, how do you see that Atlas Copco can contribute to the further development of the wind Industry?

AL: Our vision is to help customer be more productive, reduce costs, and ultimately to help the industry become more efficient. Our leading market position in other sectors such as automotive has been built on working closely with customers to bring innovation that delivers true value to their operations.

We have proven that with major brands over many years, and we believe we can achieve the same in wind by working together to find new innovative solutions and by demonstrating that our products really deliver what they promise.