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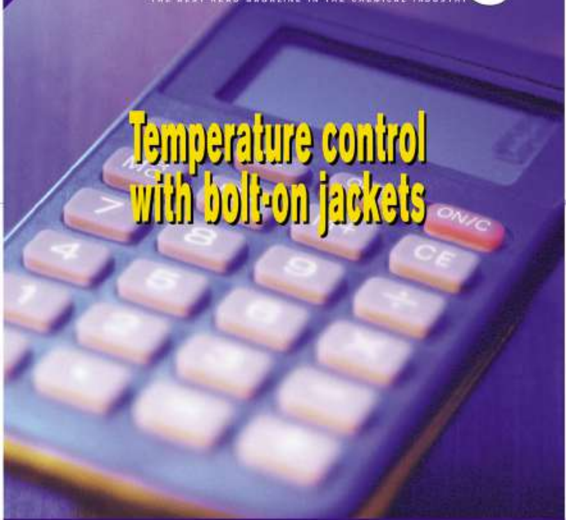
Chemical Processing

THE BEST READ MAGAZINE IN THE CHEMICAL INDUSTRY



Temperature control with bolt-on jackets

Process temperature control with bolt-on jackets

Economy, availability, adaptability among pluses

Traditionally, the integrally jacketed processing system (piping and equipment) has been made by fabricating a jacket onto the base components (Fig. 1), or by producing equipment from double-wall castings.

The thermal performance of the integrally jacketed system is the benchmark against which other process heating sources are compared. An integrally jacketed system heats quickly and maintains uniform processing temperatures. It has the "melt-out" capacity to achieve fast start-ups in the event the process freezes because of an unexpected stoppage of steam or other heating medium.

Disadvantages cited for the integrally jacketed system include high cost, limited selection of jacketed components and long delivery times.

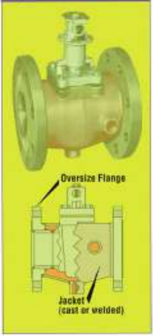
These limitations emphasize some advantages of the bolt-on heating system (Fig. 2), which warrant consideration for any project requiring close temperature maintenance.

Cost considerations

Initial and maintenance costs of the bolt-on jacket (and component) are lower than the integrally jacketed component. Reasonable delivery times are normal.

While most process components can be effectively heated with bolt-on jackets, the higher heat input rate of an integral jacket

Fig. 1.



Cast or welded (pictured) integral jackets on valves and other components provide benchmarks against which other process heating methods are compared.

Fig. 2.

Bolt-on heating jackets have evolved to a level of effectiveness that allows plant engineers and process designers to optimize processes by choosing from a wide selection of heated equipment.

is often cited as a performance advantage. It is true that bolt-on jacket heating speed is lower than that of integral jackets, but bolt-ons provide more than adequate heating speed for most processes.

The primary function of most heating jackets is to maintain process temperatures. The net heat transferred to a process, ideally, is zero. Therefore, the purpose of most heating jackets is to offset process heat loss to the atmosphere.

In this context, the jacket is a heat shield under normal processing conditions (Fig. 3). Melt-out is another function that properly designed jackets provide, even though heat input to the process is somewhat restrained by the double-wall heat path.

While the double-wall heat path retards thermal performance during start-up, it offers a singular advantage that easily offsets a lower rate of heat transfer. This important advantage is elimination of the possibility of crosscontamination.

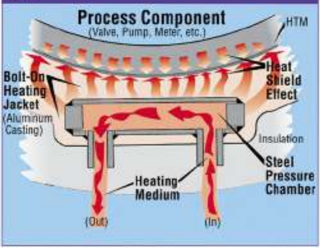
When process liquid enters the heating medium system or the heating medium breaches the process, cross contamination occurs (Fig. 4). Defects in castings and cracks in base components or core piping cause cross contamination that, in turn, can cause extensive problems in product quality. Production and maintenance costs skyrocket.

Unfortunately, cross contamination occurs more often than is commonly acknowledged.

Chemically aggressive processes and anhydrous processes are prime candidates for bolt-on heating systems. Products such as acrylic acid, cyanuric chloride, dimethyl terephthalate (DMT), phthalic anhydride, sodium, sulfur, phosphorus and various foodstuffs are typical processes that cannot tolerate cross contamination. The bolt-on heating system will melt out these processes while isolating the heating fluid from the process fluid.

The major contribution bolt-on heating technology makes to chemical processing is the extensive selection of jacketed equipment it makes available to designers and process engineers. For example, practically all flow measurement devices such as Coriolis meters, vortex shedding meters, orifice elements, turbine meters, and positive displacement meters are available with bolt-on heating jackets.

Fig. 3.



The primary function of the bolt-on heat jacket is to act as a heat shield, compensating for process heat loss during normal operation.

This jacketing versatility extends to valves, pumps, instruments, and special assemblies.

Jackets for valves

The two styles of bolt-on jackets most widely used for valves are shown in Fig. 5:

1. Cast aluminum bolt-on jacket with a steel pressure chamber embedded in the aluminum. The pressure chamber receives the heating fluid and the aluminum transfers heat to the valve body.

In a typical installation, heat transfer cement is used to fill any voids between the internal surface of the jacket and the body of the valve. The jacket covers the flanges of the valve. It can also be made to cover the mating flanges on adjacent piping, thus providing a heat shield to an entire valve station.

When the jacket raises component temperature to the process equilibrium temperature, the heat-shield effect (Fig. 3) comes into play, maintaining the process temperature within close tolerances.

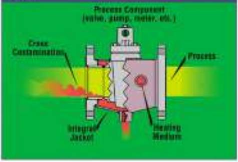
2. Fabricated bolt-on jacket, of carbon or stainless steel, made of several components. It is an all-welded construction fabricated with an outer shell and a contoured inner shell that corresponds to the component body. The hollow annulus conveys the heating fluid.

Fabricated bolt-on valve jackets are difficult to manufacture in accordance with the ASME BPV Code. There are two underlying reasons:

a. The internal dimensions of the jacket may be sufficiently large to put the fabrication within the jurisdiction of the Code, thus requiring a Code "Stamp" which substantially increases the unit cost. This is especially true when the jacket shape is complex enough to require proof testing of a finished assembly.

b. Joint designs in the fabricated jacket, when made in accordance with the ASME Code, add substantially to the cost of the jacket, compared to jackets made without ASME Code-sanctioned joint details. Fabricated bolt-on jackets usually do not fit the process component as well as the cast aluminum jackets, because most component shapes are more easily duplicated by molding than by fabrication.

Fig. 4.



When the heating medium breaches the core piping, the resulting cross contamination can create major quality and maintenance problems.

Fig. 5.

A cast aluminum jacket (left) and an all-steel fabricated jacket (right). Both types of jackets are designed to heat the mating flanges that sandwich the butterfly valves.

Pressure loads must be carefully analyzed to determine the number and location of pressure retaining stays (Fig. 5). Jackets with large, non-stayed areas are subject to potentially dangerous deformation under relatively low pressure loads.

Fabricated bolt-on jackets are installed on valves with heat transfer cement between the inner surface of the jacket and the body of the valve. From a thermal standpoint, these jackets can be made to perform well in service. They often require the use of substantially more heat transfer cement than the cast aluminum jackets.

Pumps and blowers

Uniform heating is critical for close-tolerance rotating equipment such as pumps and blowers. This equipment is difficult to jacket by fabricating integral jackets onto machined casings. The casings are very susceptible to warping caused by the welding process.

There are two methods of producing integral jackets on pumps. One method is to weld a jacket onto the pump casing and then machine the pump to the required tolerances. Another method is to cast the jacket and the pump simultaneously. Integral jackets for large pumps or blowers are not readily available. Several manufacturers of both centrifugal and positive displacement pumps have recognized the advantages of bolt-on jackets and actively promote this heating technique. Examples of pump and blower jackets are shown in Fig. 6.

Sizes of centrifugal pumps heated with bolt-on jackets range from 2-in x 1-in x 6-in to 10-in x 8-in x 18-in. Induced draft blowers frequently used in sulfur storage facilities (with wheel diameters up to 8-ft) have been heated with bolt-on jackets. At the other end of the spectrum, small gear pumps used in synthetic fiber production and only a few centimeters in diameter can be uniformly heated to 750°F.

Meters and instruments

As noted earlier, the versatility of the bolt-on heating technology is illustrated by the variety of meters that can be heated uniformly to their highest temperature limits with bolt-on jackets (Fig. 7). Compared to tube tracing, the major advantage of the bolt-on jacket is the consistency of installation that can be achieved each time the meter or instrument is pulled from the line for maintenance and calibration.

Many meters and instruments are sensitive to thermal-stress distortion that occurs when a section of the component body receives high heat input while another section is relatively cold. Uneven heating creates thermal stresses that can distort measurement accuracy. The bolt-on jacket, because it covers the entire component, heats the body of the component uniformly during start-ups. It maintains a uniform heat shield during operation that minimizes thermal stresses.

Fig. 6.

A broad range of rotating equipment uses bolt-on jackets.

Fig. 7.

Bolt-on jackets heat meters and instruments uniformly, minimizing thermal stresses that can cause inaccurate outputs.

Special assemblies

Bolt-on heating jackets have solved several unique thermal processing problems:

1. A polymer additive system operating at 500°F consisted of melt-pots, pumps, meters, and valves (Fig. 8). It was designed to allow an R&D facility to quickly vary formulations of polymer additives and provide the optimizing data to production. Hot oil heating was selected for this application.

Due to the complexity of the interconnecting piping with numerous valves and meters, the uniform heating provided by bolt-on jackets could not be duplicated by other heating methods without severely exceeding the plant's budget.

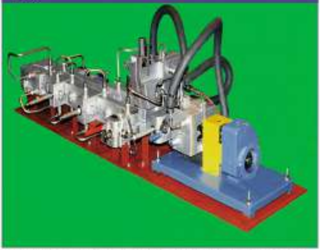
2. Bolt-on jacketing was selected for a pilot plant that needed relatively quick equipment rearrangement so that the products and processes under development could be tested with various pieces of equipment (Fig. 9). Fast equipment change-out with uniform heating was the major design contribution of the bolt-on heating system.

3. A heated process consisting of

Fig. 8.

Uniform temperature control for this polymer additive unit was achieved with a "total" bolt-on heating system, which proved to be more economical than a fabricated jacketed system.

Fig. 9.



Bolt-on heating system for pilot plant allows versatile testing of various equipment arrangements to speed development of new processes.

many jacketed components was needed in a relatively short period to meet an aggressive production schedule.

To simplify fabrication and speed-up delivery, the designers elected to heat the equipment (valves, pumps, meters and instruments) with bolt-on jackets (Fig. 10). Swaged jacket construction with insert flange connections was used on the piping system. The bolt-on jackets gave designers the freedom to select off-the-shelf equipment. The owner credits bolt-on jackets with helping ensure that the plant was erected and operational on the fast-track project schedule.

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Fig. 10.

Bolt-on jackets for valves, pumps and meters received high marks from plant owners for helping ensure that project construction met the start-up schedule.