Addax Composite Cooling Tower Couplings | Operation Manual

Equipment Installation Maintenance

REXNORD

A–EQUIPMENT – COMPONENTS SUPPLIED

A-1 – General

1. The Addax® coupling is a quality product that has been supplied to the cooling tower industry for over 20 years. When properly handled, installed and maintained, your coupling will provide many years of satisfactory service. To maintain this quality and level of service, follow the recommendations in this Manual.
2. We recommended that anyone designing cooling towers or their components be very familiar with the Standards of the Cooling Technology Institute. Any questions regarding the CTI or its functional usage in industry can be found at www.cti.org. Chapter 9 of these Standards covers Materials and Chapter 10 includes all of the Mechanical Equipment. A wealth of other technical publications and papers cover additional details of cooling tower operation and maintenance.
3. Warranty information can be found at www.rexnord.com.

A-2 Hubs

The Addax coupling hubs are made from a casting equivalent of 316 stainless steel CF8M. These hubs are precision machined, bored and keyed. An interference hub fit is not conducive to the Addax coupling design because it does not allow the elements to be axially aligned. Rexnord/Addax can not offer a warranty for a coupling that is not angularly and axially aligned properly. Therefore it is necessary to have keyed shafts on each end for the Addax coupling installation.

A-3 Elements

The Addax flexible elements are a patented design fabricated from advanced composite materials and 316 stainless steel bushings. This element was developed to withstand the harsh conditions and high misalignment conditions in cooling towers. The element is encapsulated in urethane for ease of handling, appearance and to prevent fretting and corrosion found in metal disc designs. The mechanical properties of continuous fiber provides high misalignment capacity and long service life.

US Patent number 6905416

A-4 Spacer

The spacer also called the spool or center section includes a filament wound tube and a flange bonded in each end. It is designed to span the distance from the motor to the gear reducer in a single span without needing a center support bearing. The bond joint consists of a proprietary method of connecting the tube to the flanges. Aerospace adhesive is used to bond the flange inside the tube. This method has been designed and tested over the years to provide 100 percent reliability in the design. Rexnord has achieved 6-Sigma quality in the integrity of this bond joint, therefore it is not required to test each shaft prior to shipment. This bond exceeds the strength of the substrate material and provides a minimum safety factor of 5 times rated torque.

A-4a Flange

This is a patented device that is a key design feature of the drive shaft.

US Patent No. 5724715.

The Addax coupling flange is an integral component of the Addax coupling. This patented component transfers torque from the flexible element to the long span composite tube. It is a low-mass, all composite structure fabricated from continuous fiber material. There is no metal in it at all. The fiber angle path has been optimized for carrying torque and minimizing stress through the flange. This design offers supreme fatigue strength for cooling tower operation. It also offers extraordinary corrosion resistance in a chlorine rich cooling tower environment.

One of the design features is a high fiber volume composite reinforcing ring designed integral into the flange area. This ring provides additional strength and stiffness in the bolt joint area. This strength in the flange provides the highest integrity for the bolt circle attaching and centering the flexible element.

Other manufacturers fabricate this flange from random fiber glass and do not have the fatigue strength of the Addax coupling flange. A random fiber flange does not have the reinforcing ring and are prone to fatigue failure in the grueling cooling tower duty. The Addax coupling flange is continuous fiber and fatigue tested to demonstrate superior strength.

A-4b Tube

The tube is filament wound with carbon fiber or E-glass fiber and epoxy resin matrix. The resin is a corrosion and impact resistant epoxy thermoset polymer. Carbon black is added to the resin system for additional protection from ultraviolet light exposure. Coefficient of thermal expansion on the Addax tubes are as follows:

Carbon Tube

Longitudinal	0.1 ppm/deg F
Hoop	3.2 ppm/deg F

Hybrid Tube

Longitudinal	0.9 ppm/deg F
Hoop	6.5 ppm/deg F

The longitudinal thermal expansion factors are small compared to steel drive shafts. Lower CTE's result in lower growth compared to a metal shaft.

A-4c Carbon Fiber

The properties of carbon fiber make it possible to span the distance between a motor and gear reducer in a single piece shaft without a bearing support. The Addax carbon fiber shaft is filament wound with a proprietary carbon fiber. The fiber properties include a fiber tensile strength exceeding 650 ksi (4.5 GPa) and a fiber tensile modulus exceeding 33 msi (225 GPa). These are minimum properties that are required to maintain exceptional quality for the coupling.

A-5 Hardware

All Addax® drive shafts are supplied with 316 stainless steel hardware as standard offering. Each component, including overload bushings, nuts, bolts and washers, is stainless. K-500 Monel bolts are also available for severe duty applications upon request.

The following are coupling bolt torque requirements:

Coupling Size	Torque
850	45 ft lb (60 N-m)
650	33 ft lb (45 N-m)
485	20 ft lb (27 N-m)
450	12 ft lb (16 N-m)
375	33 ft lb (45 N-m)
350	33 ft lb (45 N-m)

Rexnord Industries follows the direction published by the Cooling Technology Institute (CTI) Chapter 9 entitled "Materials of Construction for Cooling Towers". This section recommends the usage of 300 series stainless steels due to the elevated chloride concentration levels in cooling process water.

Corrosion caused by high chlorine concentrations is minimized by the usage of high Molybdenum content 300 series stainless steel alloys. Reference CTI technical paper (TP-263A) entitled "Cooling Tower Hardware Corrosion Studies".

Chapter 10 of the CTI Standards identifies Stainless alloys, 316 and K500 Monel as metallic materials to be used in the drive shaft and couplings. Non metallic materials allowed by CTI are advanced composite materials also offered by Rexnord Industries. It is recommended that anyone designing cooling towers or their components be very familiar with this section.

A-6 Coupling Accessories

1. Backstop - This device bolts to the back side of the coupling hub. Its function is to prevent backward fan rotation usually caused by backdraft and wind conditions during nonoperational times.
2. Brake Disc -- This device is mounded on the coupling hub. Its function while used with a brake caliper is to prevent fan rotation in either direction when the brake is engaged.

A-7 Storage

It is recommended to store the Addax coupling in the shipping container. For extended periods, store it horizontally and preferably up on a rack off the ground to prevent accidental damage from adjacent containers or equipment. Never stack anything on top of the coupling or the shipping container with the coupling inside.

B INSTALLATION AND OPERATION

B-1 Receiving

The Addax coupling is manufactured to the highest level of quality using Lean Manufacturing and Six Sigma practices instilled throughout every component in the manufacturing and assembly process. The Addax coupling is shipped assembled in an impact resistant and robust container. Disassembly of the coupling hardware will be required prior to installation.

B-2 Handling

The Addax® Composite Coupling is very durable and will provide years of service if handled properly. Minor scuffs and surface abrasions on the spacer will not affect the performance of the coupling.

Soft spots caused by heavy impact, cuts or gouges are areas of concern. Any time a soft spot is seen; the coupling should be removed from service and replaced.

The flexible element should be inspected periodically, or after a high torque or misalignment event. If there are protrusions (bumps) on the surface of the flex element, it should be removed from service.

B-3 Safety precautions

Because of the possible danger to person(s) or property from accidents which may result from improper use or installation of products, it is extremely important to follow the proper selection, installation, maintenance and operational procedures. All rotating power transmission products are potentially dangerous and can cause serious injury. They must be properly guarded in compliance with OSHA, A.N.S.I. and any other local standards for the speeds and applications in which they are used. It is the responsibility of the user to provide proper guarding.

Rexnord recommends proper guarding outside the stack to cover the coupling as well as antiflail guards inside the stack on both the gear and motor ends. Rexnord also recommends that no one enter the stack unless the motor is locked out and the fan is mechanically stopped to prevent rotation.

B-4 Installation

It is recommended to carefully follow the Addax installation instructions that are supplied with each coupling. If you do not have these instructions, please call the Rexnord phone number listed below for an immediate copy. These instructions also include alignment instructions that must be followed to guarantee long term coupling life.

B-5 Alignment

Addax couplings are rated for 1° of misalignment per end. However for maximum service life, we specify initial alignment to less than 1/3°. This allows for some thermal growth movement during operation and to not exceed 1° total during operation.

Rexnord offers a very simple alignment tool that mounts on the coupling hubs. Details are outlined in the Addax® coupling installation instructions.

Following the alignment process, it is very important to properly bolt down the gearbox following CTI Std 111.

B-6 Hub Fits

The Addax hubs are designed and manufactured to be slight slip fit to the shaft. Interference fit hubs are not recommended and will inhibit the alignment capability of the coupling assembly.

During installation, if the hubs do not slide on the shaft, it is recommended to slightly dress the shaft, key or the hub bores. To do this, it is also recommended to use a file or emery cloth on the shaft. Hub bores can be opened up slightly using a flapper wheel on a drill. A non-seize type lubricant should be used on the shafts to facilitate removal in the future.

Do not use hammers for installation or removal as this could damage the hubs.

B-7 Catenary deflection

A beam's static deflection from its own weight is called its catenary deflection. Catenary deflection is nearly zero for these shafts because of the extremely high stiffness to weight ratio. This ratio is approximately 5x larger than that of steel. The worst case Addax coupling has a catenary deflection less than .005 inch (0.1 mm) at its maximum length.

B-8 Hot and Cold Conditions

Maximum temperature is 180 F (82 deg C) continuous and 210 F (99 deg C) intermittent.

The austenitic stainless steel and composite materials are all qualified to operate at cold ambient temperatures as low as -50º C.

CAUTION: In a wet cooling environment any water exposed at -50º C will very quickly change to ice. Ice contact or adhesion may result in abrasion, wear, imbalance and eventual damage to the Addax Coupling. Ice jamming between coupling components and wedging between adjacent cooling tower components may also cause damage.

B-9 Stress Corrosion in Chlorine Rich Environment

Alloy 316 stainless steel has excellent corrosion resistance properties. Rexnord is aware that high levels of chlorine could cause stress corrosion cracking in highly stressed stainless steel components. Stress corrosion cracking has never been a problem for Addax coupling components. This phenomenon is more common in highly stressed components in atmospheres over 50 deg C. If our customers are concerned about stress corrosion cracking, we do offer K-500 monel which is a nickel alloy. We are not concerned about the stainless steel hubs due to the modest stress level observed in a cooling tower fan

drive.

B-10 Shaft natural frequency

Lateral Natural Frequency (LNF) relates to beam stiffness and mass of the composite coupling. All beams have a natural frequency. The Addax® driveshaft is a long slender beam that has a LNF commonly referred to as critical speed. Critical speed of the shaft is calculated in the Rexnord Addax Selection Program, SelectC 2007 and supplied to our customers. Blade pass frequency (BPF) is the number of blades multiplied by the fan speed. The fan blades induce a forcing frequency caused by pressure pulsations on adjacent components in a cooling tower.

A vibration may occur if the drive shaft's natural frequency coincides with the fan blade pass frequency. Shaft natural frequency and blade pass frequency must be 8% away to be sure there is no overlap. Blade pass vibration is caused by pressure pulsations on the drive shaft when the drive shaft natural frequency is coincident with the fan blade pass frequency. When the drive shaft is experiencing a blade pass harmonic, sometimes it can be seen bouncing out of plane. This shaft vibration usually manifests itself in the motor and gearbox. Properly designed Addax shafts exhibit minimal vibration contribution to the overall spectrum.

The Cooling Technology Institute (CTI) recommends a 1.3 factor - critical speed over operating speed. The 1.3 factor was established prior to composite shafts when only steel drive shafts were used. Steel shafting is massive, deflects from thermal growth, less predictable and potentially dangerous when approaching critical speed. Composite shafts are less than 1/3 the mass of a steel and dimensionally stable. As composite shafts offer 1/3 less mass the deflection magnitude is significantly less than steel and safe when approaching critical speed. Rigorous testing has proven that a 1.3 margin is not required for composite shafting and a 1.15 margin is adequate. Excess safety margin translates to unnecessary cost to our customers. Each Addax shaft model has been tested and validated for minimal LNF variability. Testing must be completed using an accelerometer and modal test set-up properly calibrated. Drive shaft testing must be conducted as a coupling assembly including flexible elements with hubs mounted rigidly in massive structure to simulate cooling tower installation. LNF verification must be conducted in a cooling tower to substantiate laboratory results. Other composite shaft manufactures may not have the capability to physically test and define their actual LNF. Caution should be exercised when applying a 1.15 safety factor when purchasing composite shafts from these manufacturers.

B-11 Programming Out Range if you have VFD

All long shafts have a natural frequency; if it is composite or steel. Because a VFD has an infinite operating range between zero and full speed, you will always have this concern with any shaft. If there is another shaft manufacturer claiming this is no problem then they are not aware of this potential problem.

Rexnord recommends locking out a ±8% range as a precaution to prevent vibration. In the past, it has not been a problem for our customers to program the controller to lock out a particular frequency. This is a rather small range that the motor will "jump over" when ramping up to full speed or back down. Dwelling on this speed could cause vibration to build-up.

C. MAINTENANCE

C-1 General

Your Addax® coupling is designed for long, trouble-free performance. The coupling spacer has been dynamically balanced to meet AGMA 515.02 and ISO 1940 minimum requirements. To insure long life and trouble free service, routine maintenance and inspection should be observed.

C-2 Element swap-out

Upon initial installation and alignment, check after several hours of operation to see if anything has moved. Check alignment and flexible elements at least every year as part of a PM program. Replace flex elements and bolts every 5 years. The elements and bolts are the fatiguing components of the coupling and should be replaced on a preventative maintenance (PM) program.

Disassembly – Element swap-out is a very easy operation. Starting at one end of the coupling, remove the nuts, bolts and hardware. The flexible element should slide out without moving the hub. Slide the replacement element back in place aligned with the coupling bolt holes and reinstall the hardware according to the installation instructions. Repeat this operation for the other end of the coupling.

C–3 Hub Boring and Reboring

All Addax® hubs are bored concentric to the bolt hole pattern. Chucking onto the barrel or the flange is not an accurate method of machining the bore concentric to the bolt pattern. Reboring a hub requires a tool fixture that attaches to the bolt circle. Any hub not machined to Rexnord specifications will not fall under warranty.

C-4 Balance

Only the coupling spacer is balanced. Tight tolerance manufacturing on the hubs do not warrant hub balancing. In field balancing is rarely required as the shafts come from the factory already balanced. In the event, an in-field balance is required, call the factory for recommendations on how to add weight.

We balance the shaft using a 2-plane balance procedure for long shafts according to AGMA 515.02 per Cooling Technology Institute requirements. Balanced weights will be attached to the shafts in 2 locations (i.e. 2-plane) on each shaft. The hubs and flexible elements are not required in the balance procedure and are therefore not included. The hubs are precision machined, the flexible elements are precision molded and when operating at 1780 and 1480 rpm do not accumulate enough residual imbalance to merit balancing individually or as an assembly.

The couplings will be very well balanced. The balance certificate supplied shows that the drive shafts were all within balance tolerance before they shipped from the Addax factory. In addition, the drive shaft is made from carbon fiber composite which is an extremely low mass and stable material. Imbalance is very rarely a problem for these shafts.

C-5 Alignment

After initial installation, recheck alignment after several hours of operation to verify nothing has moved. Check again yearly. Use the alignment tool offered by Rexnord and the instructions outlined in the Addax Coupling Installation Instructions.

C-6 Surface Recoat

In the event your coupling has experienced serous UV degradation or chemical attack, Rexnord offers a recoat on the tube that is more corrosion resistant than the original tube itself. In should be noted that this coating will change the natural frequency of the coupling and this must be evaluated by Engineering when this solution is offered. The coupling must be returned to the factory for this process. There is no in-field coating process recommended.

D. TROUBLESHOOTING

D-1 Key signs of a failed element

1. Large cracks (in excess of 1 mm) opened up in the

urethane coating near bolt. Exposure of element link including severe tears in urethane material

2. Buckling or severe distortion of flex element link beyond deformation caused by misalignment.
3. Oblong holes in the composite spacer flange or stainless steel hub caused from wear and contact of the bolt, nut or overload bushing.
4. Broken or missing flexible element bolt.
5. Coupling spacer operating nonconcentric from stainless steel hub.

D-3 Possible Causes of Failed Flexible Element

1. Misalignment – This mode accounts for the vast majority of coupling failures. Misalignment in both the angular and axial direction must be within the Addax® specification. It is evidenced by a ragged failure of the element followed by bolt heads contacting the inside of clearance holes followed by a flexible element failure. It is usually caused by the coupling not being in alignment due to installation error or from gear reducer movement after installation. Occasional monitoring of coupling alignment is important.
2. Frequent motor starts – Excessive motor starts causes fatigue in the flex element. This usually happens when users have the water temperature dead band set too narrow. Motors on automatic controllers will start and stop as the water temperature varies slightly. This mode on the Addax coupling is evidenced by a ragged failure of the element followed by bolt heads contacting the inside of clearance holes followed by a flexible element failure. It is recommended that users refer to the motor manufacturer for their maximum starts per hour or day. This value should not exceed 25 starts per day. Minimizing the motor starts improves the life of the entire drive train not just the coupling.
3. Fatigue – Under normal operating conditions, moderate misalignment, chemical attack, motor starts and other factors will eventually cause the elements to wear out after several years. The flexible element is a fatiguing component in the coupling system. It is recommend to replace Addax flexible elements and bolt kits about once every 5 years of continuous duty in a preventative maintenance program. If the elements and hardware are not replaced, eventually they will fail and possibly damage the coupling spacer tube. This mode on the Addax coupling is evidenced by a ragged failure of the element followed by bolt heads contacting the inside of clearance holes followed by a flexible element failure.
4. Broken or bent element bolts. This failure is followed by a broken flexible element. A broken or bent bolt is usually caused by an over torque condition. Overtorque can be caused by several things including:
   A. Fan resistance, i.e. blades contacting the stack from severe stack deflection, blade contact with ice, broken or loose fan blade contacting tower structure
   B. Non-standard motors – Nonstandard NEMA or IEC motors in use. It is important to understand the motors used in cooling tower applications because motors can be manufactured and wound to special requirements causing high breakdown torque. Verify standard NEMA B or IEC Metric frame motors in use. Obtain motor speed-torque curve from motor manufacturer.
   C. Starting motor while fan windmilling backwards. Recommend using backstops.
   D. Changing motor speeds too rapidly (common on 2-speed motors). Need time delays built into controller.
   E. Starting motor with fan brake engaged or holding the fan with a rope.
   F. Gear reducer resistance or lock-up.
   G. Motor or controller electrical anomalies. EMF generated by Fast Bus Reclosure (ref CTI paper TP97-10). This paper can be found on www.cti.org.
5. Loose fasteners. Evidence of loose fasteners can be seen by thread indentations in the flange or hub bolt holes. A loose fastener will eventually cause element failure. This is usually caused by improper installation from the onset.
6. Non standard Addax hardware. It is very important to use the hardware supplied with the coupling as there is a tight tolerance fit on the coupling bolts. Nonstandard bolt substitution will likely cause wear in the elements and bolt holes followed by flexible element failure. It may also cause nonconcentric operation and vibration.
7. Improper installation. It is critical to install the coupling strictly to the Addax Installation Instructions. It is possible to alternate bolt in the wrong holes, miss overload bushings or not tighten hardware correctly.
8. Improper coupling selection. Review all applicant data to assure coupling was selected properly.
9. Hubs moving causing misalignment. If set screws come loose, hubs can slide on the shaft causing axial misalignment. It is critical to tighten the set screws to the specified torque in the installation instructions.
10. Key coming out of hub. If the set screw is not adequately tightened, the set screw can loosen and eventually slide out. It is very important to follow the torque tightening specs for the set screws.

D-4 Possible Causes of Composite Tube Failure

1. Cutting failure of the tube - This mode is evidenced by circumferential cutting and fraying of the fibers near the failure point. This is caused by something hard contacting the rotating shaft – usually the coupling guard or the fan stack.
2. Impact failure of the tube - This mode is evidenced by a crushed or shattered area of the tube with bluntly cut edges and fraying of the fibers near the failure point.
3. Vibration – The drive shaft can operate off of center sometimes called 'flutter'. This can be caused by blade pass frequency if the shaft was not properly selected. It may also be caused by severe axial misalignment. If the shaft operates off center, it may contact the coupling guard or fan stack and cause damage to the composite tube. It is recommended to find the root cause of the vibration.
4. Inherent tube damage – This is usually caused by mishandling in shipping or transport. This damage is not always visible on the exterior of the tube. Can usually verify an internally damaged tube by the tap test.
5. Chemical attack – Process chemicals can get into the cooling tower water. This is more likely to happen in the refining / chemical industry. These chemicals can be very detrimental to the cooling tower structure and less detrimental to the Addax® coupling due to the high level of chemical resistance inherent to the coupling. If there is a concern of the coupling, we recommend the Protective Coating described in C-6 above.
6. Torque failure of the tube - This mode is very rare and is a result of something else wrong. It is evidenced by long spirals of fiber near the failure point of the tube.

D-4 Other Coupling Maintenance Topics

Scratches, scrapes, gouges, impact damage – Impact

damage and gouges usually occur during handling. If the damage is severe enough to cause internal damage, then the shaft should be returned to the factory for inspection or possible replacement. Internal damage can be assessed to some extent using the tap test (see below).

What is severe enough to remove from service? – Do the tap test. Using a large coin, tap on the composite tube near the damaged area and listen for a change in sound from one area to the next. You will be able to determine the size of the damaged area. If this damaged area is larger than 2 inches (5 cm), then the tube should be removed from service. If you have any questions about this, call the factory for verification.

Rubs or grooves – Rubs occur during operation when a coupling spacer contacts a guard or fan stack and wears a groove in the composite tube. It is important to define the depth of this damage. Any damage in the tube laminate deeper than 0.020 inch (0.5mm) should be removed from service.

Water in coupling – On rare occasion, water has gotten inside of the spacer tube usually caused by damage to a balance weight and opening a small crevice in the tube wall. This may cause an imbalance at operation speed. Before attempting to remove the water, call the factory for assistance.

Element bushing came out – This usually occurs when installing a bolt at a severe angle through the flexible element. Care should be taken to prevent this. It is recommended to contact the factory and purchase another element.

Discoloration on tube – This may be caused by several things. In a severe case, water chemistry out-of-balance can cause a subtle reaction to the resin system in the spacer. Out-of-balance water chemistry can also cause solids to attach to the coupling. Ultraviolet attack on the tube will cause discoloration. Usually these are not severe enough to cause a coupling failure but should be addressed on a case by case basis.

Surface rust on hub – Occasionally surface rust appears on the stainless steel hubs. This is likely caused by the process water or something in the process water attacking the hub's surface. This is simply a surface impression and will have no effect on the operation of the coupling. These hubs will last the life of the cooling tower.

Levels of vibration acceptable – Refer to CTI Chapter 10 for these levels. It is different depending upon tower construction, i.e. wood, fiberglass, concrete or steel.

Solids collecting on tubes – On rare occasion when water chemistry is not correct mineral deposits will collect on the coupling during operation. These deposits are typically not detrimental to the operation of the coupling. It is recommended to remove these deposits with vinegar or slightly acidic solution. Contact the factory for verification of methodology.

D-5 Water Chemistry

Non Salt Water Towers

The Addax® coupling is capable of withstanding water having a pH (at 25° C) of 6.5 to 9.0; a chloride content (NaCl) up to 750 ppm; a sulfate content (SO4) up to 1200 ppm; a calcium content (CaCO3) up to 800 ppm; silica (SiO2) up to 150 ppm.

Salt Water Towers

If the chlorine content exceeds 10,000 ppm, then it is recommended to use K500 Monel hardware. Due to its composite and stainless steel construction, the Addax coupling is also well suited for seawater applications having chloride (NaCl) levels in excess of 25,000 ppm.

In general, Rexnord Industries is not water chemistry experts and we refer you to your cooling tower manufacturer or the CTI chapter 6.

The following information is required for any inquiries.

1. Purchase / Installation date
2. Coupling Model number
3. Coupling Serial number
4. D. DBSE

World Class Customer Service

For more than 100 years, the dedicated people of Rexnord have delivered excellence in quality and service to our customers around the globe. Rexnord is a trusted name when it comes to providing skillfully engineered products that improve productivity and efficiency for industrial applications worldwide. We are committed to exceeding customer expectations in every area of our business: product design, application engineering, operations, and customer service.

Because of our customer focus, we are able to thoroughly understand the needs of your business and have the resources available to work closely with you to reduce maintenance costs, eliminate redundant inventories and prevent equipment down time.

Rexnord represents the most comprehensive portfolio of power transmission and conveying components in the world with the brands you know and trust.

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