MAINTAINING PROCESS TEMPERATURE

WITH

BOLT ON JACKETS

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ABSTRACT

Controls Southeast, Incorporated (CSI) has developed a family of attachable or "bolt-on" heating jackets which can be used with standard process valves in service at elevated temperatures. These jackets are in operation around the world on many different types of valves from many manufactures in many different processes at temperatures up to 400 degrees Celsius. The use of this jacketing technology offers many advantages to other methods of jacketing process valves as well as other process equipment.

INTRODUCTION

A large portion of today's process applications involve fluids which freeze at temperatures well above the freezing point of water. This requires that the designer, engineer and operator provide an environment around the process valve or other component which will be maintained at a temperature above the freezing point of the process under normal operation. This is commonly called "jacketing". As a matter of function, the jacket must also be capable of melting the process and bringing it to operating temperature should the process freeze.

Traditionally, the integrally jacketed processing system (piping and equipment) has been made by fabricating a jacket onto the base components (Fig. I), or by producing equipment from double-wall castings. An option to this configuration is to manufacture an independent device which attaches or bolts around the outside surface of the valve.

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. In the event the process freezes because of an unexpected stoppage of steam or other heating medium, the integrally jacketed system has the “melt-out” capacity to achieve fast start-up.

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.

THEORY and DISCUSSION

While most process components can be effectively heated with bolt-on jackets, the higher heat input rate of an integral jacket is often cited as a performance advantage. It is true that bolt-on jacket heating speed is lower than that of integral jackets, but they provide more than adequate heating for most processes. This is true since the melting of the valve or process component and its contents is rarely the critical path item for re-heating the system.

The primary function of most heating jackets is to maintain process temperatures. This duty is called “thermal maintenance”. The net heat transferred to a process, ideally, is zero. Therefore, the primary 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 bolt-on 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 startup, it normally offers several advantages that easily offset the lower rate of heat transfer.

The first important advantage is elimination of the possibility of cross contamination. 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 or heating medium 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 (PA), 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. ControHeat jackets (See description below) are currently in use on all of these processes.

The second advantage is that the properly designed bolt-on jacket covers sufficient additional surface area such as the perimeter of the flanges to offset the lower rate of heat transfer.

The third advantage is since the bolt-on jacket is used with a standard valve or process component it eliminates the requirement to purchase and stock expensive, specially modified items.

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 valves, pumps, general instrument elements and special 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. Since ControHeat jackets can easily be designed for conditions up to 400 degrees Celsius, the limiting factor for operation for valves and other process components with ControHeat jackets is the temperature limit of the component itself.

Jackets for Valves

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

1. CSI's ControHeat 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. The relatively high thermal conductivity of the aluminum very quickly results in a uniform jacket temperature at equilibrium conditions. (Fig. 6) Please note that the aluminum is not used as a pressure containing component.

In a typical installation a very thin layer of 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 the valve temperature to the process equilibrium temperature, the heat-shield effect (Fig. 3) comes into play, maintaining the process temperature within close tolerances.

Each valve jacket is designed specifically for each brand and model valve. The jacket fits the exact contours of the exterior of each specific valve. CSI has over 4000 patterns available for immediate use. As the ControHeat technology has become the preferred method for temperature maintenance of process components, new patterns are produced at a rate of 500-600 each year. Production capacity has recently been expanded to 15,000 units annually to accommodate the increasing demand.

2. Fabricated bolt-on jacket, of carbon or stainless steel, made of several components. The fabricated bolt-on jacket is an all-welded construction, fabricated with an outer shell and a contoured inner shell that corresponds to the component body as closely as possible. 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. This must be fabricated by a shop certified for ASME Code fabrication.

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.

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. They often require the use of substantially more heat transfer cement than the cast aluminum jackets.

Pumps and Blowers

Uniform heating is also 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. 7.

Sizes of centrifugal pumps heated with bolt-on jackets range from 50 mm x 25 mm x 250mm to 250 mm x 200 mm x 450 mm. Induced draft blowers frequently used in sulfur storage facilities (with wheel diameters up to 2.5 m) 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 400 degrees Celsius.

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. 8). 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.

APPLICATION EXAMPLES OF ALUMINUM BOLT-ON JACKETS

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

1. A polymer additive system operating at 260 degrees Celsius consisted of melt-pots. pumps, meters, and valves (Fig. 9). 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. 10). Fast equipment change-out with uniform heating was the major design contribution of the bolt-on heating system.

3. A heated process consisting of 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. 11). 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.

SUMMARY

The use of bolt on jackets on standard valves and process items is a proven and often preferred alternative to fabricated weld on or integral cast jacketed components. The use of such jackets allows the use of more readily available and less costly components while eliminating the possibility of cross contamination. The cast aluminum ControHeat jackets manufactured by Controls Southeast, Inc. offers improved fit compared to fabricated bolt-on options resulting in superior thermal performance.

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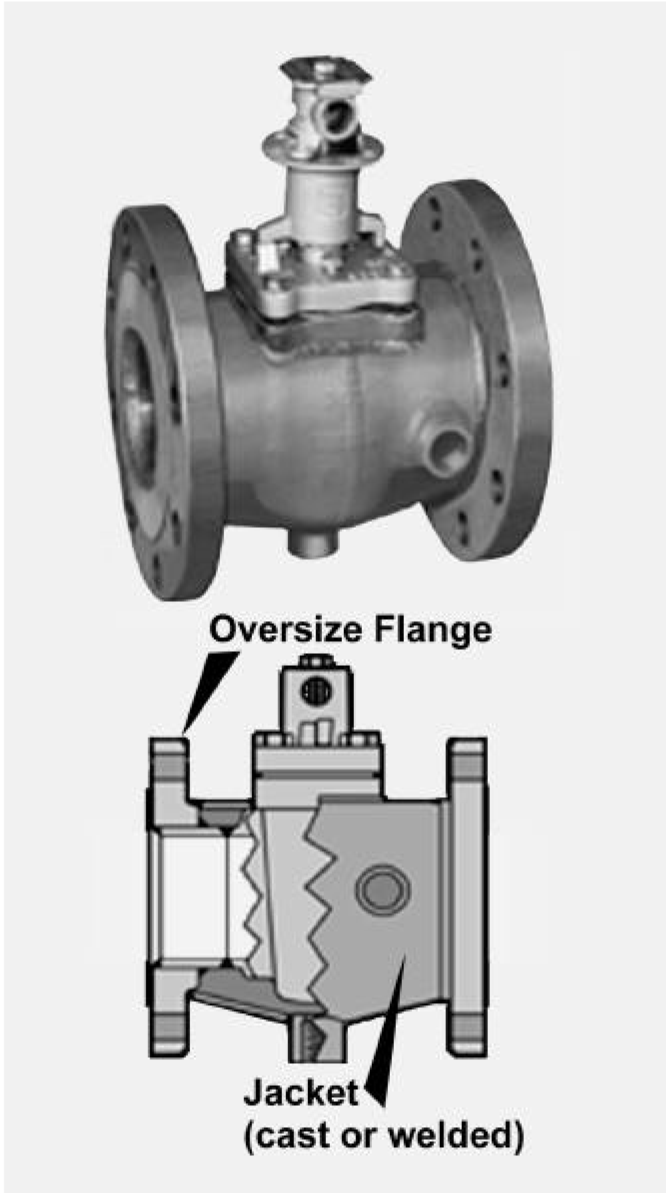


Figure 1
Fabricated Jacket

Figure 2
ContraHeat Bolt-On Jacket

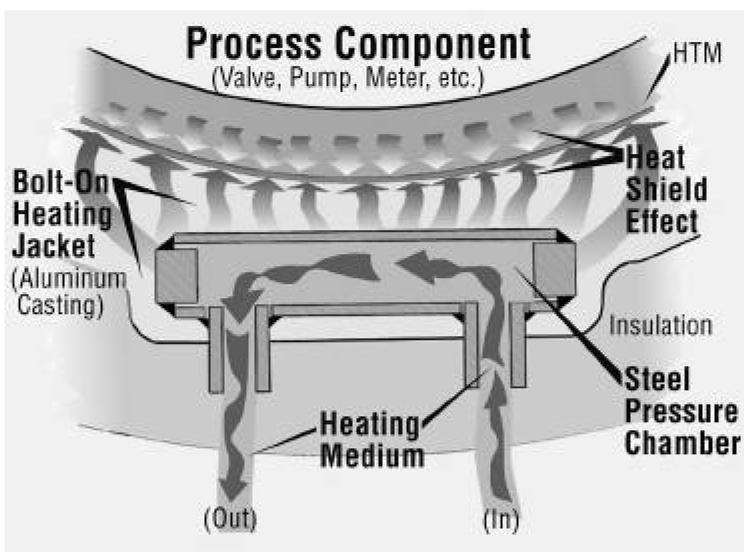


Figure 3
Heat Shield Effect

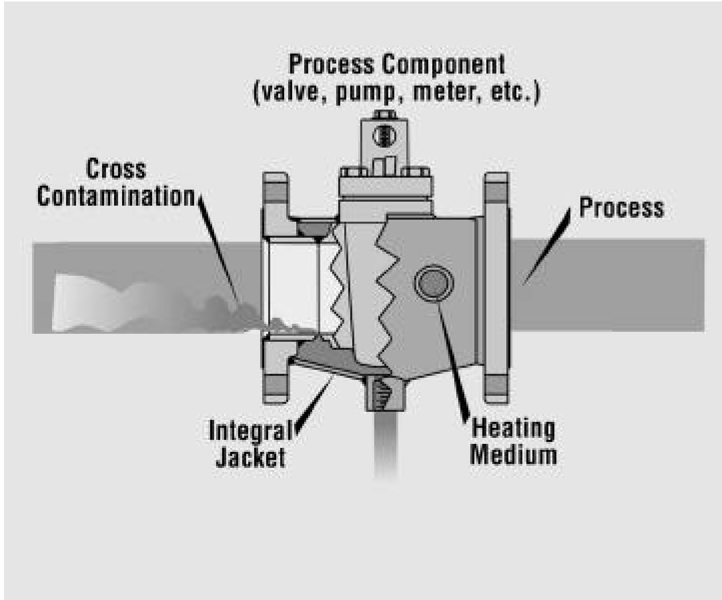


Figure 4
Cross Contamination

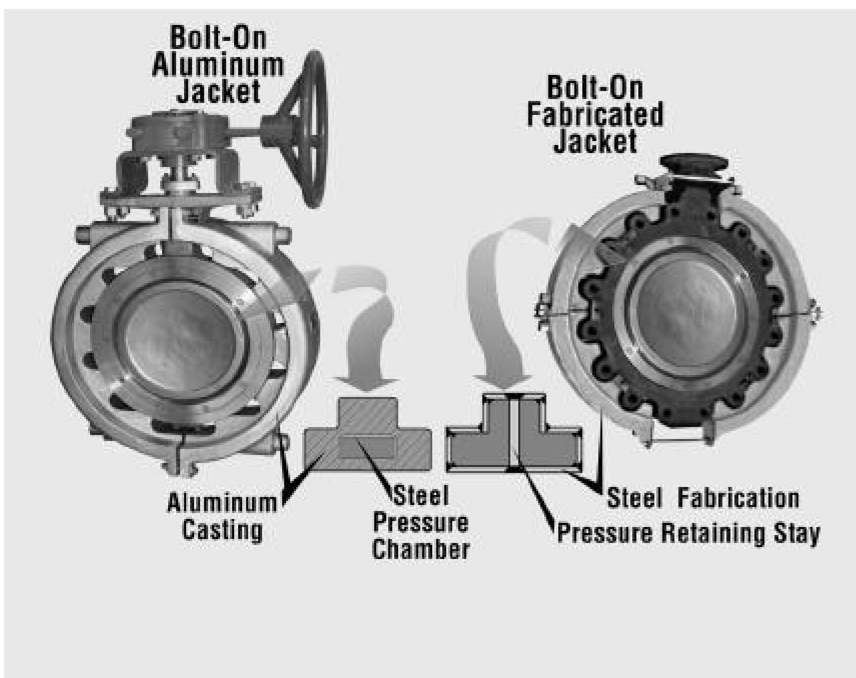
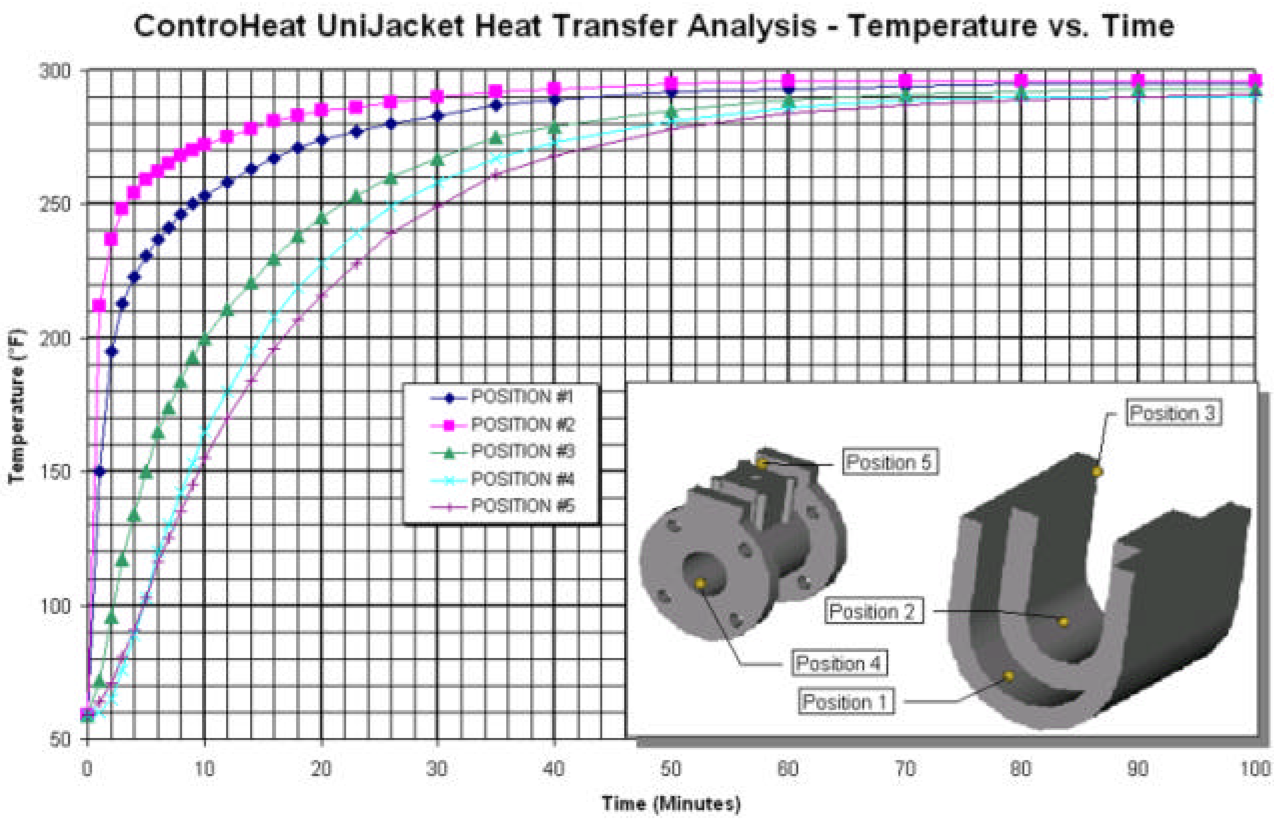


Figure 5
Cast Aluminum vs. Fabricated Bolt-On Jacket



Test was performed using a 1" 316 stainless steel plug valve in a ControHeat UniJacket. For optimal performance, Controls Southeast Grade 1 Heat Transfer Cement was used. The assembly was insulated with 2" of fiberglass and heated with 50 psig steam until equilibrium had been reached.

Figure 6
Heat Transfer Performance

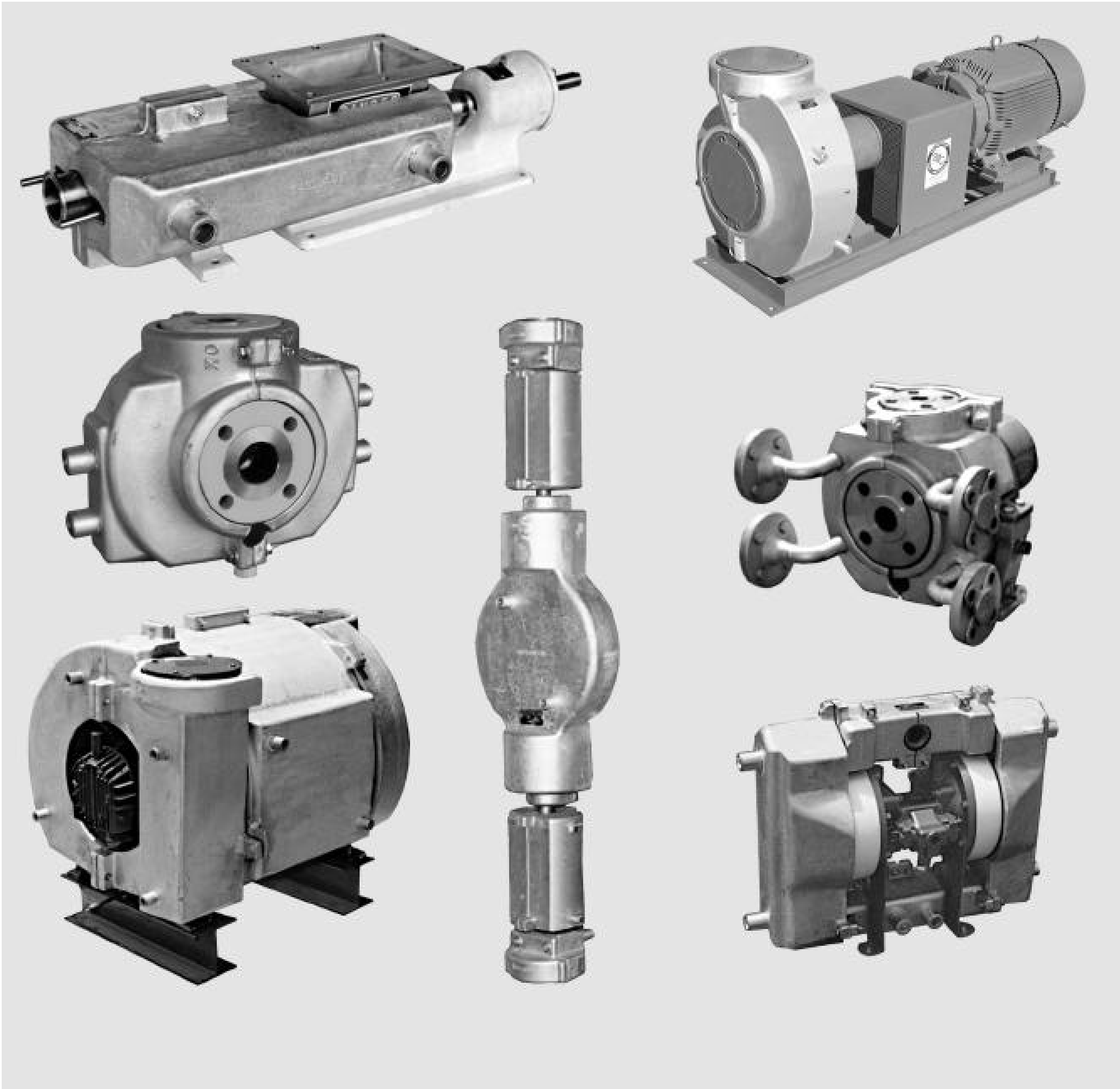


Figure 7
Bolt-On Jackets on Rotating Equipment

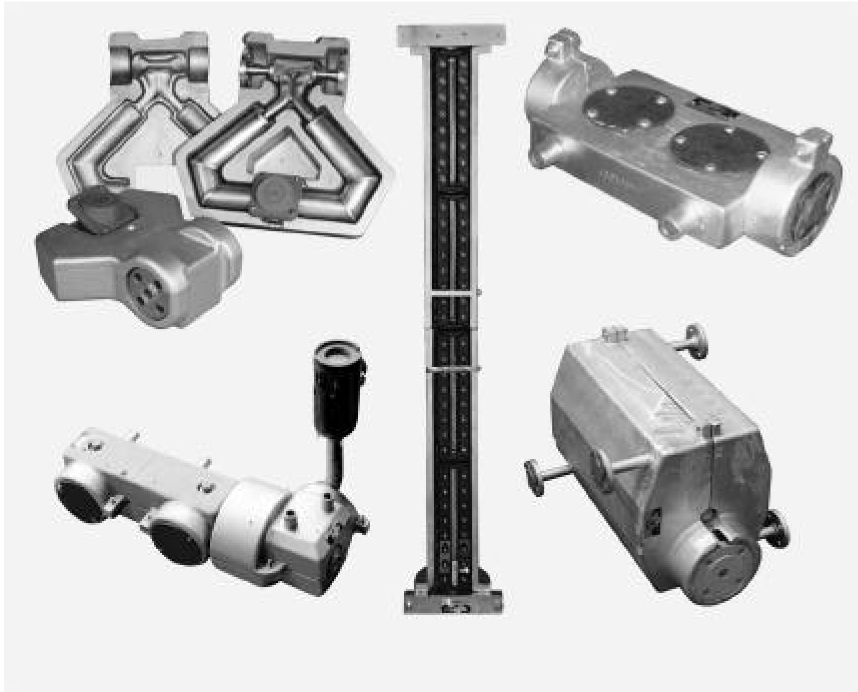


Figure 8
Bolt-On Jackets on Instrumentation

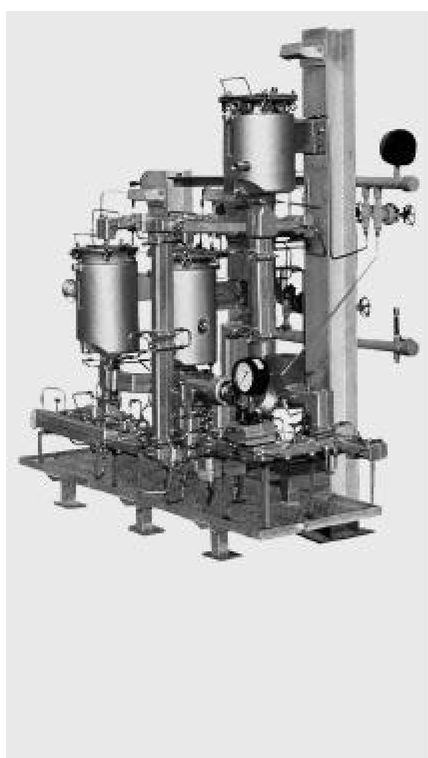


Figure 9
Bolt-On Jacketing on Polymer Additive System

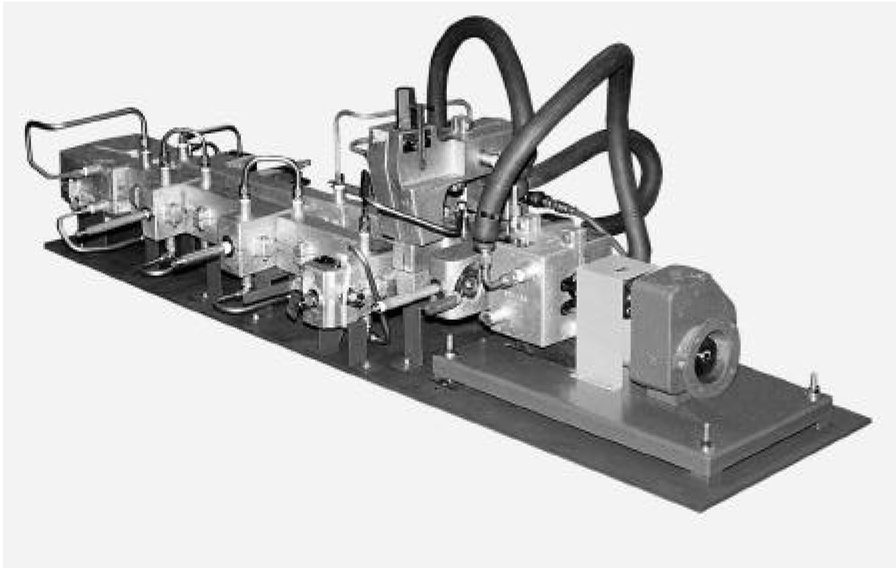


Figure 10
Bolt-On Jacketing on Valve and Metering System

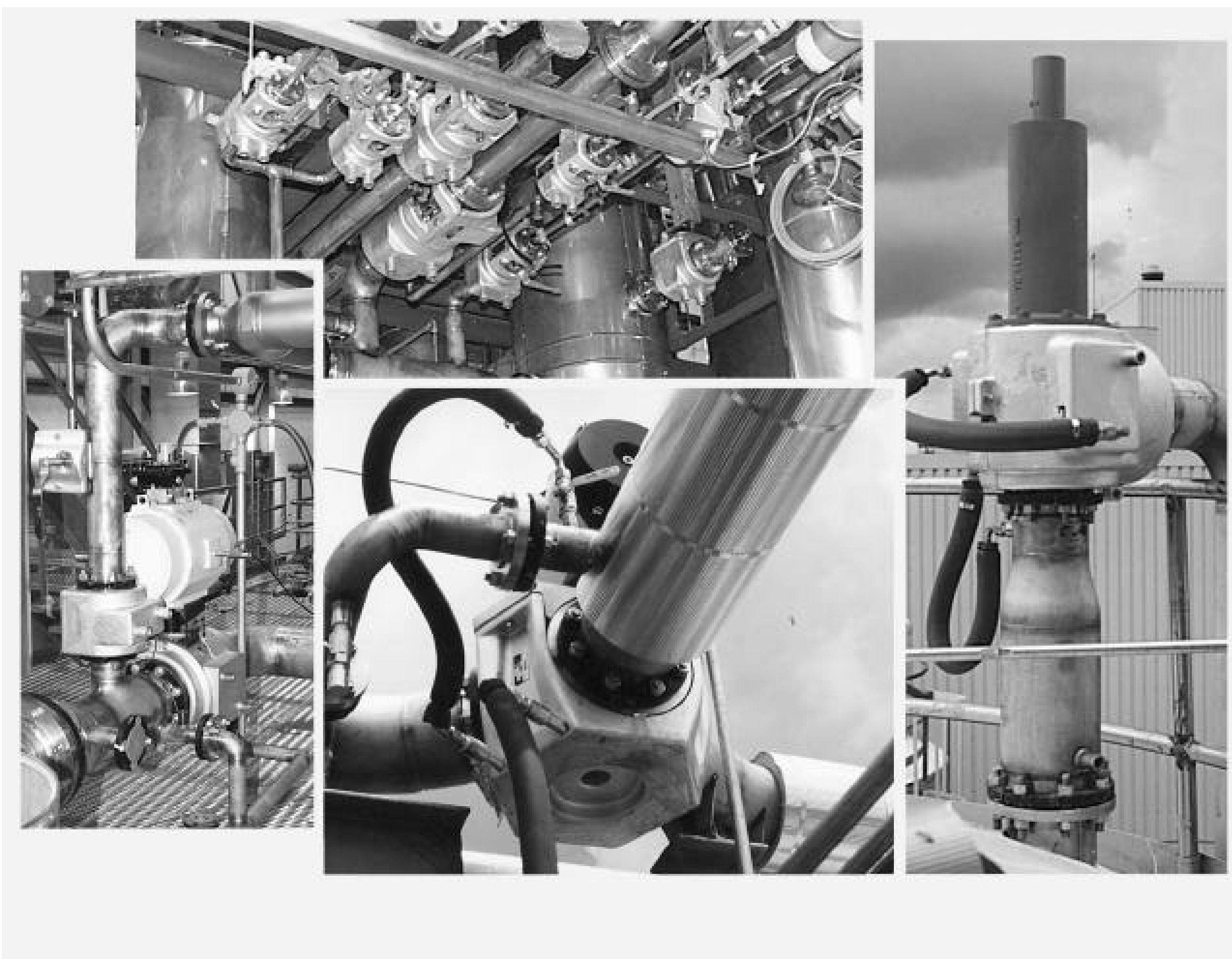


Figure 11
Bolt-On Jackets on Complete Process Systems