HY

THE MAGAZINE FOR
MODERN BOLTING SYSTEMS

Issue
6/2018

WIND ENERGY 2018

SPECIAL ISSUE FOR WINDENERGY

50 YEARS OF
quality &
innovation

Visit us at WindEnergy 2018 in Hamburg, Germany
stand B232 in **hall 7**

www.hytorc.de

With Us, Costs Will Drop!

50 YEARS OF quality & innovation

Catrin Junkers

Patrick Junkers

Jörg Lindemann

Dear readers, dear visitors of WindEnergy 2018,

Welcome to the globally leading international wind energy trade fair. A globally leading trade fair should be of considerable size, and WindEnergy truly is: More than 1,400 exhibitors present their products and services, and technical knowledge and insights are shared in more than 500 first-class expert presentations. Although we at HYTORC do not know in detail what all these exhibitors are presenting, one thing is for sure: The sector of wind energy is missing out on an opportunity to reduce operating costs, if smart bolting systems are not used.
And that is our cue. Because our portfolio covers everything you need to increase the length of your facilities' maintenance intervals. Tools, knowledge, accessories. How it works? All you have to do is to use yield point-controlled tightening. What that is? To learn all about it, please see page 4. How it pays off in real life is explained by a seasoned wind turbine maintenance expert on page 7 – and at our WindEnergy exhibition stand, of course.

IT'S ALL IN THE WASHER

Apart from yield point-controlled tightening tools, we have, of course, also brought along all other bolting systems for the application in wind energy settings. This includes washers from our zWasher and Backup Washer series. They make it possible to eliminate reaction arm and back-up wrench (the Backup Washer prevents the bolt from turning), and they are suitable for applications requiring a tightening torque between 60 and 190.000 newton meters. The advantage of bolting without a reaction arm: Work safety increases, because the risk of the arm crushing a hand drops to zero. Because of the no-rotation washers, this method also reduces wear: The set of bolts can be reused. Process reliability increases, too, because methods like yield point-controlled or tightening based on torque and angle can only be used reliably if the bolt does not rotate during the tightening-process.

What else should be part of your bolting concept to make sure that the operation of your wind turbines is as trouble-free as possible? Come see us at **stand B232** in **hall 7** and we will show it to you! Live and in color.

Content

CONTACT AND FLAG

HYTORC
Barbarino & Kilp GmbH
Justus-von-Liebig-Ring 17
82152 Krailling / München
Germany
Phone: +49/89/23 09 99-0
Fax: +49/89/23 09 99-12
www.hytorc.de

EDITORIAL OFFICE
BRAND+IMAGE
www.brandandimage.de

DESIGN
FLAME GmbH
www.hello-flame.com

Werbeatelier PUR²
www.pur2.de

Image credits: front page Shutterstock, page 6 Fotolia, rear page Fotolia

Why Torque Is Not Everything

When preload (boltload) has to be applied to a bolted joint, torque-controlled tightening is the most widespread approach. It is, however, not suitable for every bolting scenario. Maintenance-free bolted joints are hardly possible – although they are indispensable in certain industries. Which specific disadvantages does the method have, and how to resolve these issues?

There is no doubt about it: Torque-controlled tightening is the most widespread method in vehicle production, machine manufacturing, and steel construction. Its technical implementation is quite easy, making it the favorite method for many design engineers and assembly workers. Nowadays, torque-controlled tightening is probably used for most large-size bolted joints like the ones used on wind turbine applications. However, this approach is not always ideal. Because with torque-controlled tightening, friction occurs on the friction surfaces, below the nut or below the bolt head, and in the threads. But friction, described by the coefficient of friction (COF), can differ from bolt to bolt. In torque-controlled tightening, different COF values result in different preload (boltload) forces.

As a consequence, the required level of preload (boltload) on bolted joints might not be reached according to the design engineers' plans, or bolted joints might be subject to plastic deformation. Torque-controlled tightening cannot prevent this from happening. Because of varying COF values, the bolted joint's dimensions often need to be extra large. This means that the bolt is getting larger and heavier than necessary all the time – a disadvantage for service technicians who, sometimes in rough weather, have to handle unhandy sets of bolts high above the ground.

At a COF of $\mu = 0.15$, required preload (boltload) levels are not achieved, making the bolted joint extremely unreliable and causing it to fail. At a COF of $\mu = 0.07$, there is a risk of plastic deformation and thus the destruction of the joint.

No lubrication? No way!

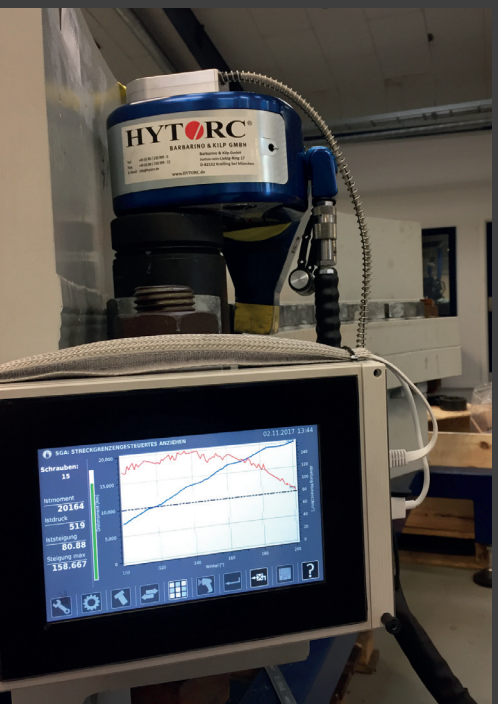
That is why in torque-controlled tightening, only between 60 and 70 % of the maximum load should be applied to the bolts to prevent them from breaking in case of higher friction. Torque-controlled tightening alone is not able to limit the number of factors of uncertainty. Requirements for torque-controlled tightening are the clearly defined lubrication of the joint and strict limits regarding the variation of the COF. As long as bolts are not to be reused and weights do not matter, the necessary use of extra-large components is irrelevant.

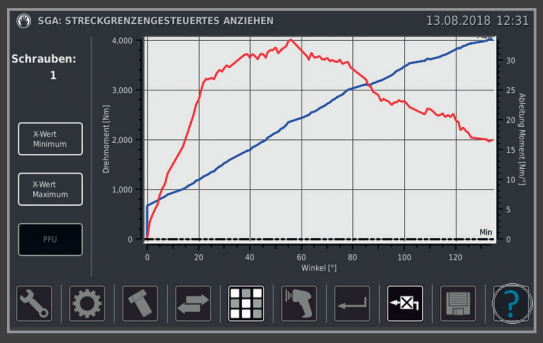
Users of a different method do not have to worry about any of this. This different method is yield point-controlled tightening. Automotive manufacturers, for example, have been using yield point-controlled tightening for decades. They are using this method, which is independent of the COF, to tighten tens of millions of bolts every day. On the following pages, you will learn more about yield point-controlled tightening and its advantages, especially regarding maintenance and related cost savings, and how it can benefit wind energy providers.

All in One –

RELIABLE BOLTING PROCESSES, LOWER COSTS, INCREASED QUALITY

In bolting, significant cost reductions are possible – and thanks to the right bolting method, bolting quality improves at the same time. Why is mobile, hydraulic yield point controlled tightening better than other methods, and which benefits does it offer in structural engineering also?





In the wind energy industry, there is a large, yet untapped potential, namely in the area of bolted joints. Tightening those with mobile bolting systems suitable for site purposes, reduces costs and increases the reliability of the bolted joint. That is exactly what mobile, hydraulic yield point-controlled tightening, a method recognized by many certifying authorities and in the German guideline VDI-2230, is able to deliver. Yield point-controlled tightening is gaining popularity in structural engineering as well.

Its higher efficiency allows engineers to design a number of wind turbine components smaller, slender and lighter, thus reducing production costs. The fact that the German Federal Ministry for Economic Affairs actively supports lightweight design underlines the importance of this topic.

For operators of wind turbines, yield point-controlled tightening has yet another benefit, which, financially speaking, might be even more important: On one hand, maintenance intervals can be extended, resulting in lower operating costs, because yield point-controlled tightening offers more preload (boltload) reserves than the torque-controlled method. Additionally, yield point-controlled tightening always adapts preload (boltload) as ideally as possible according to material characteristics and joint tolerances, without user intervention on site. Yield point-controlled tightening ensures the best bolted joint possible, without demanding too much of the technicians on site. A bolted joint that has been perfectly adapted to the right load is also less sensitive to hot, cold and moist conditions. The lubricant's reaction with moisture will change the friction factor, if an application has been assembled using a torque-controlled method in moist conditions. This is of particular relevance to offshore wind farms. There, factors such as accessibility, sea conditions, weather, and large-scale components result in service and maintenance costs accounting for up to 25 % of the overall costs.

Yield point-controlled tightening in detail

Please note: When the term "yield point" is mentioned in the context of bolting, what is really meant is the offset yield point. For technical material, usually 0.2 proof stress or elasticity limit $R_p0.2$ is mentioned instead of the yield point.
Yield point-controlled tightening uses the fact that during tightening of nut and bolt, not only axial stress, but as a result of thread friction, also torsional stress develops.
A permanent deformation of the bolt will occur, once the equivalent tensile stress of tension and torsion reaches the material's elastic limit (yield strength). Shortly after tightening, the most part of torsional stress in the bolt bounces back, thus reducing the equivalent tensile stress while maintaining the remaining preload (boltload). The application tightened beyond the elastic limit hence regains a sufficiently elastic reserve.
In yield point-controlled tightening, tensile and torsional forces make the bolt reach its individual yield point or offset yield point (in bolting, the term yield point is used to describe the offset yield point). Since torsional load disappears when the tightening process is stopped, an ideal level of preload (boltload) is achieved. In addition, independent of friction, each bolt is being tightened to its individual yield point (offset yield point).
Hydraulic reliable bolting processes based on yield point-controlled tightening can even be used on painted components with the process pump Eco2TOUCH. This method ensures a reliable process for the achievement of sufficient preload (boltload) levels, thus ensuring a distribution of forces in the paint-coated application. From the outset, the frictional connection generated in the joint prevents damages such as movement in the gap and possible failure of the application. Furthermore, the corrosion protection stays intact during tightening and loosening, provided suitable paint/coating systems are applied.
The pump records every bolting operation; this recording of data is an important factor with regard to the adherence to bolting rules and regulations, e.g. according to VDI-2862 part 2: "Minimum requirements for application of fastening systems and tools". The pump also switches off reliably before $R_p0.2$ is reached; this way, bolts never break, and can even be reused. Yield point-controlled tightening ensures that it is impossible to apply too much load to the bolted joint, because the elastic limit of all stressed components is monitored in a closed loop.

"There is no reason not to apply yield point-controlled tightening."

Dipl.Ing. (FH) Holger Junkers, CEO of JUKO Technik GmbH, about the advantages of hydraulic yield point-controlled tightening for the wind energy industry.

Q: What advantages are there in real life?
A: First of all, maintenance intervals can be extended, because yield point-controlled tightening offers more preload (boltload) reserve than the torque-controlled method. Additionally, yield point-controlled tightening always adapts preload (boltload) as ideally as possible depending on material characteristics and joint tolerances, without user intervention on site. Yield point-controlled tightening ensures the best bolted joint possible, without demanding too much from technicians on site.
Q: Does the method also work on painted components?
A: This is the major advantage of yield point-controlled tightening, because it can deal with the preconditions changed by the layers of paint. Yield point-controlled tightening is suitable for bolting such components, which has been successfully proven in real life and in the lab with different paint systems.
Q: Is there any reason not to use yield point-controlled tightening in the wind energy sector?
A: From a technological point, there is no reason at all. There might only be a regulatory reason, because yield point-controlled tightening has not yet found its way into the standards of structural engineering, which are relevant to the towers of wind turbines.
Q: When it comes to reliable bolting processes: What are the requirements for the tools?
A: From my point of view, suitable equipment, i.e. tools and corresponding pumps, is not only important, but indispensable. Only equipment developed for the use of yield point-controlled tightening can ensure a reliable bolting process. If the bolting system is able to record bolting operations, the end-user also receives reports to prove the evidence of a process-controlled bolting application, as required e.g. by VDI/VDE2862 sheet 2.
Q: Do you know of any statistics/examples which substantiates the effectiveness of a reliable bolting process?
A: Well, I don't have any specific statistics, but I know at least about one example. The operator of an offshore wind energy project had to replace all sets of bolts on the boat landings, because no reliable bolting process had been applied. The costs of this mistake added up to about 2 million Euros.

Offshore Wind Farms:

RESEARCH VS. MAINTENANCE COSTS

At offshore wind farms, bolted joints installed subsea are quite common. The current lack of standards for effective subsea bolting systems keeps resulting in high maintenance costs. A research project is determined to resolve this: Experts analyze the preload (boltload) behavior of such bolted joints. Objective: longer maintenance intervals, lower operating costs.

The Sea comes with a price tag: In case of offshore wind farms, maintenance costs account for up to 25 % of the overall costs compared with onshore wind farms, their share is in the low single digits. The reason for this is the increased level of challenges faced offshore, i.e. lack of accessibility, the weather and sea conditions. Nevertheless, regular inspections and maintenances are a must, as the breakdown of a turbine would be even more expensive than its maintenance.

These extreme conditions do not only make maintenance more difficult. Since salt water is taking its toll, maintenance is required more often than on onshore wind farms. Additionally, preload (boltload) applied during tightening of different types of bolts, e.g. on boat landing structures, often do not match the engineers' specifications. The cause for this is the thickness of painted coatings on flanges. It usually measures more than 600 micrometers according to DIN EN ISO 12944, which describes the application of painted coatings for offshore structures located in tidal zones and permanently immersed areas.

Although painted coatings do protect components, it also changes a joint's preload (boltload) behavior at the same time. Coating systems suitable for maritime steel structures are mainly based on epoxy resin or polyurethane, and a coating thickness of about 350 micrometers already causes preload (boltload) losses of more than 25 %.

However, the preload (boltload) behavior of subsea bolted joints over time, and the frictional forces involved are yet unknown.

Consequently, established findings on subsea bolting applications are very much required. Hence, a verifiable and tested bolting method for subsea applications can significantly reduce costs for maintenance on bolt applications in exposed locations.

As a result, the Fraunhofer Research Institution for Large-Scale Structures in Production Engineering (Fh-E) in Rostock, Germany, and the Technical University in Dresden (TUD), Germany, have joined forces to develop the necessary basics for reliable subsea bolting within the framework of a two-year research project. Both institutions are supported by several companies, including HYTORC. The bolting experts supply the tools required for the project, namely the Eco2TOUCH process pump, the Avanti-3 and Avanti-5 hydraulic square drive wrenches, both with angle sensors, anti-rotation washers (zWasher and Backup Washer M27 and M36), as well as other hydraulic bolting equipment. HYTORC will utilize the findings of the bolt tests to successfully develop specific solutions for the growing offshore wind industry, with a special focus on the area of subsea bolting. The research project allows service providers to ensure that bolted joints meet the maintenance instructions and the high quality standards, as well as being able to replace fasteners with safety-optimized bolt assemblies, if necessary. Owners of offshore wind farms will most probably be the ones who feel the largest benefit: Increased bolting precision will enable them to extend maintenance intervals, thus significantly optimizing the wind turbine's economic efficiency.

How Maintenance Can Reduce Costs

Wind turbine operators are always on the lookout for opportunities to reduce their wind farms' costs. So, it is only natural for them to be looking at maintenance costs – after all, those can account for up to 25 percent of the total costs. And it is indeed possible to lower these costs without cutting back on safety. The solution are smart bolting systems.

Depending on the manufacturer, maintenance intervals of wind turbines vary. But in almost every wind turbine, a comprehensive check of all bolted joints is due 300 - 500 operating hours after commissioning of the wind turbine. After that, maintenance work is necessary every 12 or 24 months, depending on type certification. When checking, inspection experts look at approximately ten percent of all bolted joints (on average). But: "In case a bolt can be turned further than specified by the manufacturer, every single bolt at this flange has to be checked", says Mario Dall. He is the Head of Global Service at RoSch Industrieservice, involved in wind turbine maintenance every day.

The required maintenance effort varies greatly, as Mario Dall points out: "For some types of turbines, bolted joint maintenance takes 120 man-hours. For other turbines, every single one of the 2,500 bolted joints on the tower, the nacelle, or the hub has to be checked; that will already take about 180 man-hours", explains Mario Dall. Bolt size is a challenge here: Type M72 bolted joints are not uncommon. One set comprising bolt, nut, and washer weighs more than 25 kilograms. This also requires high-performance hydraulic tools. "You need a tightening torque of at least 15,000 newton meters, that's for sure", says Mario Dall.

As bolted joints on turbines keep increasing in size, the required maintenance equipment keeps getting larger, too. Some pieces of equipment have become so unhandy they need to be operated by two technicians at the same time. It would be possible to make technicians' jobs easier, if turbine developers relied on the yield point-controlled method for tightening and loosening. Yield point controlled tightening significantly improves bolt loads, thus allowing for smaller joints, which can also be fitted in a more maintenance-friendly position. According to Dierk Kampschulte, Global Project Manager Wind at RoSch Industrieservice, yield point-controlled tightening is "the ideal torque-based method to achieve a reliable bolted joint". Based on his experience, especially the graphic illustration on the display of the Eco2TOUCH hydraulic pump has proven to be very beneficial in real life.

Higher bolt joint reliability could mean longer maintenance intervals – which in turn can lower maintenance costs either directly, or indirectly. With yield point-controlled tightening, the odds of a spot check turning into a check of the entire tower are lowered significantly. What's more, according to Mario Dall, service-friendly design by engineers makes it possible to reduce the number of man-hours required per maintenance.

All that makes yield point-controlled tightening the ideal solution for wind turbines. Because right now, wind energy providers are trying to reduce operating costs to a minimum until, 20 years after its commissioning, the facility no longer receives feed-in tariffs based on the German Renewable Energies Act (EEG). That is why the assessment of a facility's economic efficiency needs to include extremely uncomplicated and budget-friendly maintenance services.

RoSch Industrieservice GmbH was founded in Lingen (Ems), Germany, in 2008, and has grown into one of the highest performing certified wind energy service providers in record time. The company's service portfolio includes maintenance, repairs, assembly and design of wind turbines, and more. All service and maintenance work is carried out according to the manufacturer's maintenance specifications; once the job is done, clients receive documentation certified acc. to DIN EN ISO 9001 on the maintenance and repair work performed. All services of RoSch Industrieservice are available in both on- and offshore settings. In preparation for future growth, RoSch Industrieservice GmbH joined ROBUR Industry Service Group GmbH as an independent service provider in April 2017. ROBUR Group is the 14th largest company for industrial services in Germany.
To enter new markets around the globe and to invest in future site developments, the partners within the group collaborate to exploit synergies, offer combined service and maintenance concepts, and make use of both innovative technologies and a comprehensive service portfolio.

A True One-Stop Shop

The continuous presentation of new bolting innovations has been an integral part of Hytorc's motivation for 50 years now. To us, occupational safety is as important as high-quality tools further improving bolting results all the time. We are only successful because we consider every bolted connection as a whole, offering a large portfolio of products – for almost every challenge.