PIPING NEWS

A Newsletter published by W. M. Huitt Co.
for designers and engineers involved with process piping

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LEAD STORY LEAD IN

At the May 2018 ASME BPE meeting in San Diego, CA there was a presentation given by the ASME BPE Women's Initiative group. This would be the first of its kind at a BPE meeting.

The presentation, given by Dr. Barbara Henon, was not listed on the formal 4-day agenda for this session of the BPE. A notification had instead been emailed out to all those attending the meeting in San Diego. But I was actually made aware of the presentation by Barbara.

We have, over the years, become good friends. Having worked together on articles related to the bioprocessing industry, as well as various Task Groups associated with both the BPE Standard and the B31.3 Process Piping code.

Having known Barbara for a number years I have great respect for her both personally and professionally. After reading through her presentation, then hearing her give that presentation I was humbled by its content.

Learning of the obstacles that she had to overcome in acquiring her PhD was enlightening to say the least. And these obstacles were not learning related, but rather foisted upon her by academic peers. Why? Not because of her lack of understanding or unwillingness to work hard, but because of her gender.

After reading and hearing Barbara's presentation my level of respect for, not only her intractable knowledge in the art of welding, but her tenacity as well, went into the stratosphere.

And I think this speaks to the spirit of many women with whom I have worked with over the years in this industry. Women who have reached management level positions through hard work and perseverance.

One of Barbara's jobs years ago, was in training welders on how to set up and use the orbital welding machines the company she worked for made. She would travel the globe training these welders on-site or in their own fab shops.

As it turns out she got a great deal of respect from these blue collar welders, but management personnel, for the most part, was a different story. You might think just the opposite was true, but the reality is that the old 50's style gender adversity is still lurking within the deep recesses of our population and our industry.

Which brings me to our lead story this month. The ASME BPE Women's Initiative is a group of women that have coalesced over a common goal. A goal in which their purpose is to get more women involved in working on the ASME BPE Standard.

Writing codes and standards, like the BPE, allows you to be a part of something that effects countries around the world. Making the world a safer place. And now to the Women's Initiative.■

ASME BPE WOMEN'S INITIATIVE
by Milena McFeeters

During the January 2018 ASME BPE meeting in Cape Coral, FL, a group of twelve women attending the meeting got together for a casual dinner. There was much animated discussion throughout the dinner out of which it was decided to found a group that would promote and incentivize the participation of women within the BPE Standards Committee.

Since that time, the inaugural group of twelve like-minded women has grown to twenty-four participants. It was decided at the onset to hold an event at each ASME BPE meeting. These events, for the Women's Initiative, include networking activities and presentations on the topic of gender diversity from members of the Women's Initiative and guest speakers.

The ASME BPE group's mission is to establish a far-reaching network that can reach out to women of the bioprocessing industry to encourage and enable participation by women that are involved in the various aspects of bioprocessing related businesses. Businesses such as chemical processing, parts and equipment manufacturing, engineering, and construction. The hope is to generate an interest for women to become more involved in the development of industry codes and standards, a governing factor of industry, instilling safety and integrity into the construction of bioprocessing facilities. This, in an attempt to help steer the future of codes and standards development by bringing a more balanced gender representation to those writing such codes and standards. Focus of the Women's Initiative is to reflect the same gender ratio in the BPE as that of the actual percentage of women employed in the bioprocess industry.

The main objectives of the Women's Initiative are:

- To increase participation by, and membership of, women in the ASME BPE Committees.
- To promote leadership roles for women in the bioprocessing industry.

Why is this needed? According to the MassBio and Liftstream gender diversity report (2016), around 50% of entry level positions in the industry are filled by women. However, women only make up 20% of leadership teams (C-suite), and 10% of Board memberships. A similar scenario plays out at BPE, where women only make up 5.7% of voting seats.

The reason there are so few women involved in BPE is not because there are few women in the industry (as the MassBio report clearly indicates) and it is not due to lack of interest or ambition. As the report also shows, when it comes to aspirations, both women and men have similar ambitions to serve in the C-suite and on company boards. The same can be said for the desire to participate in the development of codes and standards, hoping to become important contributors with the capacity to influence and improve industry practices. The group's goal is to help overcome the obstacles that may deter women from attending and becoming voting members at BPE, by taking actions such as:

- Mentoring new and existing female members
- Encouraging employers to support female participation in Standards committees
- Encourage female members to volunteer for leadership roles
- Improve value gender diversity

The presentations organized by the Women's Initiative are open to the public. Dr. Barbara Henon, past Vice Chair of ASME BPE, during the May 2018 BPE meeting in San Diego, CA presented her personal story of discrimination and discouragement that began back in the 1950's and continued throughout many decades. The men who attended the presentation, men who have known and respected Barbara for years, were unaware of the difficulties she experienced early in her career, difficulties based purely and solely on her gender. Her hard work

break in the meeting, I made my way to the ladies restroom (where there was no line, due simply to the fact that few women were in attendance) when this very nice lady from Italy caught me in the hallway and approached me. She vigorously shook my hand, all the while telling me how wonderful it was to meet me, the only woman, sitting at the table with all those men. Not until that moment had I realized that I was, indeed, the only woman at that table. I find it somehow odd, and perhaps a little discerning that it was not apparent to me before.

and determination at times went largely unrewarded, and at other times simply ignored. Above is a photo of Barbara receiving a standing "O" after her 2018 presentation In San Diego.

At the last ASME BPE meeting in Portland, OR Indu Conley presented a summary of the findings of the MassBio report that provided those in attendance with the facts related to gender diversity in the bio-processing industry. Such timely and interesting presentations help bring awareness to the entire industry. The photo shown on the right was taken at the dinner meeting held in Portland.

Some years back, at one of the ASME BPE Standards Committee meetings, only one woman, myself, Milena McFeeters, was seated at 'the big table'. The table where all of the voting committee members are seated and report on the weeks activities. During a

I suppose you could say that this is the world we live in. But should it be? Currently the perception of a few women seated at the committee table is the norm. Our mission, as the Women's Initiative, is to change that perception into it being an exception not to have more women seated at the table. Even if it means longer lines at the ladies bathroom! Something we have all learned to live with.■

Edited by W. M. (Bill) Huitt

ASME B31.3 and BPE MEETINGS

The ASME B31.3 Process Piping Committee meets two times each year and the BPE Committee meets three time each year. This year their Meetings, which are open to the public, will be held as follows:

B31.3 Process Piping Committee Meeting

Fall 2019

September 16-18, 2019 – Monday-Wednesday, with B31 Code Week

Venue & Location:

Lord Baltimore Hotel
http://www.lordbaltimorehotel.com
20 West Baltimore Street
Baltimore, MD, United States

Spring 2020

April 06 2020 08:30 AM - April 08 2020 05:00 PM, Monday - Wednesday

Venue & Location:

Royal Sonesta New Orleans
http://https://www.sonesta.com/us/louisiana/new-orleans/royal-sonesta-new-orlenas
300 Bourbon Street
New Orleans LA, United States

Bioprocessing Equipment (BPE) Committee Meetings

Fall 2019

September 09 2019 08:00 AM to September 12 2019 12:00 PM, Monday - Thursday

Venue & Location:

Lord Baltimore Hotel
http://www.lordbaltimorehotel.com
20 West Baltimore Street
Baltimore, MD, United States

Winter 2020

January (TBA)

Venue & Location:

Caribe' Hilton
https://www.caribehilton.com/
1 San Geronimo Street
San Juan, Puerto Rico 00901

The ASME BPE Clamp Joint Assembly

The hygienic clamp joint assembly, or union has been around going on 70 years. Initially designed and marketed for the food and dairy industry by the Tri-Clove corp. it is made up of four different components:

- 2 Mating Ferrules
- Circumferential Clamp
- Bolt or Bolts
- Gasket

This design provided for easy assembly and disassembly. A necessity for the food & dairy industry for cleaning piping systems between campaigns. This was prior to the concept of integrating Clean in Place (CIP) systems like we currently do today to a large degree.

In the 1980's, when the pharmaceutical industry began moving from glass tubing and glass-lined pipe and equipment to stainless steel, they too were looking for a system that was easy to assemble and disassemble, for much the same reason as the food & dairy industry.

The tubing components used in the food & dairy industry, like the clamp assembly, were referred to as sanitary fittings, and still are. But the tubing fittings for the pharmaceutical industry, while initially referred to as "sanitary" fittings evolved into a higher expectation of cleanliness by changing the term to "hygienic" fittings. These clamp assemblies, for a number of years after being adopted by the pharmaceutical industry, continued to be referred to as the Tri-Clamp joint. So named by the Tri-Clover Corp.

Problem was, there was no standardization of the clamps, the ferrules, the tees or even the elbows, which were referred to as long tangent elbows at the time.

The finer points of the BPE clamp assembly components can be described in the following manner:

2 Mating Ferrules

In looking at the ferrule and its relative attributes to the assembly there are two Types found in the BPE standard, Types A & B (Ref. Figure 1). Type A applies to ferrules in sizes 1" and smaller. Type B ferrules apply to sizes 1" and larger.

The 1" size overlap of the two Types is due to a leak integrity issue years ago having to do with the 1" Type B ferrule; the specifics of which are not relative to this subject matter and will not be described in this column.

As shown in Figure 1 the 1" and smaller Type A ferrules have a different gasket seat design than the 1" and larger Type B ferrules as also reflected in Figure 1. Since the 2009 edition of the BPE Standard there has been a choice of the two Types of sealing surfaces for the 1" ferrules.

Figures 2 and 3 represent a segment of the clamp joint assembly consisting of the clamp, 2 ferrules (welded to tubing), and a gasket. In Figure 2 there are three forces working on this assembly. They include: 1. Hydrostatic End Force, which is pressure of a confined fluid acting in parallel to the pipe axis to oppose the sealing force at the ferrule face. 2. Internal Pressure, which is the force acting at right angles to the pipe axis attempting to overcome confinement. 3. Gasket Load, which is a function of the force created when clamp draw-down forces the ferrules to compress the gasket enabling the sealing surface to withstand internal fluid pressure.

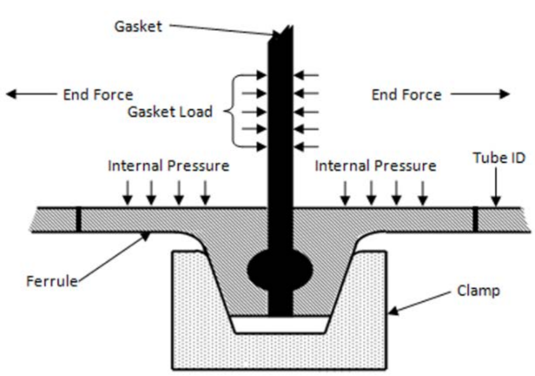
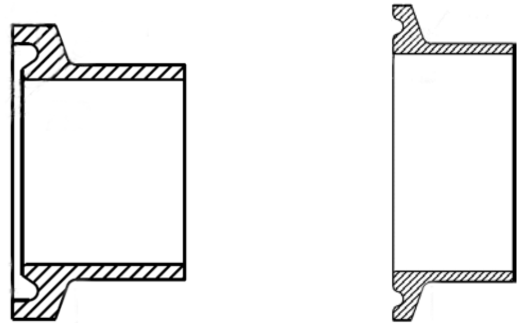


Figure 2 – Forces Acting For and Against Containment



Type A Ferrule Type B Ferrule

Figure 1 – ASME BPE Ferrules

In Figure 3 there are two forces at work. They include: 1. Clamp Draw-Down Force, which is the force applied to the assembled ferrules through the act of drawing down the clamp over the ferrules with a bolt or bolts. 2. Ferrule Secondary Reaction Force, which are deflective opposing forces created by drawing down the clamp creating a pre-load on the gasket.

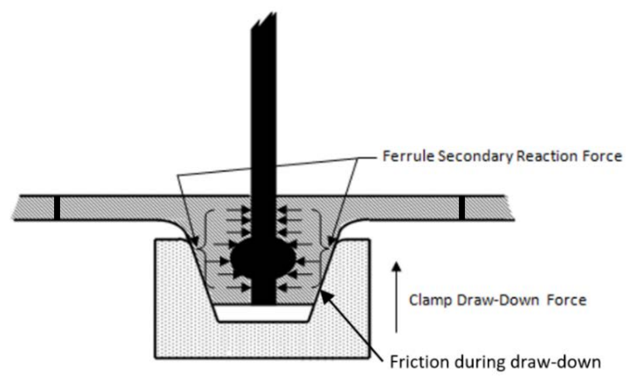


Figure 3 – Forces Acting To Seal the Joint

As seen in Figures 2 and 3 the two ferrules in the hygienic clamp joint assembly provide the assembly's sealing surfaces, which requires a pliable material between the two surfaces in the form of a gasket. Gaskets and their material will be discussed later. But in order to pre-load the gasket between the two ferrules a clamp with a concaved wedge pattern is forced down over the two ferrules creating a draw-down force. This peripheral force, achieved in large part to resistance from the highly rigid form of the round tubular ferrule, is applied to the backs of the two ferrule flanges creating opposing deflective or secondary reactive forces on to both ferrule flanges and the gasket between them.

The re-directed force against the gasket becomes the preload force and has to be sufficient enough to contain the internal fluid pressure plus the hydraulic end force pressure attempting to separate the two ferrules.

For metallic ferrules and clamps, temperature does not become a factor in load calculations until it becomes elevated enough to begin depreciating the allowable stress value (S_a) of the metal. For 316 and 316L that temperature is 399°F (203°C). At 400°F (204°C) and above the allowable stress of this austenitic stainless steel then begins to depreciate making it, at those elevated temperatures, an essential factor in load calculations.

Bolts

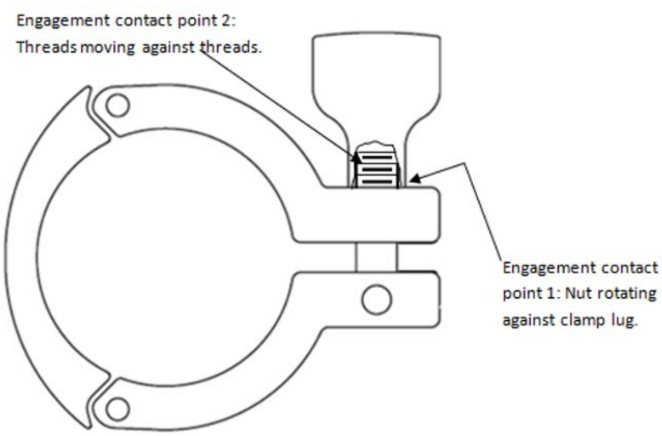


Figure 4 – 3-Piece Double Pin Clamp Joint Assembly

There are two general types of hygienic clamps, those that are hinged and secured to the ferrule and gasket assembly with a single bolt and wing nut (Fig. 4), and those that are made up of two separate pieces forming a peripheral clamp and secured to the ferrule and gasket assembly with two bolts and nuts (Fig. 5).

When assembling a hygienic clamp joint union much of its theoretical sealing integrity is based on a pre-determined torque value used in fastening the bolts. Sealing integrity refers to the ability of the gasket and ferrules to seal against the internal fluid pressure while not exceeding the intrusion/concavity tolerances specified in ASME BPE Para. SG-4.2 and Fig. SG-4.2-1.

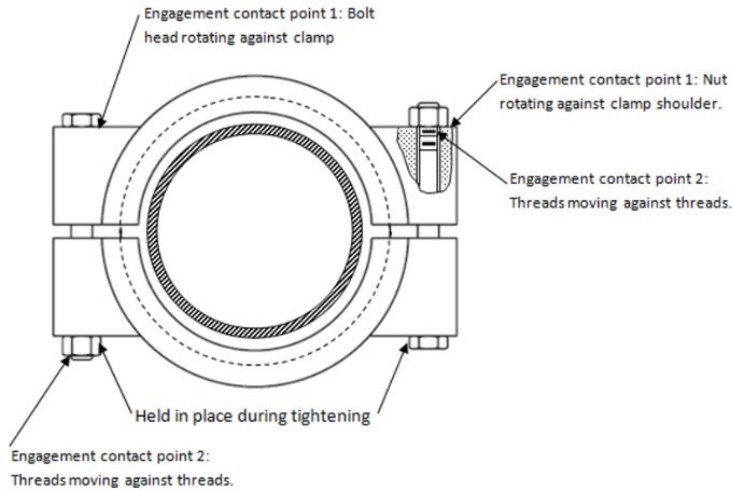


Figure 5 – 2-Bolt High Pressure Clamp Joint Assembly

In taking a page from the Machinery's Handbook it states that, "Laboratory tests have shown that whereas a satisfactory torque tension relationship can be established for a given set of conditions, a change of any of the variables, such as fastener material, surface finish, and the presence or absence of lubrication, may severely alter the relationship. Because most of the applied torque is absorbed in intermediate friction, a change in the surface roughness of the bearing surfaces or a change in the lubrication will drastically affect the friction and thus the torque tension relationship."

In a paraphrased statement found in Federal Standard FED-STD-H28A it elaborates on the previous statement by further stating that, "Thus, it must be recognized that a given torque will not always produce a definite stress in the bolt but will probably induce a stress that lies in a stress range that is satisfactory."

These statements go to the heart of the fact that using a torque value to pre-load a hygienic clamp joint assembly is not a truly accurate mechanism for gauging load on a sealing surface, but will instead achieve a load value approximate to a predetermined target value. And then, only if the bolt(s) are properly lubricated.

When tightening a bolt in order to seal an ASME B16.5 flange joint or an ASME BPE hygienic clamp joint the installer is attempting to apply tension to the bolt or bolts used to create the sealing load. There is a direct correlation between bolt tension and the amount of load placed on the affected sealing surfaces whether it is a flange joint or a hygienic clamp joint. Bolt tension is directly related to the amount of compressive force that is applied to the gasket.

That tension, while in the bolt's elastic range, creates a live load on the sealing surfaces which allows the joint to remain sealed throughout fluctuations of thermal cycles and transient dynamic surges; unless, that is, bolt tension relaxes due to gasket creep, or bolt stress exceeds the material's elastic range.

And even though gauging bolt stress may be a more accurate approach in determining gasket load, in field installations this is not often practical. To use such sophisticated and costly instrumentation as an ultrasonic stress analyzer to detect bolt tension when tightening bolts, thousands of bolts in many cases, cost and schedule make this method prohibitive. It is instead much more economical and practical to set a torque value and then use a torque wrench to meet that compressive load target value.

In using torque values as a target value the gasket manufacturer has to first of all set a torque value that establishes the needed load or force required in tightening the nuts and bolts in order to achieve the gasket compression necessary to seal the joint. That pre-determined torque value is then achieved during installation with the use of a torque wrench. But this, even though a much more practical method, can be flawed if not done properly.

The torque wrench measures and quantifies the energy required to tighten a nut to a predetermined torque value, which is given in in-lb or ft-lb values. Therefore the measurement of torque is an indication of the force applied at the nut, which does not necessarily translate into the force or compression load realized at the gasket. Nor is it a direct correlation with bolt tension values as mentioned previously.

In order for torque values to work properly for a given application those values have to be pre-determined through testing and qualifying by, in this case, the gasket manufacturer or a qualified third-party tester. However, the inherent problem with using torque values is that it is, as mentioned earlier, an indirect and somewhat inaccurate method of measuring bolt tension, which is, as also mentioned, the less direct value associated with gasket compression.

The problem is that when assembling possibly thousands of mechanical joints in the field it is very inefficient to gage bolt tension on thousands of bolts. By therefore being relegated to using a torque wrench against pre-determined torque values the process then becomes dependent, in large measure, upon replicating the method used initially to determine the proper pre-established torque values that will achieve the necessary gasket compression.

What occurs in the process of assembling a clamp joint is this: in tightening bolts there can be considerable variation and opportunity for loss in torque, or quantified force in the contact points between the bolt head, where the torque measurement is taken, and the gasket where the force is needed.

This is due to what is referred to as a "non-linear variation" caused by friction loss that occurs at the points between the bolt head (torque reading) and the gasket surface.

The loss in force is due mainly to friction created at two points: The face of the nut against the shoulder of the clamp lug (engagement contact point 1 Figures 4 & 5) where as much as 50% or more of the torque value can be lost; and also at the engagement threads (engagement contact point 2 Figures 4 & 5) where as much as 30% or more additional torque value can be lost, leaving approximately 20% of the torque value, or force actually being transferred, via bolt tension, to the gasket and ferrule sealing surfaces. There is also a resistant friction force created as the clamp moves down over the ferrule flanges (Ref. Fig. 3).

Since only the bolts are lubricated when determining required torque values for gaskets, lubricating this point of the clamp can be considered over-lubricating. When gasket manufacturers or fitting manufacturers insert a qualifying statement with their product such as, “Torque values are based on nuts and bolts being lubricated and maintained in such a manner as to achieve a free-running condition”, this same method of assembly has to be replicated as closely as possible during installation and joint make-up. Otherwise the same degree of gasket compression cannot be expected to be achieved even though the torque read-out value might be the same as the recommended value; that could be considered a false reading.

A lubricated 7/16” dia. bolt at 20 ft-lbs of torque will create a bolt load of ~2800 lbs thereby creating a bolt stress or tension of 30,000 psi. A non-lubricated 7/16” dia. bolt tightened to a torque value of 20 ft-lbs will create a bolt load of ~1400 lbs thereby creating a bolt stress of 15,000 psi. That is a 50% loss of force due to friction. If the specified force applied at the torque wrench is not being transferred efficiently through the bolt then it is not transferring sufficient compression force to the gasket and sealing surfaces.

If the gasket and fitting manufacturers qualify the pressure containing integrity of their components by using a methodology in which torque values, using lubricated bolts and nuts, are used as determinant values instead of bolt tension values do we need to concern ourselves with bolt tension values? No, not exactly.

While bolt tension is certainly a key factor, what the installer needs to do is replicate the process by which the manufacturers have qualified the integrity of their product. This is why bolt torque requirements, rather than bolt tension values, are specified for installation requirements for the flange or clamp type mechanical joints in relation to the type of gasket material.

If the installer pulls a new clamp out of the box and installs it as-is the amount of torque load transferred to the gasket and ferrule seating surfaces as the wing nut or hex head bolt is tightened could be 50% or less of that indicated on the torque wrench dial. A lubricant applied to the bolt threads and other engagement contact points can allow more of the torque to transfer to the sealing surfaces where it is needed. But this too can be a double edged sword.

If bolt lubrication is used too freely when assembling ASME B16.5 flange joints you simply achieve greater compression at the gasket surface with no harm done, to a point. Doing the same with the hygienic clamp joint can cause the compression load to exceed the qualifying amount experienced by the gasket manufacturer due to the additional lubrication.

SG-4.2 Static Seal Performance

Static seals shall meet the general performance requirements of SG-4.1.

On initial installation, a hygienic static seal shall provide a substantially flush interface with the hygienic clamp ferrules. Hygienic seals shall meet and be designated by one of the following intrusion categories when tested by the seal manufacturers:

(a) Intrusion Category I. Seals having a maximum intrusion/recess of 0.025 in. (0.6 mm).

(b) Intrusion Category II. Seals having a maximum intrusion/recess of 0.008 in. (0.2 mm).

Figure 6 – ASME BPE-2014 Para. SG-4.2 (Partial)

The added lubrication, let’s say at the clamp and ferrule contact points, makes the transfer of load from the torque wrench to the ferrule/gasket sealing surface much more efficient thereby transferring a greater percentage of the torque value reflected on the torque wrench dial. When the gasket manufacturer warrants their gaskets to meet the tolerance requirements of ASME BPE Class I or Class II (Ref. Fig. 6) they base this on an assembly procedure that included a lubricant on the clamp bolt(s) only. In order to achieve a comparable outcome the field installation must be done in the same manner.■

The above discussion on the ASME BPE Clamp Joint Assembly will be continued in the July issue of Piping News.

A Word About System Design Conditions

In the April 2019 issue of Piping News I defined System design pressure as: A gage pressure limit at a coincident temperature at which a fluid is not expected to exceed. (Note: The design pressure can be based on a pump's TDH, process limitations, or equipment limitations. Such limitations are controlled by pressure relief devices and/or pressure control devises.)

System design pressures and temperatures are the base values for determining component pressure ratings, pipe/tubing wall thickness, and leak testing pressures. Once these values have been determined, typically by the process engineer, then para. 301.2.1, of the ASME B31.3 Process Piping code can be complied with, which states, in part:

"(a) The design pressure of each component in a piping system shall be not less than the pressure at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service, except as provided in para. 302.2.4."

The piping code does not provide guidance or stated requirements for system design pressure. The only requirement is that the pressure rating, whether calculated or listed, for components, pipe/tubing wall thickness, and equipment Maximum Allowable Working Pressure (MAWP) needs to meet or exceed the system design pressure.

While mechanical joints, such as flanges, have a pressure rating, buttweld fittings do not. As ASME B16.9 Pressure Ratings, subparagraph 2.1 Basis of Ratings, states it:

"The allowable pressure ratings for fittings designed in accordance with this Standard may be calculated as for straight seamless pipe of equivalent material (as shown by comparison of composition and mechanical properties in the respective material specifications) in accordance with the rules established in the applicable sections of ASME B31, Code for Pressure Piping. For the calculation, applicable data for the pipe size, wall thickness, and material that are equivalent to that of the fitting shall be used. Pipe size, wall thickness (or schedule number), and material identity on the fittings are in lieu of pressure rating markings."

It goes on to describe the "proof test" procedure for the manufacturer under paragraph 9.3, which is essentially pressurizing the test coupon assembly to either the point of "…rupture or held at or above the computed minimum proof pressure for a period of at least 3 min."

The equation for the proof test is the modified Barlow's formula, as shown in eq. 1:

$$P = \frac{2St}{D} f \qquad \text{(Eq. 1)}$$

Where			
	D	=	specified outside diameter of pipe
	f	=	testing factor from table in para. 9.3
	P	=	computed minimum proof test pressure for fitting
	S	=	actual tensile strength of the test fitting, determined on a specimen representative of the test fitting, which shall meet the tensile strength requirements of the applicable material of section 5
	t	=	nominal pipe wall thickness of the pipe that the fitting marking identifies [*Deduct from (t) any mechanical allowances.*]

The resultant proof test pressure is then divided by a safety factor of 4 to arrive the MAWP or pressure rating for the buttweld fitting.■

QUESTION OR COMMENTS

If you would like us to address a specific topic or simply answer a question, related or unrelated to the content of this Newsletter, please contact us at: staff@wmhuittco.com. In the subject line of the email please enter "Newsletter Question/Comment."

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