White Paper

Keeping Your Cool: Grooved Technology as a Means to More Efficient Data Center Construction and Operation

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For many years, air cooled systems provided sufficient cooling capacity for data centers; however, increased computing density produces more heat and, therefore, requires a more efficient cooling method. In larger data centers, the most cost effective method of cooling is a chilled water system. According to the Science of Aquatics, water is 4,000 times more efficient than air. This is why, in recent years, companies like IBM have developed methods for bringing cooling water directly into server racks.

In a chilled water system, chilled water is pumped out of the mechanical room and into computer room air handlers by way of under-floor water distribution lines. The air handler then removes heat and humidity by drawing warm air through coils filled with circulating chilled water. The water absorbs the heat from the air and circulates back to the chiller where the heat is transferred to a condenser water loop and eventually released through a cooling tower.

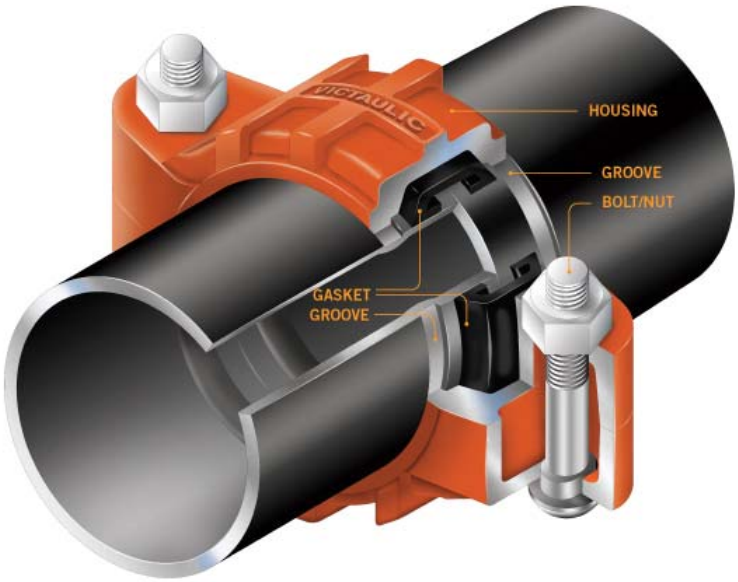
Hard piping utilizing carbon steel pipe or copper tubing is common in a chilled water system. Traditional pipe joining methods for hard piping systems consist of welding, brazing or flanging which generally work well in data centers; but, with increased loads, frequent changes, and system expansions, these joining methods have become problematic. Piping systems utilizing a welded, brazed or flanged joining method are not easily accessible, feature limited design flexibility, introduce fire hazards to the jobsite and require lengthy system shutdowns to perform routine or unplanned maintenance activities.

Grooved mechanical piping technology—a method of pipe joining that requires no flame—provides a reliable piping system that ensures efficiency in construction and operation of a data center by reducing deployment time, providing an easily adaptable system and reducing downtime during routine or unscheduled maintenance.

Grooved pipe joining technology

In 1925, Victaulic designed the first grooved end pipe joining system for water and air service piping. Recognized for its design flexibility and speed of assembly, grooved end pipe joining technology transformed the piping industry, leading to dramatic gains in building construction productivity. That is why among HVAC specifying engineers, building owners and installation contractors around the world, grooved mechanical pipe joining is the preferred pipe joining solution for both new construction and retrofit.

The mechanical joint, or coupling, is comprised of four elements: the grooved pipe, the gasket, the coupling housings, and the nuts and bolts. The pipe groove is made by cold forming or machining a groove into the end of a pipe. The key section of the coupling housing engages the groove. The bolts and nuts are tightened with a socket wrench or impact wrench, which holds the housings together. In the installed state the coupling housings encase the gasket and engage the groove around the circumference of the pipe to create a triple seal unified joint that is enhanced when the system is pressurized.



Installing a grooved mechanical piping system

The installation of the piping system using the grooved mechanical pipe joining method leads to significant on-site man hours savings. On average, field fabrication of a grooved system is up to 10 times faster than welding and six times faster than installing a field-fabricated flanged joint. The simplified assembly and installation leads to a reduction in project calendar days by as much as one half, optimizing labor risk management. The reduction in calendar days realized by installing a mechanical piping system gives owners the ability to meet, and even beat, compressed construction schedules and avoid liquidated damages.

By reducing on-site man hours and eliminating the risk of fire and release of noxious fumes, the installation of mechanical piping systems increases jobsite safety and decreases overall risk when compared with welding, brazing or soldering.

Most injuries on job sites occur via material handling, but the most significant risks — in terms of potential impact on people and businesses — are caused by fire and fume hazards. Mechanical pipe joining eliminates fire, open arcs, sparks, flames and toxic-fume hazards that are associated with welding, brazing, and soldering. Welding is associated with a number of potential health risks, as well as the risk of severe burns. By specifying a mechanical pipe joining system, an engineer reduces the owner's overall risks, especially those related to project schedule, costs and potential liability.

Depending on the type of project (e.g., new construction vs. expansion/retrofit), hazards may become a risk not only to construction workers, but also to the occupants of the structure and surrounding facilities. When someone is welding, to comply with mandatory safety regulations, all other work in the area must be postponed, leading to costly downtime and possible employee evacuation. Evacuations are beneficial to safeguard workers, but business realities lead to yet another potential danger: the pressure and rush to catch up from a shut down or loss in

productivity, thus leading to an increased risk of injuries. Making wise decisions during new construction and specifying mechanical systems from the start helps to reduce downtime and alleviate the burdens often associated with future repairs, replacements, expansions and retrofits.

In addition to the elimination of flames and fumes associated with welding, the installation of mechanical piping systems increases safety by dramatically reducing the time and risk associated with rework. Unlike the hard pipe joints of a welded spool, mechanical joints offer rotational allowance and can be easily oriented on site without potential health and safety risks. The rotational allowance of a flanged joint is determined by the incremental movement from bolt-hole to bolt-hole while the grooved system offers 360 degrees of rotational allowance for field flexibility.

Once installed, mechanical systems are easily inspected. Most grooved systems provide for quality control through visual confirmation of proper installation. When installers inspect the completed grooved joint, metal-to-metal bolt-pad contact confirms that the joint is properly and securely installed and no re-work is necessary. Similarly, flanged joints are visually inspected upon completion of the sequential bolting, however, the level of gasket compression for sealing is unknown because the specific bolt torque is unknown. Welding, on the other hand, often requires X-rays for quality inspection. Furthermore, in the case of a failed x-ray inspection, the time-consuming re-work increases facility downtime and reintroduces the risks associated with welding.

Maintenance and expansion of grooved mechanical piping systems

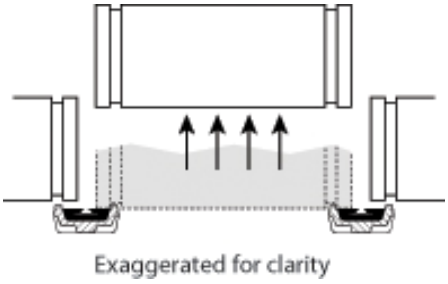
Over the operating life of a data center, a piping system requires three basic categories of maintenance: routine inspection and maintenance, physical changes or expansion, and unscheduled repairs. Because of its intrinsic design qualities, grooved mechanical pipe joining makes maintenance and system access easy, fast, and safe while minimizing downtime.

Grooved couplings provide a union at every joint, allowing for easy system access, maximum field flexibility for on-site decision making and flexibility for future system expansion. To access the system, a worker needs to de-pressurize the system and simply unscrews two nuts. No torches, saws, or welding machines are needed. Required maintenance, such as cleaning strainer baskets or replacing corrupt pipe sections or adding in a tee to expand or join piping systems, is then easily accomplished. To complete the job the gasket is re-installed, the coupling housings are placed back on the pipe or fitting and the bolts are tightened. Welded systems don't have unions; to repair the piping system, workers actually have to cut out the damaged pipe section, which causes operational concerns and safety hazards, particularly in exiting facilities and occupied spaces. Additionally, because grooved mechanical pipe joints can be installed on wet lines, there is no time required to let the system dry out.

In a traditional flanged system, multiple bolts are needed to create the seal, and removing these bolts is a time-consuming process. For example, when working with a 12-inch ANSI Class 150 flanged system, 12 bolts need to be removed to gain access to the system. These torqued bolts employ a very high compressive load on the gasket, which is required to form and maintain the

seal. When the multiple bolts are removed and the flanges are pulled apart, the gasket will tear and therefore needs to be replaced.

With a mechanical coupling, the compression loads on the gasket are different than the flange. The gasket has a C-shaped cross section seal that is pressure responsive and designed to handle cyclical loading. Systems can be pressurized and depressurized repeatedly for many years without fatiguing the elastomer material. Once installed, these couplings do not require any routine or periodic maintenance and can be left in place for the life of the system.



Grooved piping systems provide a union at every joint for ease of maintenance and future retrofits.

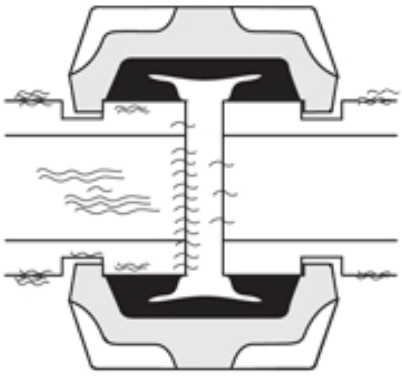
Operating efficiency is maintained during retrofit work, and systems can remain live without interrupting cooling because properly placed butterfly valves installed using grooved couplings provide “dead-end” shutoff service for isolation allowing for easy system expansions or re-routing with little to no interference with existing operations. Expansion projects can be completed in occupied buildings without vacating the space because mechanical grooved piping does not release noxious fumes or introduce a fire hazard eliminating the need for hot-works permits or fire watch.

Protecting equipment using grooved mechanical piping systems

In addition to making maintenance fast and safe, a grooved mechanical pipe joining system accommodates movement and deflections within the piping system reducing the need for periodic product repair or replacement and maintaining the operational integrity of the piping system. Traditional welded or flanged piping systems have rubber bellows or a braided flexible hose to accommodate these movements; however, these materials often wear out over time requiring costly and time-consuming replacement.

Flexible mechanical systems are engineered to allow the pipe to move and vibrate within the coupling, therefore localizing vibrations generated by HVAC equipment and reducing the amount of noise transmitted down the pipe line. The elastomeric gasket, contained inside the internal cavity of the ductile iron housing, creates a discontinuity in the piping system which aids in isolating vibrations therefore, protecting vital cooling equipment within the piping system. Furthermore, the ductile iron housings and gasket material have vibration dampening qualities

of their own, also serving to absorb vibrations. Testing has shown that systems utilizing three consecutive flexible couplings near a source of vibration will experience a similar level of noise dampening as those systems using specialty products. Additionally, the ability of grooved systems to accommodate system movement reduces loads at equipment connections and keeps vital cooling equipment operating at peak efficiency.



The flexible grooved-pipe couplings reduce the transmission of stresses through a piping system, while the gasket and ductile iron housing combine to dampen vibration.

Nowhere is it more important to plan ahead for disasters than in a data center. According to The Uptime Institute, in 2001 a Tier III data center allocated 1.6 hours per year for IT downtime and only 0.4 hours of downtime in a Tier IV. Because the cooling system is vital to the operational integrity of the IT equipment, when the cooling systems goes down it is only a matter of minutes before the IT equipment begins to overheat.

Piping systems in earth quake prone areas will be exposed to forces and deflections beyond normal static conditions. These seismic forces can cause extensive damage when piping systems cannot accommodate these movements. Mechanically joined grooved systems can be designed so that the differential piping movement associated with a seismic event will be accommodated. The inherent deflection capability of the flexible grooved pipe coupling reduces transmission of stresses through piping systems. The deflection allowed by a flexible grooved-pipe coupling reduces the transmission of stresses through a piping system thereby minimizing potential system damage. As mentioned above, flexible and rigid couplings also provide discontinuity at each joint which helps minimize pipeline stresses generated during seismic movement.

Testing performed at the Real-Time Multi-directional Experimental Laboratory at the Center for Advanced Technology for Large Structural Systems at Lehigh University in Bethlehem, Pennsylvania; U.S.A proved the suitability of Victaulic grooved mechanical couplings to maintain operational integrity of piping systems during seismic events.

Conclusion

Owners, engineers and contractors are challenged to design, operate and maintain reliable and easily adaptable facilities that accommodate a revolving door of innovative technology. And while there are many construction and operational concerns to take into consideration, a data center's cooling strategy is vital to all business operations. For cooling strategies that include chilled water systems, grooved mechanical piping technology provides a reliable piping system that maximizes efficiency by reducing deployment time during new construction, reducing downtime during maintenance and/or system expansions and maintaining operational integrity of the piping system and equipment on a day–to-day basis and in the unfortunate event of a natural disaster.

For more information on the Victaulic Seismic Testing Program, visit www.victaulic.com/seismic.

For more information on Victaulic solutions for data centers, visit www.victaulic.com/datacenters.

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