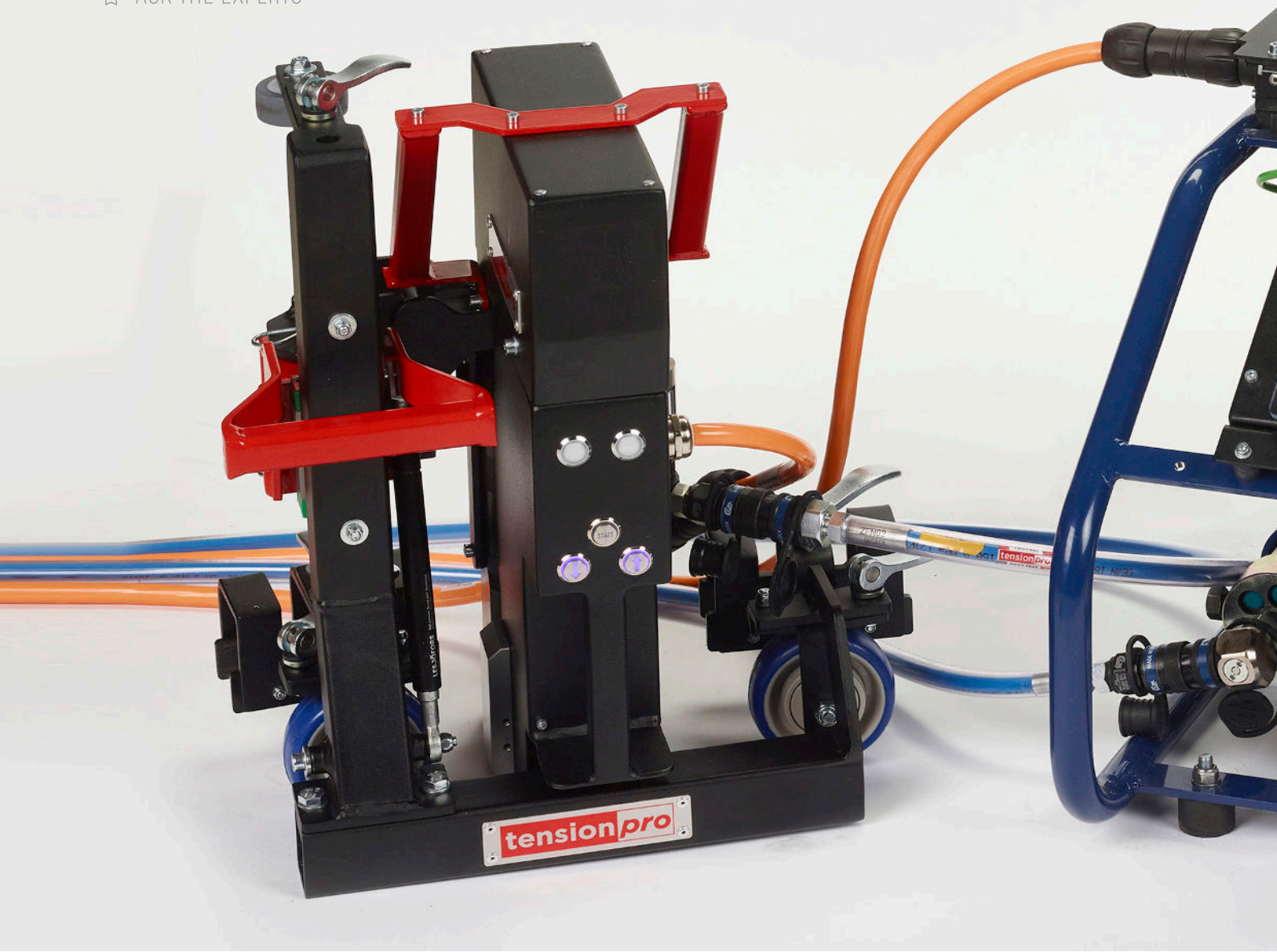


Advancing bolt tensioning for larger turbines

As wind turbines increase in size, the challenges of bolt tensioning become more complex, posing significant risks to the structural integrity and safety of these massive structures. Ensuring precise, reliable and safe bolt tensioning is crucial for the effective operation and longevity of wind turbines, especially as they scale up in size and power. Richard Outram, Sales & Business Development Manager at TensionPro discusses with PES how his company is tackling these challenges with innovative solutions designed to meet the evolving demands of the wind energy industry.

PES: Thank you for talking to us today, Richard. We're looking forward to learning more about TensionPro. As wind turbines continue to grow in size, what challenges are associated with bolt tensioning for these larger structures, and how is TensionPro addressing these challenges?

Richard Outram: It's great to talk to you today. In answer to your first question, the increasing size of wind turbines poses several challenges where bolt tensioning is concerned. Larger turbines require bolts with larger diameters and higher load capacities, adding another level of complexity, both with initial installation and ongoing maintenance. Traditional tools and methods used for bolt tensioning may require additional technology or processes to help meet the demands of these supersized structures.

At TensionPro, we address these challenges by continually innovating our bolt tensioning solutions. We prioritize listening to feedback from our global customers and partners in a continued effort to improve our tools and processes. This feedback helps us enhance safety, accuracy, and overall value, ensuring that our solutions meet the evolving needs of the wind energy sector.

PES: What are the potential risks of improper bolt tensioning in wind turbines, and why is it crucial to achieve the correct bolt load?

RO: Improper bolt tensioning can lead to a range of serious problems. These include structural damage, operational disruptions, and in severe cases, catastrophic failures. Ensuring the correct bolt load is essential to maintaining the structural integrity and safety of wind turbines. Each bolt, whether in the foundation, tower, or generator, needs to be precisely tensioned to prevent issues such as loosening through vibration or dynamic loading, or in some cases complete failure of the joint.

Proper bolt tensioning is crucial because it ensures that all components function together as intended thereby avoiding potential operational and safety hazards and ensuring maximum efficiency of the turbine. Moreover, when taking into consideration the huge costs of ongoing maintenance, anything we can do to minimize risk, assist in predictive maintenance regimes, and in many cases reduce the number of inspections needed on what bolted joints may have previously been considered problematic or in need of unusually frequent maintenance.

PES: How has the industry's approach to bolt tensioning evolved, and what role do advanced bolt tensioners play in this evolution?

RO: Bolt tensioning has been used extensively for more than 40 years across the energy sector and in other industrial markets. However, when taking into consideration the number of bolted joints throughout the world, the reality is that bolt tensioning still only accounts for a small proportion. The customer approach toward bolt tensioning has however evolved significantly, in some cases this could mean previously using only torque tightening tools to now adopting standard and indeed more advanced bolt tensioners. This shift is driven by real world experiences and an awareness of the importance of ensuring more accurate bolt loads which are repeatable each time.

The debate between whether bolt tensioning or torque tightening will always be present and the reality is that both methods have their place and should be specified according to suitability for the particular application Bolt tensioners offer several clear and known advantages over torque tools however, including the linear relationship between applied pressure and bolt load without having to account for frictional forces.

In applying a direct stretch to the bolt rather than the torsional rotation to the nut it negates the need to consider said friction and also bolt lubrication which are major factors heavily associated with torque tightening methods. Additionally, the simultaneous use of multiple bolt tensioners in sequence speeds up the tensioning process and as all the tools have the same hydraulic pressure area this ensures an accurate load goes into each bolt around the flange

As the wind energy industry has grown, so too has the demand for more sophisticated verification methods. There will always be a place for what is considered to be standard equipment, but more advanced bolt tensioning systems address these needs by providing additional information and data to the user, further improving accuracy and reducing the risk of human error.

PES: Can you elaborate on the limitations of conventional hydraulic tensioners and how newer technologies are designed to overcome these limitations?

RO: Conventional hydraulic tensioners typically rely on pressure measurement to determine the bolt load. This approach can be limiting because it assumes a direct relationship between the applied pressure and the resulting load. In practice, other factors need consideration and can affect this relationship, leading to potential inaccuracies.

New technologies have been developed to address some of these limitations by incorporating additional measurement methods. Industry experts know that the ability to measure bolt elongation is the one true way to verify actual bolt load. There are several systems that can be used to do this and including them in the overall process provides more accurate and repeatable tension values but as yet there is not really a single technology that is capable of providing absolutely everything that sophisticated customers are asking for, at least at a viable price.

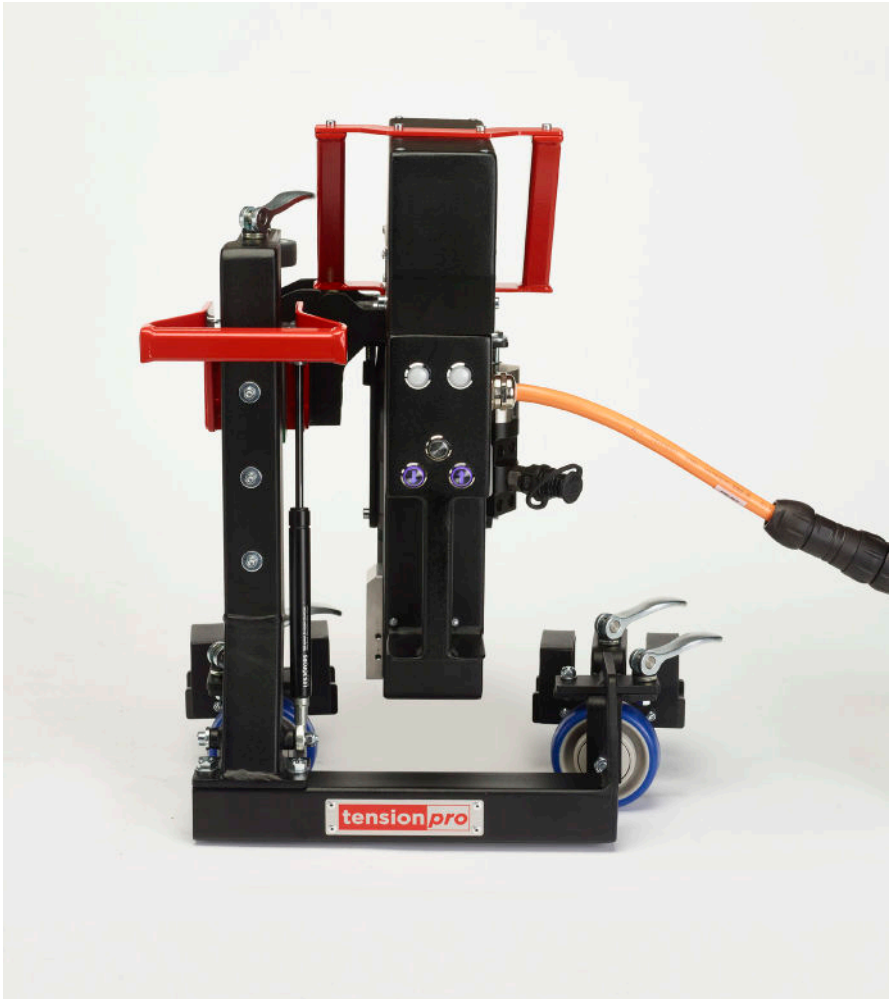
PES: How has Tension Pro responded to this?

RO: With our latest innovation, Quantum, we are bringing to market a complete semi-automated tensioning system with the objective of further improving asset and operator safety. The two main elements that make up the system comprise a digitally controlled pump unit connected to an electro hydraulic tensioning tool. The pump unit itself houses a PCB to control the pump, store preset programs, and record the crucial completed bolt tightening data.

There is an easy to read LCD display that acts as a digital gauge and provides visual confirmation that the target pressure has been reached during operation and a read out showing the angle of turn of the nut each time a bolt is tensioned. The pump also provides power to the tensioning head which has its own set of built in controls on the front face of the tools by the lifting handle.

A motor that is controlled by two simple illuminated buttons enables the operator to run the tensioner down onto the bolt before tensioning begins and screw it off after it is complete. Depressing the start button starts the tensioning process and to ensure safe controlled operation this has to be depressed until the tensioning cycle and nut rotation are complete. If the operator otherwise takes their finger off the button prior to completion, the system will stop safely and the sequence will not be completed until the operator resumes it by once again depressing the start button.

A visual indication that the bolt tensioning cycle has finished comes from a green light. At this point, the tool can be screwed off the bolt and the trolley can be moved effortlessly along the flange and into position ready to tension the next bolt. If the light stays red the process has not been completed and must be repeated. This incomplete cycle data will be recorded as such within the system records.



Richard Outram

All flange/bolt data is preprogrammed via the built in software before the user taking the system on site and there no possibility to override the system, removing potential errors and ensuring that only the correct pressure corresponding to that bolt and joint is applied when in use. Once the target pressure is reached the system shuts off the pump and records this pressure data whilst the nut is simultaneously rotated down to meet the flange face. The final nut rotation is measured via a sensor and the angle data is saved to the system's memory.

The process is simply repeated according to the number of bolts and upon completion of the joint all corresponding stored data for the job can be downloaded via the built in USB input on the pump and retained for reference and traceability.

The Quantum system is versatile and can be configured with different sized trolleys and tensioning heads depending on the bolt size and flange geometry. It is easy for one technician to operate alone and where a large quantity of bolts is being tightened, multiple units and technicians can work simultaneously to speed up the overall process.

PES: What other advancements in bolt tensioning technology are being introduced to enhance operational efficiency and safety?

RO: Other advancements in bolt tensioning technology can feature digital or hands-free controls, real-time data recording, and fully automated functions. These innovations help streamline the tensioning process by reducing the need for manual adjustments and minimizing the potential for human error.

Our Quantum system focuses on traceability whereby operators can track and review current and historic tensioning data specific to an overall project or individual bolted joints. Other features enhance safety and reliability, such as preprogrammable system settings, automatic shutoff and real time user feedback. These advancements are a key

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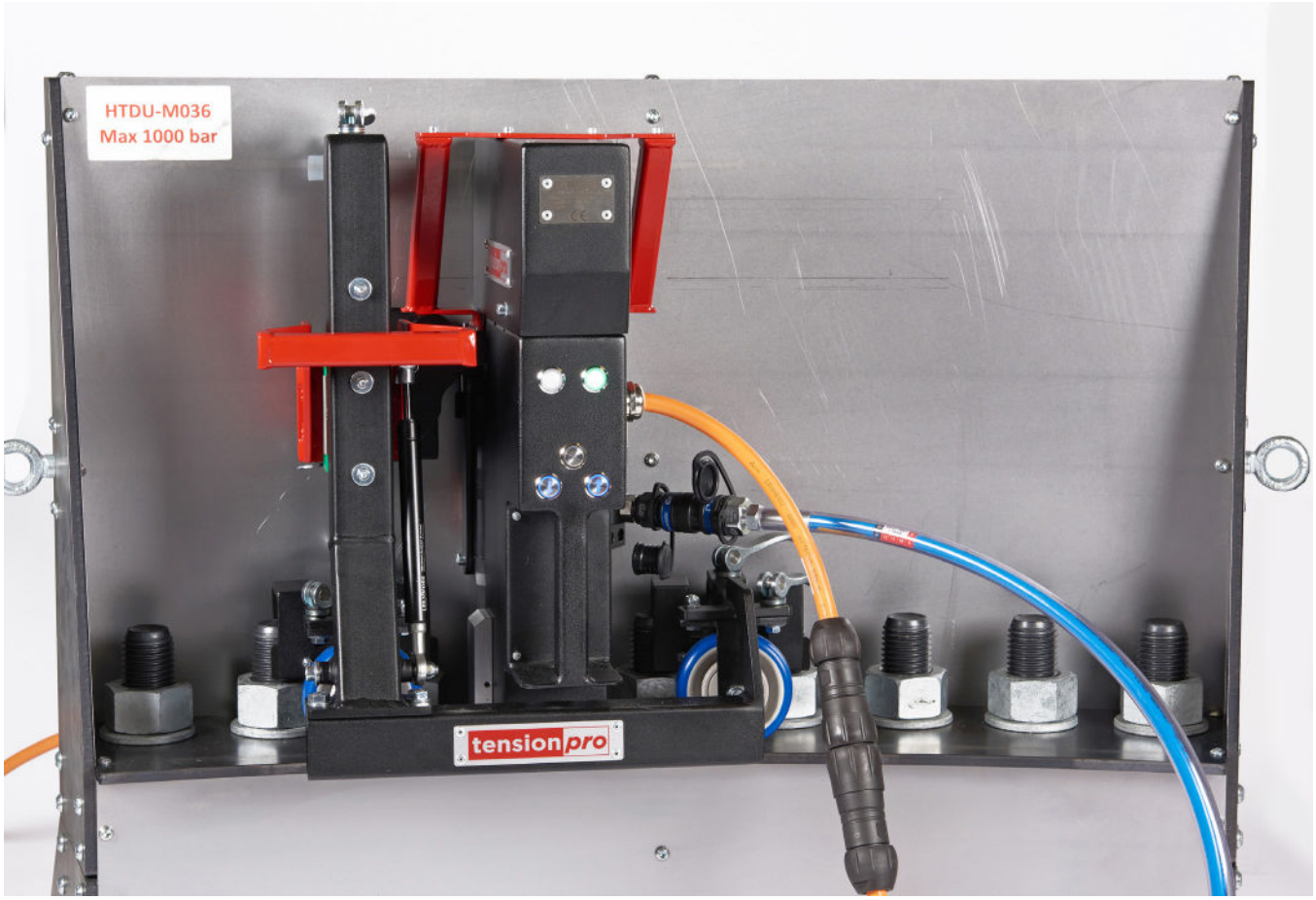

contribution toward meeting the increased demands of today's wind energy projects and making ongoing improvements to operational effectiveness.

PES: How versatile are your latest bolt tensioning systems, and in what types of applications can they be used?

RO: The Quantum system is highly versatile and can be adapted for a wide range of applications. Its design accommodates different bolt sizes and flange geometries, making it suitable for both large and small scale applications. For example, while the system is particularly effective for larger bolts used within the turbine structure, such as monopile to transition piece connections and tower bolts, it can also be used on smaller bolts which may be located in more confined spaces. These bolts can be considered equally as important to the overall turbine integrity.

The advanced features built into this modern bolt tensioning system provide greater process control and long term assurances that challenging technical requirements can always be met for both onshore and offshore wind energy projects.

PES: What kind of feedback are you expecting from customers regarding these new technologies, and how do they compare to existing solutions?

RO: We anticipate a positive response from customers who are seeking more precise, efficient, and reliable bolt tensioning solutions. The new technologies offer several advantages over traditional methods, including improved automation, real-time data collection, and enhanced safety features.

These improvements address many of the limitations of previous solutions. Improving the accuracy and repeatability of the bolt tensioning process will inevitably contribute toward reducing initial construction and future operational costs. We expect customers to appreciate the relative simplicity of our system and its user friendly operation whilst each time knowing that they are gaining valuable knowledge and crucial data directly relating to their assets

PES: How can potential customers learn more about these advanced bolt tensioning systems or arrange for a demonstration?

RO: Potential customers can learn more about our system by contacting us at sales@tensionpro.co.uk. We also offer onsite demonstrations and are always happy to welcome visitors to our facility to showcase our technology.

Additionally, we can provide budget pricing for specific applications and we are happy to answer any questions. Our goal is to help customers experience the benefits of our innovative solutions, find the best fit for their needs and provide any other valuable knowledge and advice.

www.tensionpro.co.uk