HYDRAULIC NUTS (HYDRANUTS) FOR CRITICAL BOLTED JOINTS

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Abstract

HydraNuts replace the original nut and torquing equipment, combining the two functions into one system. Designed for simple installation and operation, HydraNuts are fitted to the stud bolts. Once all HydraNuts are fitted to the application, flexible hydraulic hoses are connected, forming a closed loop hydraulic harness, allowing simultaneous pressurization of all HydraNuts. Hydraulic pressure is obtained by the use of a pumping unit and the resultant load generated is transferred to the studs and flange closure is obtained. Locking rings are rotated into place, supporting the tensioned load mechanically after hydraulic pressure is released. The hose harness is removed.

1. Introduction

The use of basic tightening techniques such as hydraulic torquing, heating and torquing or simply hammer wrenching for bolted joints can lead to galling, uncontrolled fastener preloads and a compromise of safety. None of the resultant factors are desired and generally lead to rework, injury and increased maintenance durations. Hydraulic tensioning, as opposed to hydraulic torquing, has greatly improved the accuracy for preloads and also reduced the risks associated with fastener damage and personal injury during the tightening or unloading phases of fasteners.

Traditional tensioners, which are essentially a hydraulic tool that stretches the fastener, although an improvement, also have limitations. Repetitive operations of installing and removing the tool for numerous fasteners on a joint, can lead to extended tightening sequences, bolt load scatter and worker fatigue, albeit reduced from that of torquing sequences. This paper will detail the use of HydraNuts on controlled bolting applications, maximizing all the benefits of tensioners, and eliminating all the traditional negative factors associated with torquing or tensioning.

2. Hydraulic Nut Assembly

The hydraulic nut as an assembly is fairly simplistic with minimal moving parts and only four load bearing components. The hydraulic nut acts as a tensioner during the hydraulic pre loading of the fastener, but then acts as a mechanical nut for the load re-tension. Essentially the Hydraulic nut is a tensioner and traditional mechanical nut combined into one unit and is fitted to the fastener as a replacement to the traditional hex nut or any other nut type currently installed.

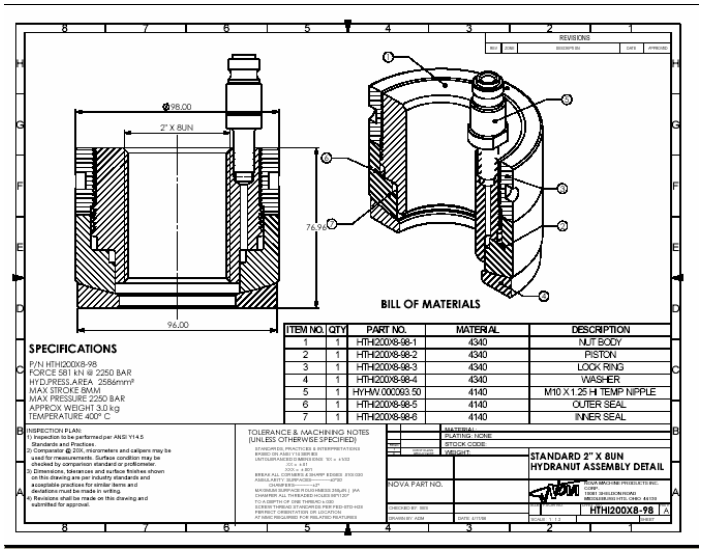

Figure 1 – Typical Hydraulic Nut assembly

2.1. **Nut Body -** Interface component between the existing stud and the Hydraulic Nut. The internal threaded portion of the Nut Body uses the same thread form as that found on the stud, but the external threaded portion utilizes the same patented thread form as that on the Lock Ring to minimize thread deflection and minimal loss of pre load.

2.2. **Piston -** This component makes up the pressure chamber in conjunction with the Nut Body to generate the pre load under pressurization. During operating conditions the Piston supports the Lock Ring and the load passes vertically down through it.

2.3. **Lock ring** - Component used to retain the applied load on the Nut Body and acts down through the Piston. The superior and patented thread form minimizes thread deflection between the Nut Body and Lock Ring, thus maximizes retained load, enabling a lower pre-load to be used.

2.4. **Spherical washer** – Used to transfers all pre-load (pressurization) and retained load generated by the Hydraulic nut down to the contact area of the equipment. It also allows the Hydraulic nut to align itself perpendicularly with the stud.

2.5. **High temperature male nipple –** Allows for hydraulic fluid to enter into the hydraulic nut and produce hydraulic pre load within the assembly and fastener.

2.6. **High temperature seals -** The patented seal design that we use in our HydraNuts is fundamentally different to all other types. Due to the nature of the design, the seal is allowed to expand and deflect with the walls of the piston and rams, thus keeping contact and sealing abilities at all times.

The seals are made as separate items and do not need to be manufactured as an integral part of the Nut, allowing appropriate and best material selection to take place.

3. Operation

3.1. Installation – Place the spherical washer over the stud and onto the flange face. Hand tighten the hydraulic nut onto the stud until it comes into contact with the spherical washer.

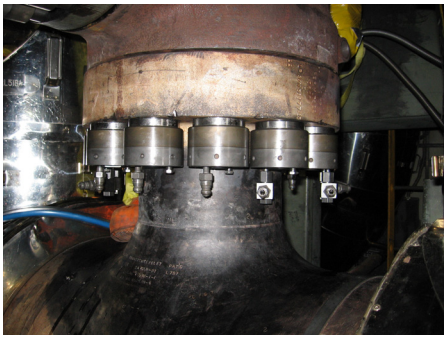

Figure 2: Hand tighten onto stud

3.2. Connect a hydraulic hose to each hydraulic nut allowing for 100% tightening solution.

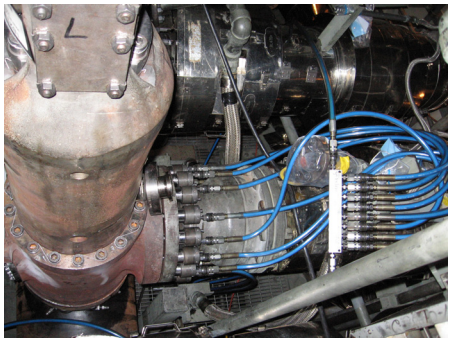

Figure 3: Connection of hoses

3.3. Connect a hydraulic link hose from the hose assembly at the HydraNuts to a single hydraulic pumping unit.

Figure 4: Connection to pumping unit

3.4. Pressure the hydraulic system with the pumping unit to a pre-determined hydraulic pressure. The hydraulic pressure acting upon a known surface area results in direct force being generated within the hydraulic nut.

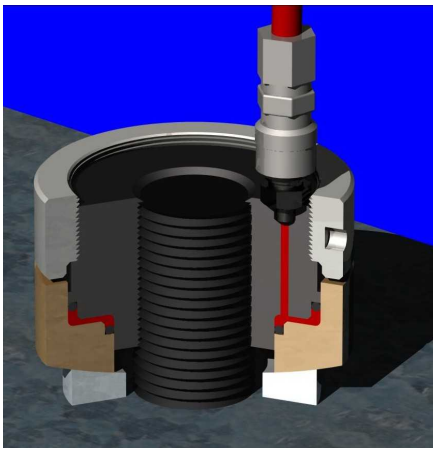

Figure 5: Resultant pre load stretches the stud and compresses the flange

3.5. The force generated by the hydraulic fluid acting upon the surface area, separates the Nut body and Piston and creates a gap between the Piston and the Lock ring. The gap is equal to the amount of stretch produced in the stud and the complete compression of the gasket and flange.

3.6. Rotation of the Lock ring down its thread, so that it contacts the top of the Piston, will ensure that mechanical load is retained after the release of hydraulic pressure.

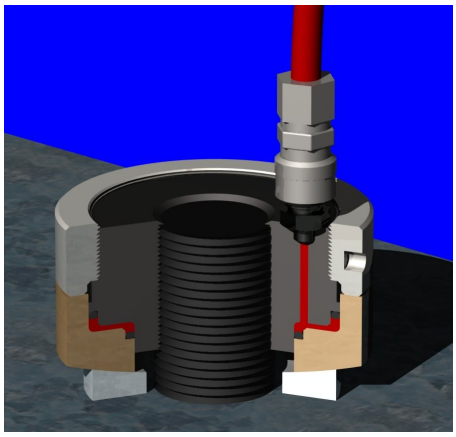

Figure 6: Rotation of Lock ring onto Piston top surface

3.7. Removal of the hydraulic hoses can take place after de-pressurization. The hydraulic nut is now in a state of mechanical load retention and will perform in a function like any other conventional nut.

4. System installations and field trials

There are some 4,500 HydraNuts now installed in North American, Swedish and Korean nuclear facilities. The first installation into a North American plant was completed in 2003 on high pressure steam valves, with multiple removals and installations being completed subsequently. The HydraNuts can be manufactured under ASME Code Section III requirements and installed into safety related applications, with the first reactor vessel head application being completed in 2006. Extensive testing has indicated that seal life is exceptional with some 200 cycles being completed before renewal of the seal was necessary. In relative terms this would equate to a life in excess of 100 outages. Heat and radiation exposure has little to no impact on the hydraulic nut function and performance, based upon the material selection for the load bearing components and the fact that the seals are metallic, therefore experiencing no degradation.

5. Applications and installation timings

Typical applications for the HydraNuts are:

- Steam valves
- Heat exchangers
- Steam generator manways
- Bearing pedestals
- Reactor coolant or re-circulating pumps
- Reactor vessel main flange (PWR and BWR)

Installation times for the HydraNuts have been measured in minutes compared to hours for traditional tightening systems. A typical steam valve flange (12 x 1 3/8" studs) can be tensioned with HydraNuts in as little as 4 minutes, including the fitting of the HydraNuts, hoses, pressurization and hose removal. Steam generator manway (20 x 2 ½" studs) closures have been completed in 21 minutes, compared to best achievable times of 2 ¼ hours using multi-stud tensioners.

The speed of the system is due to the fact that only one component must be fitted to the stud – the hydraulic nut assembly. All HydraNuts can be connected in series or parallel, allowing them to be pressurized simultaneously and eliminating traditional torque or tensioning patterns. Comparing the fitting of the HydraNuts to any other tightening device, illustrates its simplicity and speed, and it has been demonstrated to be the fastest and safest way to close a bolted joint.

6. Benefits

Benefits are many, but traditionally the focused ones are:

6.1. **Time savings** – leading to reduced maintenance times and dose reduction
6.2. **Elimination of galling** – the function of the hydraulic nut removes the factors that lead to galling.

6.3. **Even load generation** – the application of bolt load to all fasteners simultaneously is the ultimate for maximizing gasket effectiveness and joint integrity.
6.4. **Safety** – HydraNuts eliminate pinch points, remove the hazards of heavy tooling and reduce worker fatigue.

7. Conclusion

Joints that have traditionally been torque tightened due to the fact that tensioners or improved bolting techniques could not be applied are now able to be tensioned using the HydraNuts and significant improvements can now be made. Whether the flange is on an existing piece of equipment or is a new component, HydraNuts will maximize its performance and reduce the possibilities of rework, saving both time and money.

HydraNuts that have been installed into the industry have generated cost savings, time and dose reductions, reduced flange leakage and maximized the effectiveness of the bolted joint. Ease of use and reliability through its simplicity ensure that adoption of the technology into an industry that is typically reluctant to change will provide benefits for many users, without compromise to the plant.