aalberts integrated piping systems

Understanding Force and Stress Requirements of Gasketed Mechanical Couplings

Introduction

Shurjoint Gasketed mechanical couplings performance standard requirements are directed and controlled by ASTM F1476 for mechanical use applications and UL-213 and FM-1920 for applications in fire protection systems. These standards provide a base-line of requirements in the form of tables, tests and specified calculations for determining stress forces that can impact a piping system, and ensuring the mechanical couplings can meet and or exceed those requirements.

Design Principals

As with most engineered components, the products design is based on the user's application requirements as well as applicable standards and specifications. The products design is influenced by factors, including pressure requirements, the need for flexibility or rigidity, pipe size, pipe material, etc. Thus, you will note that the pressure ratings of products will vary by size, pipe material and schedule. Additional influencing factors can include pipe end preparation, including the type of groove (rolled or cut), dimensions, profiles, etc.

To assist users, including engineers and designers, Shurjoint designs, engineers and tests its coupling designs both internally and with independent third-party approval bodies and then publishes its performance standards and ratings within specified groove dimensions, pipe material, pipe schedule (wall thickness), and even bolt torque requirements when applicable.

Grooved mechanical couplings for steel pipe are designed and tested with grooves specified in the most current edition of AWWA C606. Some tolerances are also adjusted to incorporate additional global and

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international standards. Mechanical couplings for copper tube may very slightly depending on the CTS tube standard to which it was manufactured. Refer to Shurjoint publications for groove specifications. Grooves produced outside of the specifications may influence the joints performance.

Shurjoint Testing Standards

Shurjoint has tested all couplings designs to the standards referenced as well as to additional standards when required or applicable. The two most stringent force and stress requirements when considering workplace safety and system performance are the Hydrostatic Strength Test and the Bending Moment Resistance Test.

Hydrostatic Strength Test

All standards mentioned in the introduction require a static, hydrostatic strength test to be performed. Depending on the applicable standard, this can be 3X the rated pressure for mechanical use, and 4X the pressure rating for fire protection listings and approvals with UL or FM. The formula for this is then:

Mechanical: Coupling rated pressure*3

UL & FM listings and approvals: Coupling rated pressure*4

Understanding End Load Force

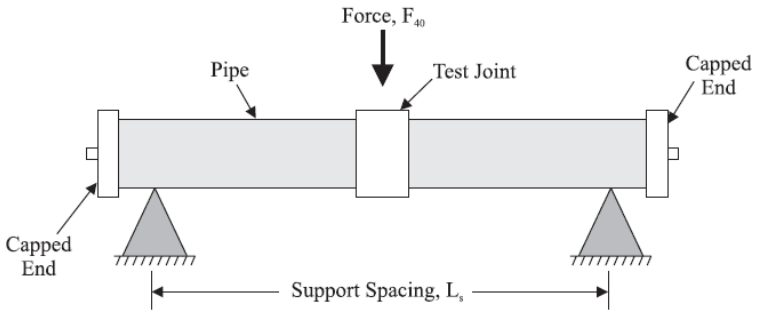
As a piping system is pressurized the pressure inside the system is increased to a pressure greater than that of the atmospheric pressure outside of the system. This increase exerts a force onto the couplings. To determine that force we use the formula; P*A. where P is the pressure and A is the area. Example: The Outside Diameter of a 4-inch pipe is 4.5 inches, which has an area of: $(4.5^2*\pi)/4 = 15.90$ in^2. Using the published rated pressure of a 4-inch model Z07 coupling, for mechanical use on schedule 40 pipe, which is 750 psi, we have: 750*15.90= 11,925 lbs. (5409,1 kg) of force. This is the amount of force which is exerted onto the couplings in a system at 750 psi. ASTM F1476

requires couplings designs must meet or exceed 3X that, or 35,775 pounds (16227 kg) of internal force. Fire protection approval bodies and listing agencies such as UL, FM, and others have their individual hydrostatic multiple pressure requirements. For this reason, the same coupling may have a different pressure rating depending on the agency and requirement. Pressure ratings will also vary with pipe material and pipe schedule utilized in the piping system.

Bending Moment Resistance

Bending resistance testing is another required test in which the coupling must withstand a given moment of external force acting upon it. ASTM and other agencies have determined that this force should be equal to twice the weight of the water filled pipe that is in a typical span between hangers.

The calculation for determining a moment of force is: M= (F X L) /4 Where:



M= moment

F= equivalent force required

L= pipe length

We already know that the moment is equal to twice the weight of water filled pipe at a given span. Again, using a 4" schedule 40 pipe as an example, and using the span given in ANSI B31.9 of 17'; the weight, (moment) is 4716 lbs./ft.

If use the formula to find the equivalent force, we would need to simulate the moment of twice the weight on a 4' test sample we have: F= (4 X 4716) /4 = 4716 lbs. of force would need to be applied. The internal pressure is that of the working, or rated pressure of the coupling. Therefore 750 psi of internal pressure was applied at the time the external force was.

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Summery

This paper was prepared to provide an overview and general understanding of the design and the testing requirements of gasketed mechanical couplings and how this testing is used to validate assigned working pressure for use on a given piping system.

System designs and expected stress analysis of the piping system is the ultimate responsibility of the design engineer and any additional stress, forces, surges and other factors must be accounted for and proper bracing, hangers or other elements must be considered to mitigate those expectations.

If you have questions regarding the information provided. Please contact me. My contact information is provided below.

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About the Author

Bachelor of Science Degree in Mechanical Engineering Technology and 25 years in testing, design, and development of grooved products, as well as directly working with customers to trouble-shoot systems and create solutions.

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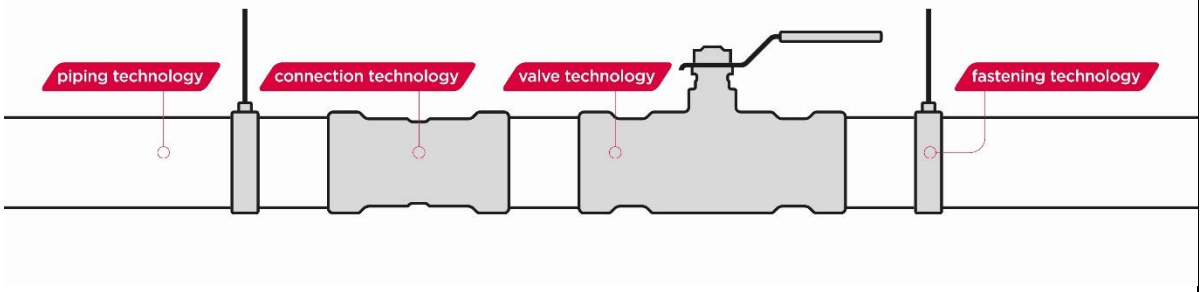

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