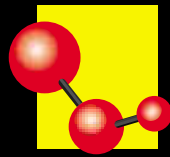


•Stop Welding on that Valve.



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Stop Welding on that Valve

Reaping the benefits of properly jacketed valves

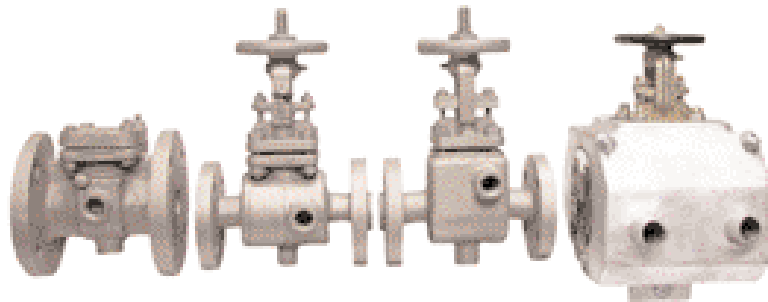
By Henry Gaines, P.E.

Recently a butterfly valve at a Taiwan refinery “torqued itself to death.” Besides shutting down a sulfur recovery unit for days and endangering refinery output, the failure cost thousands of dollars in labor and replacements.

The root cause was a poorly designed weld-on jacket that did not provide adequate heat to the bearing housing area and the adjacent process flanges. Sulfur condensed and froze as the result of heat loss through those critical areas. Weld-induced distortion in the bearing housing area exacerbated the problem. The valve was jacketed with a conventional welded-on steam jacket designed and fabricated by a traditional pipe fabrication shop. When the valve actuator received the “go” signal and applied power to move the stem, the disc would not budge.

Unfortunately, failures of this sort are all too common. Over-torquing a frozen valve is just one of many possible failure modes. Casting defects exposed when external pressure is applied during hydrotest or by the heating medium are fairly commonplace, as is weld failure in the heat-affected zone. Pancaking (concaving) of flanges, caused by too much welding heat, can result in bolt-up problems during valve installation.

Many fabricators of weld-on valve jackets fail to apply good design practices because no industry standards govern this specialty fabrication. Furthermore, most corporate engineering specifications for jacketed valves are old, very broad and do not specify any design or fabrication standard. In general, almost any design and fabrication practice is allowed as long as the valve type, model, trim, manufacturer and rating are within specification; the face-to-face dimension is within tolerance; the flange size and rating specification is adhered to; and Nondestructive Evaluation Program (NDE) requirements are met. NDE requirements usually involve a simple jacket hydrotest, but rarely is the valve required to be post-tested to ensure the class (leak rate) is maintained.



A jacketed valve specification rarely references or requires:

- 1 American Society of Mechanical Engineers (ASME) Section VIII Code compliance.
- 1 Fabrication completed by welders currently certified to Section IX of the ASME Code.
- 1 Specific joint configuration for terminating the jacket at the flange or bonnet.
- 1 Weld detail for “seal” welding the bolts at the bonnet.
- 1 Specific jacket coverage requirements.
- 1 Specific construction materials

Although all the pictured valves can be classified as jacketed, the first valve (from the left) has very little coverage on the body and no coverage on the bonnet flange. The second has body coverage but lacks bonnet flange coverage. The third has body and bonnet flange coverage, but like the previous two, no pipe flange coverage. The last valve is jacketed with a bolt-on jacket; body, bonnet flange and pipe flange coverage is standard.

for the jacket, flanges or bonnet bolts.

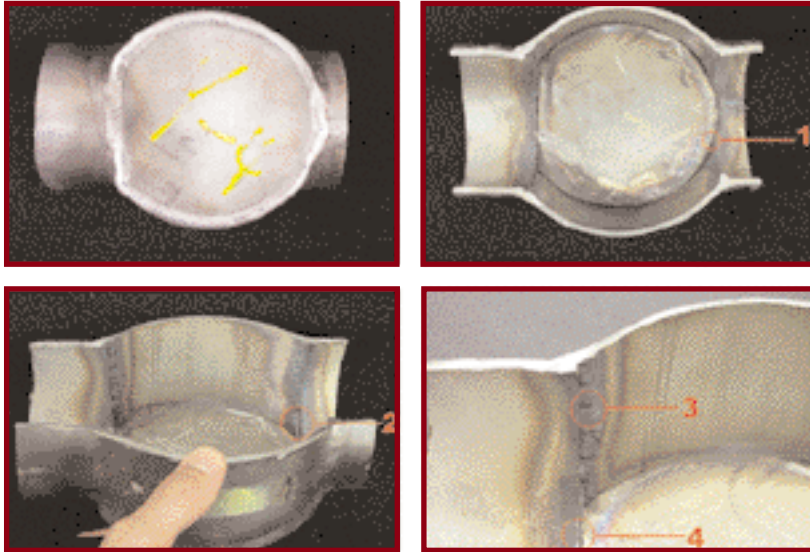
- 1 Solution annealing or other post-weld heat treatment.
- 1 Approval drawings prior to construction.

Left to their own devices, fabricators often default to the lowest-cost design to ensure the highest potential for contract award. Most valve manufacturers have encountered problems or failures after fabricating and modifying the original equipment in an attempt to provide the customer with a jacketed valve.

Preventing valve failures
Valve failures occur across all process industries as a result of improper jacketing. Annual costs in lost production, spare parts and maintenance overtime easily can add up to millions of dollars. Almost

¹The author’s company has designed and manufactured both weld-on and bolt-on jacketing for more than 30 years.

VALVES



From its outward appearance, the joint configuration and welding techniques appear to be of high quality. However, several problems can be seen by using a borescope to look at the jacket internally:

1. The joint configurations are not designed in accordance with any code and are not allowable by ASME Section VIII, Div. 1, Appendix 9. Neither full penetration nor appropriate fillet welds are used.
2. Misalignment is clearly evident, and "slugging" is used to close gaps caused by poor layout.
3. The obvious oxidation, or sugaring, of the weld resulted because a purge gas was not used to make the stainless weld.
4. The materials clearly were not beveled, and metal slivers remain on the base metals.

all of these failures could be prevented through the use of bolt-on jacketing, which does not require modification of the original valve.¹ If welded jacketing is unavoidable, a valve-jacketing expert should perform the task.

A valve is not a piece of pipe. It is a precisely made flow-control device. Its performance depends on tight tolerances. It is not designed to withstand the heat input from welding a jacket to its body and flanges.

Most process valves are made of castings that are machined to final tolerance. Inevitably, these castings have tiny areas of porosity, inclusions and tiny cracks that go undetected when tested under internal pressure. However, these flaws are exposed and become problematic when external pressure is applied. Many fully jacketed valves have needed repairs or have been scrapped because of casting defects that showed up in a post-

fabrication hydrotest. More often than not, the larger the valve (and the more expensive) the higher the probability of a casting defect. Such a defect can upset a project schedule if the valve has a significant lead-time and the defect is not found until the final testing stage before installation.

Although the original equipment is designed to perform for years, once an arc is struck on it — no matter how carefully — all bets are off. Even the most careful fabrication techniques still can result in problems.

Fabrication craftsmen employ very creative techniques to "lay a cool bead." For example, some will pack a valve with a cooling fluid, use stabilizer rods and bolt on a blind flange with a machined channel for cooling fluid. Unfortunately, these techniques do not help much when 40 pounds of weld metal is being applied to an 8-inch (in.) by 10-in.

jacketed valve. Most valves simply are not designed to be jacketed or modified prior to use.

In defense of weld-ons

Although fabrication of a weld-on valve jacket is a torturous process and should be avoided if possible, welded jacketing does have its place. Until about 10 years ago, it was still the predominant methodology for maintaining the process temperature through a valve.

In fact, no better solution is available for achieving melt-out in a specific component after a process upset. Because of the independent barrier between the heating medium and the valve, a bolt-on jacket could take longer to heat up the valve body. If the jacketed component is the limiting factor for resuming operations, then a weld-on jacket may be the preferred solution.²

A weld-on jacket also remains the preferred solution in some demanding heated processes. A few processes, including some bituminous process streams and molten salt applications, have operating temperatures from 850°F to 1,100°F and could benefit from weld-on jackets.

Likewise, nylon producers typically dictate the use of weld-on jackets. Direct contact of the heating medium to the valve is preferred because of the narrow required temperature difference between the heating medium and the process maintenance temperature. The required nylon maintenance temperature in the transfer line typically is within 1°F of the Dowtherm heating medium temperature — commonly operating near 600°F. It also is common in nylon applications to require the jacketed valves to be heat-treated after welding. Very extensive and expensive NDE requirements commonly are used in an attempt to guarantee many years of acceptable performance. Furthermore, welded jacketed valves for nylon service normally must have very precise flow patterns, dimensions and surface finishes, putting them into a unique and expensive category.

²It is the author's experience, however, that valve or piping component melt-out rarely is the bottleneck to resuming production.

VALVES

Bolt-on benefits

For the vast majority of heated processes, bolt-on jacketing is the smart choice. It has proven itself through years of operating success across a broad range of process applications. It eliminates the need to modify the original equipment and eliminates the variance in design and fabrication seen across weld-on jacketed valves.

For many years, control valve



and flowmeter manufacturers have used bolt-on jacketing to protect sensitive, expensive equipment. For example, no fabricator wants to accept responsibility for welding a jacket on a Fisher Vee-Ball Series control valve or a Micro Motion Coriolis flowmeter. Why treat ball, gate, check, butterfly or plug valves differently? This type of equipment can be just as critical to process operations as the control equipment. If the valve or the jacket fails, the line shuts down. Restarting the line after repairing or replacing the component is much easier to accomplish if a bolt-on jacket is employed.

Bolt-on jacket construction

As the name implies, bolt-on jacket-

ing bolts around the valve body and is readily removable. It usually consists of a two-piece aluminum casting made specifically for each process component's type, size and model, and fits very closely for good heat transfer (usually with the help of a thin layer of heat-transfer mastic). An integral cast-in pressure chamber made from carbon steel or stainless steel contains the heating medium.

The pressure chamber, designed and tested in accordance with



This cast-iron aluminum jacket is manufactured specifically to fit the type, size, model and rating of the component being jacketed. The pressure chamber is cast into the jacket and can be manufactured with any "jumper" connection specified.

ASME Code, is fabricated with the requested inlet and outlet connection to transfer the heating medium — water, steam, hot oil, hot oil vapor or glycol/water, depending on service temperature requirements and customer preferences.

Failure prevention aside, bolt-on jacketing typically cuts valve ownership cost by at least 25 percent over a traditional weld-on jacket with over-size flanges. Its cost is comparable to that of partial weld-on jackets. Standard jackets are available for most major valve manufacturers in most types, models, sizes and rat-

ings. With more than 5,000 jacket setups in factory inventory, most are available on a two- to three-week lead-time.

Because the jacketing is a separate component, it can be manufactured concurrently with valve procurement. This is particularly advantageous on capital projects with demanding schedules because the valves can be shipped directly from the manufacturer and installed into the piping system prior to jacket arrival. This scenario also saves on freight costs. Furthermore, because bolt-on jacketing allows the use of standard "off-the-shelf" valves, custom spares are not required. Weld-on jacketing, by contrast, is always a custom job requiring valve receipt before the jacket can be manufactured. Weld-on jackets typically require longer lead times and the stocking of custom spares.

Because the bolt-on jacket is removable and reusable, it need not be thrown away if the valve cannot be fixed. Instead, the jacket is unbolted from the valve needing replacement and bolted onto the new valve.

A proven solution

Thirty years ago, when bolt-on jacketing was new to the chemical processing industry, proven weld-on jacketing was the mainstay technology. But over the years, tens of thousands of bolt-on jackets have gone onto valves and process components of all types. Their value, functionality and reliability have been proven.

When requested, for example, ControHeat cast-aluminum bolt-on jackets carry an official Canadian registration number; as such, they are approved by the Canadian Boiler Board for every province. This is a good indication of the acceptability of the bolt-on jacket as pressure-containing equipment, because testing for this approval is stringent. Furthermore, the pressure rating of the jackets is attained via destructive testing in accordance with ASME Section, VIII Div. 1, Paragraph UG.101.

Bolt-on jacketing works for thermal maintenance in molten sulfur

processing and transport, as well as in production of phthalic anhydride, caprolactam, acrylic acid, dimethyl terephthalate, asphalt, resins, hot-melt adhesives, bisphenol-A and many other heated processes.

Standard bolt-on jackets are available for plug, ball, gate, check, control and butterfly valves. Valve size and class are not a problem. For example, a polymer plant recently used bolt-on jacketing for all of its high-temperature ball valves — from sev-



Hundreds of bolt-on jackets were used for temperature maintenance on the valves in this jacketed system.

eral 2-in. Jamesbury 5150 valve to a Neles Jamesbury 12-in. 300# two-piece ball valve with a face-to-face dimension of 25.5 in. ExxonMobil has hundreds of bolt-on jackets that maintain the temperature of its plug valves used in molten phthalic anhydride service. And the world's largest molten sulfur transport ship passed the five-year mark without a single freeze-up in any of its pumps or 35 valves. All have bolt-on jacketing.

Frequently special bolt-on jackets are manufactured for large high-ticket custom process components. For example, a 42-in. butterfly jacket for a Fisher A31D butterfly valve was built for use in sulfur tail-gas service at an ExxonMobil refinery in Malaysia.

Jacket retrofitting

If a valve with a weld-on jacket fails, a changeover to a standard valve

can be made, and bolt-on jacketing can be added at that point. Usually the switch can be made with no modifications to the piping system. If the failed valve was only partially jacketed (i.e., the jacket terminated prior to the flange, enabling a core-size flange with a standard face to face), no pipe modifications are required. A standard valve with a bolt-on jacket can be ordered.

Even if the failed valve was designed with oversized flanges to allow the jacket to terminate on the back of the flange, typically no modifications are required. Often, it is still cheaper to size up the valve one size and order a bolt-on jacket than to replace the weld-on jacket. With the exception of critical instrumentation and control applications, applications using a larger valve body rarely create a problem with the process.

If problems occur in sizing up the valve, a field modification of the mating process flanges can be performed to enable installation of a standard valve and bolt-on jacket. For a new project, a simple change to the piping specification calling for core-size flange terminations allows the use of standard valves and bolt-on jackets.

If the block-valve specifications are old, they likely will call for a weld-on jacket. However, the specifications probably were written before bolt-on jacketing had proven itself. A process engineer should be consulted to get the change approval. In 95 percent of cases, the change can be made.³

Bolt-ons to avoid

An alternative type of bolt-on jacket features an all-welded carbon or stainless-steel construction and is fabricated with an outer shell and a contoured inner shell that corresponds to the component body. The hollow annulus conveys the heating medium. Although occasionally fabricated, this type of bolt-on jacket is not recommended.⁴ Its use has sev-

eral drawbacks.

First, fabricated bolt-on jackets do not fit the process component as well as cast-aluminum jackets because the component shapes are replicated more easily by molding than by fabricating.

Second, fabricated bolt-on jackets are very difficult to manufacture in accordance with applicable ASME codes.⁵ Often, the internal jacket dimensions are large enough to put the fabrication within the jurisdiction of the code, thus requiring a code stamp (U). This significantly increases the cost, especially if proof-testing of a finished assembly is required. Additionally, the joint designs, when fabricated in accordance with the ASME Code, add substantially to jacket cost.

Last, the lead-time associated with manufacturing these jackets typically is longer because of the products' labor-intensive nature and the care and craftsmanship required to fabricate the jacket with acceptable joint configurations.

When bolt-ons are not an option

Sometimes a nonnegotiable specification or existing equipment precludes bolt-on jacketing. And welded jacketing is imperative in a few applications to meet process requirements. In these cases, plants must ensure jacket welding minimizes adverse effects on the valve. These tips can help plants protect their investments and the integrity of their processes when weld-on jacketing is unavoidable:

The jacketing should be designed and fabricated by a valve-jacketing specialist who manufactures valve jackets using practices set forth by the ASME Pressure Vessel Code. Both the design and the fabrication must be correct. Too often, jacketed valves are put into service with jackets exhibiting large flat areas without pressure-containing stay pins. Poor jacket design and fabrication caused a major oil

³Also, it is very likely the system pumps, control valves and flowmeters will be jacketed with ControHeat bolt-on cast aluminum jackets when they arrive from the manufacturer.

⁴Based on the author's experience.

⁵Every fabricated bolt-on jacket the author's company has inspected as a third-party expert used unacceptable joint configurations, according to ASME code.

leak at one polymer plant in Georgia, posing severe fire and environmental safety hazards.

The plant should ensure the fabricator understands valves and can evaluate the valve performance both prefabrication and post-fabrication. The valve might become damaged during fabrication; therefore, the plant might want to find a fabricator with the in-house capability to repair the valve.

The fabricator should have proven experience and be willing to guarantee his or her work. The plant also should determine whether or not the valve manufacturer will stand by its original equipment warranty after the fabricator has modified the valve, or vice versa.

The design should address heat distribution, especially on large valves. All cold spots need to be prevented. Many problems occur in large process vapor services employing large butterfly valves. Although the valve body is jacketed, the large adjacent process flanges often are left unheated. They can become a huge heat sink, pulling heat away from the valve. The process condenses and often freezes, causing problems with valve performance.

The design should provide for only ASME-approved welds. Such designs might be more expensive, but the plant is assured the joint configuration is sound. Many fabricators will employ corner joints to reduce fabrication costs. However, this joint configuration is not acceptable by any code and is likely to result in a safety hazard. If the construction is in question, a boroscope should be used to view the construction internally.

Post-fabrication performance testing of the valve should be required as a condition of acceptance. The plant should write it into the job order at the outset, and should ensure it covers the full function over the entire operating range. Pre- and post-fabrication testing will ensure the fabrication does not compromise the seating capability of the equipment.

The fabricator should consider the

bolts on the bonnet flange. Standard bolts provided with the valve may not be of suitable materials for welding and could compromise bolt integrity. In addition, plants should insist on seeing the proposed weld design for "sealing" off the bonnet bolts. A seal weld commonly is employed to terminate the bolts into the bonnet. If the bonnet bolts are not recessed properly when the seal weld is applied, the bonnet bolt attachment might not withstand the internal pressure of the process or the torquing of the bolts.

The plant must ensure the valve is fully jacketed. The bonnet area or the packing-gland area often is mistakenly left unjacketed. This leaves a heat sink exposed to ambient conditions in the most critical area for functionality. Even with the best-designed jacket — weld-on or bolt-on — an expanse of bare metal can chill the process fluid, especially on applications with narrow temperature windows. The result is a freeze-up in the worst possible area. A bare flange, bonnet or packing gland can create cold spots, out-of-spec conditions and off-spec product. Damaged or compromised insulation on the adjoining piping and flange exacerbates the problem.

Before bolt-on jackets, no easy method was available for bringing the jacketing up and around the bonnet flange and the packing-gland area. However, bolt-on jacketing makes it easy to cover this area. The bolt-on solution for bonnets works regardless of whether the body is jacketed with a bolt-on or a weld-on jacket.

Likewise, the plant should ensure the jacket covers the flanges. They represent a large surface area and a heat sink. Partial weld-on jackets are less expensive and easier to fabricate than full flange-to-flange jacketing but can compromise the performance of the valve.

Adding value

Although properly jacketed valves represent just a small percentage of total plant costs, they exert enormous leverage where it matters, in throughput and uptime. Any failure

in the valve or the jacket will cause a line to shut down and throughput to plummet.

Getting the jacketing right is worth the cost. With no codes or standards in place to govern or even address this specialty fabrication, the job should be entrusted to an experienced thermal maintenance specialist. If possible, bolt-on jackets should be used to eliminate the need to alter the original equipment.

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