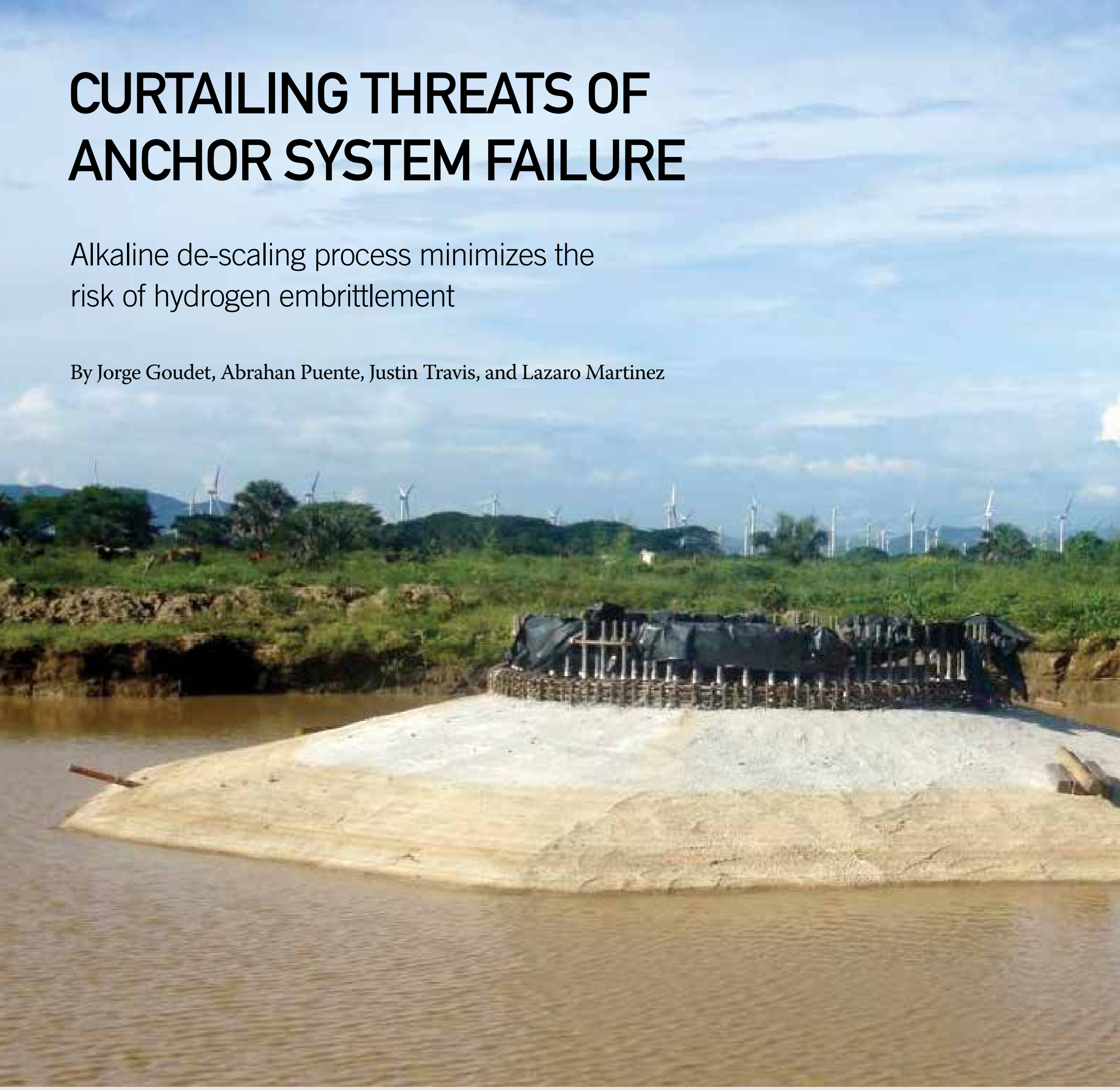

CURTAILING THREATS OF ANCHOR SYSTEM FAILURE

Alkaline de-scaling process minimizes the risk of hydrogen embrittlement

By Jorge Goudet, Abrahan Puente, Justin Travis, and Lazaro Martinez

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IT IS NO SURPRISE THAT A COMMON GOAL amongst the wind industry's participants is to lower the total cost of ownership associated with developing wind farms without sacrificing on HSE. One way that companies can achieve this goal is by consistently seeking ways to adopt best business practices and by thinking outside of the box.

Auge Industrial Fasteners has a commitment to safety and innovation. One way in which it demonstrates this is through the integration of R&D and customer collaboration, or concurrent engineering.

To help illustrate this point, this article focuses on the significance of removing entrapped hydrogen from steel and how Auge, in collaboration with a customer, sought an innovative approach to minimize the risk of hydrogen embrittlement without cutting back on quality or safety.

In seismic regions around the world, hardened high-tensile strength anchoring systems are required (See figure 1.), which must be at a minimum 1040 Mpa (Reference ISO 898-1).

To make such materials comply with this value of resistance, its hardness is usually located above 35 HRC, as these are thermally treated by means of quenching and tempering. The original equipment manufacturers of wind turbines have established as a

requirement the avoidance of the natural phenomenon of corrosion by means of hot dip galvanization.

The process of hot-dip galvanizing typically consists of three steps per the American Galvanizers Association, including surface preparation, galvanizing, and inspection. During the surface preparation step, the steel material is introduced to acidic solutions like sulfuric acid or hydrochloric acid as a method for the removal of surface impurities and oxides.

The problem arises when coating a high-strength hardened alloy material by means of the hot-dip galvanization process. During this first step, there is a high probability of a phenomenon known as "Environmental Hydrogen Embrittlement" occurring because of the material coming in contact with the acid medium.

Environmental Hydrogen Embrittlement results from hydrogen being absorbed by solid metals. When hydrogen diffuses along the grain boundaries the hydrogen atoms are absorbed into the metal lattice and diffused through the grains, tending to gather at inclusions or other lattice defects.

Disassociated hydrogen ions take up very little space, but when the hydrogen ions combine to form hydrogen molecules (H2) they take up tens of thousands of times more space.

This applies stress on a granular level and may cause cracks to form, thus causing the part to fail when additional outside stress is applied during use. Also, this usually results in a loss of ductility or load carrying capacity, which may cause catastrophic brittle failures at applied stresses well below the yield strength. Failures occurring in service are serious and may be very costly.

Figures 2 and 3 show hydrogen embrittlement introduced during the galvanizing process.

For hydrogen to impose damage to steel, it must be in the atomic form. Being that hydrogen has the smallest atomic mass, it can enter the molecular structure of the steel. This is not true when two hydrogen atoms combine to form a stable H2 molecule. Hydrogen in the molecular form is too dense to penetrate the steel structure.

Because hydrogen is exceptionally mobile, it quickly penetrates into any recently formed cracks, lesions, or material surface discontinuities, and creates high stress areas within the steel structure.

When embrittlement failures do occur, they often drastically increase the costs and lead times associated with the development of a project.

In order to prevent this phenomenon, it is very common to use alternative methods of cleaning such as sand blasting or air blasting instead of using acid solutions. Also, it may be recommended

CRITICAL NATURE OF WIND TURBINE BOLTED JOINTS PRESENTS THE NEED FOR COMPETENCY TRAINING FOR WIND ENERGY PERSONNEL

By David Lay

It has been said that those who do not learn from the mistakes of the past are doomed to repeat them. Yet in an industry where geometric growth and relentless technological innovation are the norm, there has been little time to develop a reliable and useful "institutional memory."

Nowhere is this more apparent than in the human factors area where often the most senior mechanical installation personnel may have less than a year's on-the-job experience and may be faced with assembling new turbine models with almost every installation.

To address this experience gap the wind industry must invest in effective competency training programs for craftspeople which transfer accumulated experience, impart new knowledge and set a standard for safety and performance.

Competency training requires more than exposure to abstract knowledge tested through written examinations or rote memorization of procedures. Competence is the ability to successfully apply knowledge and to demonstrate one's capabilities by doing, not just knowing. Moreover, it implies performance to meet a generally accepted standard.

We take for granted that a welder must be certified before he is allowed to lay a bead. The same is true of electricians, crane operators, and even the drivers of heavy goods vehicles who deliver to our sites.

But for many of the crafts no clear performance standards have been set, and little or no formal instruction is required. One example is the skill of bolted joint assembly. There are nearly a thousand critical bolts in the average wind tower and turbine, the failure of any one of which could potentially cascade into a catastrophic system failure. Great efforts are made to check and recheck the tightness of bolted joints at pre-determined intervals at great expense in time and money, yet little or no attention has been given to pre-qualification of bolting personnel and procedures to avoid the loosening of critical joints in the first place.

Other industries have begun to take up this challenge. The bolting of pressure vessels common to power plants, pipelines, and oil and chemical refineries is now done subject to strict "best practices" guidelines such as those published by ASME and by CEN (the European Committee on Standardization) both of which are in the process of issuing training and testing standards personnel involved in bolting pressure joints. In the structural bolting field clear guidelines and procedures govern every aspect of joint assembly in bridges and buildings but no clear standards have been set and no specific curricula has been adopted by the wind industry.

Most of the incoming mechanical workers who will be needed to staff the continued growth of the wind power industry will have to come from trade and technical school programs specifically targeted to the skills necessary in the wind industry. One of the pioneering education programs that early-on realized the need for measurable standards in wind technician education is presented by Airstreams Renewables, Inc., headquartered in Tehachapi, Calif. Mike Messier, vice-president of training describes his course as "sound classroom instruction paired with hands-on practice on real-world equipment." Similar high-quality programs are now underway at a growing number of colleges and trade schools across the U.S. and internationally.

We applaud these efforts and urge manufacturers, erection and maintenance contractors, and the academic community to collaborate and develop workable education and qualification standards to ensure the future safety and security of the wind industry and to make sure that the lessons so dearly learned are not lost or left to be relearned by each new generation.

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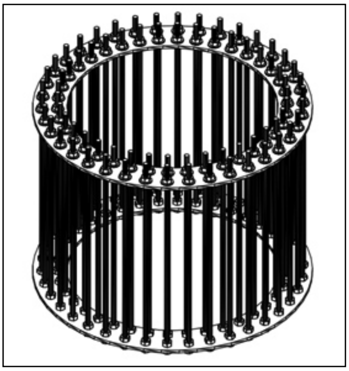

Figure 1: Foundation for wind turbines.

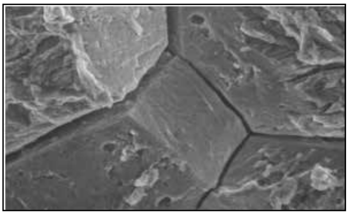

Figure 2: Hydrogen embrittlement introduced during the galvanizing process.

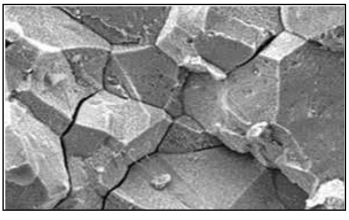

Figure 3: Embrittlement of steel microstructure due to exposure to hydrogen.

to use post-backing for dehydrogenization.

To ensure risk reduction, Auge Industrial Fasteners has developed an alternative cleaning method consisting of an alkaline de-scaling process. The results are in full compliance with ASTM A153 and EN 10684 (thickness, adhesion test, etc.). Upon completion of laboratory testing and customer approval, Auge now applies hot-dip galvanized anchoring systems safely, through a process free of acidic solutions. This process achieves the reduction of cost and lead time by reducing the need for baking the steel.

This alkaline cleansing process, known as Auge Rhino™, is one example of how Auge can create secure and innovative solutions that benefit the customer's bottom line, security, and industry. Since 1965, Auge Industrial Fasteners has been recognized as a leading manufacturer and distributor of a wide variety of commercial, specialty, and exotic alloy fasteners, and specialty machine parts. Auge's 150,000 sq. ft. state-of-the-art manufacturing facility near Mexico City has a large capacity to produce specialty fasteners tailored to the customer's unique specifications and drawings. The plant is a fully integrated turnkey operation. Every process is performed under the same roof, from the stocking of the raw steel (foreign and domestic), to the in-house heat treatment, to the coating/plating (if applicable).