jacketing over insulation

BY JOHN W. KALIS

Proper selection of jacketing over insulation in most industrial settings is just as important as the selection of the insulation. An insulation jacket that fails may cause the entire insulation system to fail. Many jacketing materials are selected on the basis of the initial cost, when in fact, this is perhaps the last item to consider during the selection process. This article discusses the materials, environmental conditions, surface size and design considerations essential to proper jacketing for hot and cold operating systems.

Examples from industrial insulation systems highlight the proper selection of jacketing.

Corrugated panels and tank head. Photo courtesy of Proto Corp.

First, it is important to consider the following environmental conditions when selecting jacketing:

List of Conditions to Consider when Selecting Jacketing

Photo courtesy of Associated Insulation.

Indoor or Outdoor Exposure

Many engineers and specification writers believe that since the equipment and pipe are indoors, the jacket or finish is simply there to hold the insulation in place. The operations that take place in a building may require wash down areas or periodic checking of sprinkler systems. The responsible person should visit the site and personally inspect the conditions. If it's a new facility, he or she should question the project engineer or manager in order to learn about all of the conditions.

Chemical Exposure

Any process that produces a chemical that can shorten the life of the jacket and insulation system must be a concern. Most manufacturers will provide information on the chemical resistance of their jacketing.

Temperature and/or Fire Exposure

Temperature exposure may be a consideration where the insulated pipe of equipment may be within inches of a non-insulated hot pipe or equipment. Even when two insulated pipes are side by side and the jacketing is touching the innerface, temperature can exceed the allowable temperature of the jacket. This is especially true where non-metal jacketing is a consideration.

Equipment and pipe systems containing combustible products may require protection with an insulation jacket that will resist chemical fires of 1700°F. for two hours. The jacketing material is usually stainless steel. Galvanized aluminum is an option, however, it is not recommended on stainless steel pipe and equipment since the zinc may leach from the galvanized aluminum and contribute to stress corrosion cracking.

Mechanical Abuse Exposure

This condition is the most difficult to evaluate. Again, the engineer must review the physical location of the pipe and equipment. The jacketing may be located adjacent to a vehicle traffic area or below a work area. Foot traffic on horizontal pipe and tank roofs is common. "Keep Off" signs do not work.

The resilience of the insulation may determine the jacketing. For example, a rigid insulation such as calcium silicate may require a lighter metal jacket than mineral wool or fiberglass insulation. This could be true where there is a pipe rack, and valves or flanges require maintenance from a ladder.

Personnel Safety

This is a concern on hot operating systems. The emissivity of the jacket surface can make a considerable difference in the surface temperature of the jacket. Run some insulated pipe systems using the North American Insulation Manufacturers Association's 3E Plus® program using various jacketing materials and their respective emissivities. The higher the jacket emissivity, the lower the surface temperature. The surface temperature can vary by as much as 40°F. The surface temperature should not exceed 140°F. The data input, such as the average high ambient air temperature and the wind speed, is critical. It is best to be conservative with a high ambient temperature and low wind speed when in doubt.

Jacketing Pipe

Jacketing insulated pipe should be a simple task–the main goal being prevention of moisture migration. This may be true on a refinery site, where the piping is done in long runs without interruption, but for chemical facilities the average straight run may be five feet to a valve, flange or ell. As long as the pipe jacketing that overlaps the seams is installed in a watershed fashion and properly secured, the insulation should remain dry.

The greatest problem occurs with jacket interruptions such as valves, flanges and fittings. The joint between the pipe jacket and the valve and flange cover jacket can fail. Many times it is caused by an insufficient overlap on the pipe insulation system. It is important to extend the flange or valve insulation cover over the pipe insulation at least two inches or the thickness of the pipe insulation, whichever is greatest. This will provide a surface area large enough to compensate for any movement between the pipe jacketing and the flange and valve covers.

Example

Several years ago an insulation contractor completed work on piping for a sulfuric acid plant. At startup, the pipe insulation jacketing pulled away from the flange and valve covers leaving open gaps. The contractor had the valve and flange covers pre-fabricated in the shop. The pipe insulator terminated the insulation at the flanges and valves where he thought was appropriate. Upon completion of the pipe insulation, the flange and valve covers were installed. The covers did not overlap the pipe insulation and jacket properly. The expansion of the hot pipe caused the joint to separate and open, exposing the pipe insulation.

Ells

Jacketed pipe ells are another source of moisture migration into the insulation. It begins with the typical two-piece metal ell installed with one of the tangent ends overlapping the metal pipe jacketing in a non-watershed fashion. At a typical plant site, it is not uncommon to find 10 percent

A pressed elbow is now available up to 24"x6". Photo courtesy of Sproule Manufacturing Co.

of the metal ell covers installed incorrectly. In addition the overlapping seams at the throat and heel seldom fit tight with a ¾" minimum overlap. Where an ell is turned horizontally, the seams must also be in watershed configuration. A bead of caulking sealant on these seams would also help.

Until recently, two-piece metal ell covers were limited to smaller size piping systems. With a pipe ell larger than 12 inches, a metal gore system was an alternative. Metal gores are labor intensive and subject to failure with the radial seams that have to be secured and sealed. Metal ell covers are now available for pipe up to 24 inches by 6 inches with 1 ½ diameter bends. This will help eliminate wet insulation and be cost effective on large piping insulation systems. (See photo above.)

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Aluminum jacketing over 2" FSK fiberglass board. Photo courtesy of Polyguard Products.

Options

In the United States, the jacketing standard on pipe and small equipment for industrial and other applications is 16-mil thick rolled aluminum. This jacketing over pipe insulation will resist most weather and abuse exposure. It is available in a variety of thicknesses, from 6-mil to 50-mil. This roll jacketing can be ordered with an acrylic coating of several colors or Tedlar® (polyvinyl fluoride) coated for severe chemical exposure. The rolled aluminum can be ordered with a smooth, stucco embossed and corrugated finish. The corrugations are circumferential, which provides additional strength and rigidity. Another feature the corrugations have is the improved sealing of the circumferential overlapping seams. It is surprising that this material is not in greater use. Some jacketing manufacturers offer 3'-and 4'-wide aluminum rolls. There are some industrial sites that use the 4'-wide rolls. The advantages include fewer circumferential seams and greater coverage production. However, the insulators would have to become familiar with the 4' rolls for it to be cost effective.

Polyvinyl Chloride (PVC) jacketing is being used more extensively in industrial applications. At one time, it was the choice only for the food industry. Now, with the ultra-violet (UV) resistance, higher temperature resistance and low flame/smoke ratings, PVC is being applied in areas where only metal jacketing was used. Although 20-mil thick PVC jacketing is commonly used on many applications it should be limited to indoor applications in areas where there is no exposure to any abuse. The minimum thickness for industrial applications, indoors and outdoors, should be 30-mil thick PVC roll jacketing. The use of PVC the past several years has proved that solvent welding of the joints can effectively seal the seam permanently when applied correctly. **A note of caution:** PVC less than 30-mil thick may not solvent-bond correctly at the seam. It is recommended that the insulator experiment with the PVC cement on sample pieces to become familiar with the application. Be sure to order the PVC roll jacketing pre-

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30-mil thick PVC jacketing on pipe next to PVC jacketed tank. Photo courtesy of Proto Corp.

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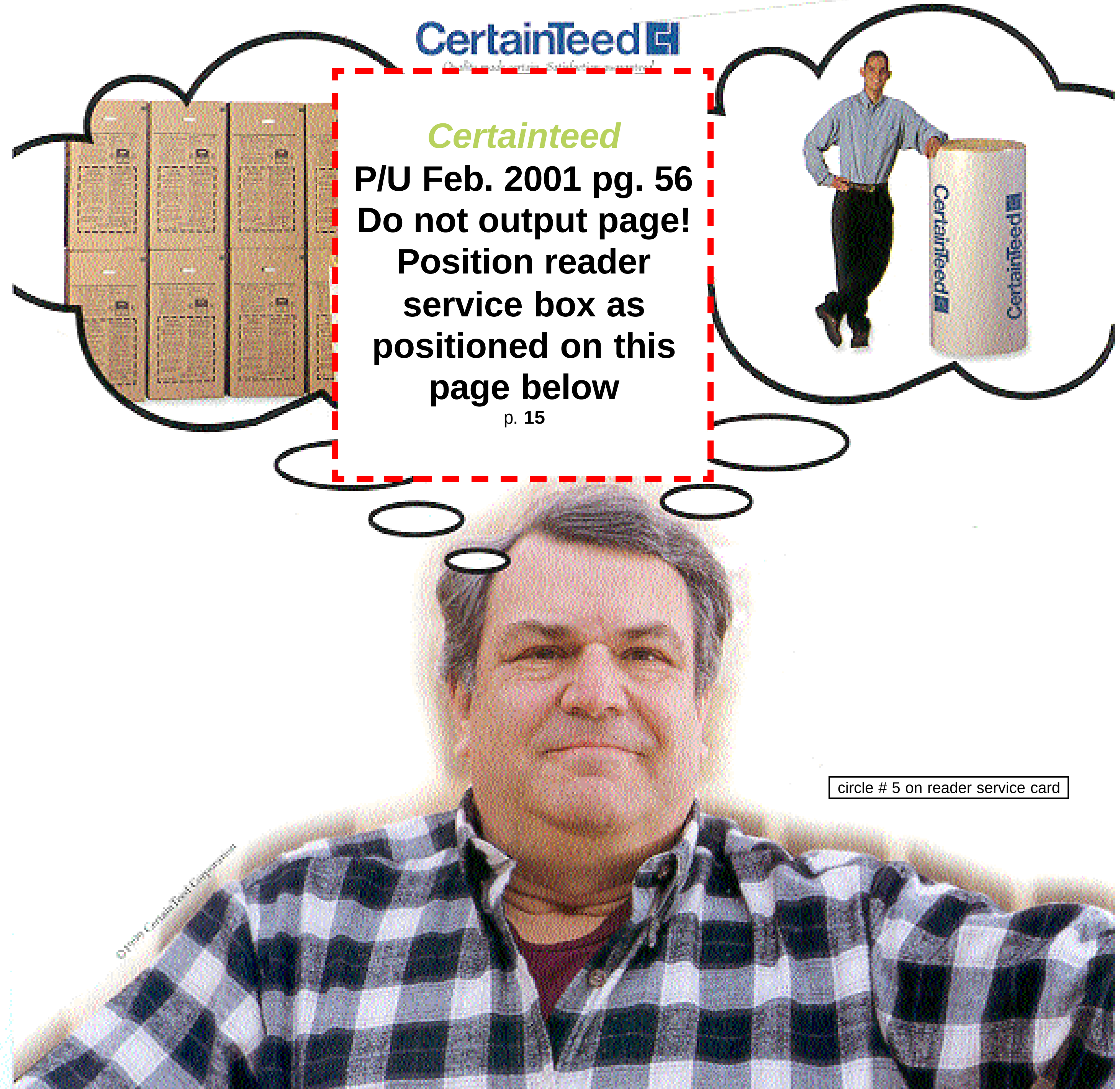

curled for piping applications, otherwise, the longitudinal seam may be difficult to seal.

Composite Jacketing

Where pipe insulation requires total protection from the weather, impact and harsh chemicals, composite flexible jacket in rolls may be the solution. This jacket is a composite of Tedlar® (polyvinyl fluoride), two layers of Hypalon®, fiberglass reinforcing and Mylar® (polyester film). Where insulation jacketing is to serve as a vapor retarder, the material is available with a corrosion resistant aluminized Mylar. This material is easy to install by overlapping the seams and sealing it with a matching pressure-sensitive tape.

A 60-mil thick rubberized bitumen compound finished with a thick aluminum foil facing is available. It is resistant to the weather and is an excellent vapor retarder. This rolled material has a contact adhesive on one side for ease of application and is ideal or HVAC and process rectangular ducts located outdoors on building roofs. It can be applied over the duct insulation or directly to the surface. The Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) recommends a minimum 50-mil elastomeric membrane for protection on exterior ducts. (See photo on p. 14.)

Factory Applied Jacketing on Insulation

There is factory applied jacketing that affords excellent insulation protection. It is a 30-mil thick PVC polyester coated fabric jacket that is resistant to weather, most chemicals, mechanical abuse and serves as a vapor retarder for cold systems. The jacket has a self-sealing longitudinal flap. The flexible melamine insulation with a wide service temperature range comes with this jacket in all pipe sizes. Installing the insulation and jacket in a single application can be cost effective for many piping projects. The factory-applied jacket comes in a variety of colors for pipe identification. (See photo below.)

Many types of insulation materials are available with ASJ (All Surface Jacket), vapor retarder. The ASJ product is a variant of the FSK (Foil-Scrim-Kraft), also know as Foil-Reinforced-Kraft. Many insulation manufacturers and fabricators provide this jacketing on their insulation. It is generally a one-piece section of pipe insulation that snaps on the pipe and is secured with a self-sealing longitudinal seam. The butt joints are sealed with matching tape.

The aluminum foil component on this jacketing uses a foil ranging from 0.000285" to 0.00033" thick. Mechanical abuse, severe handling or wrinkling of this thin foil may compromise the performance as a vapor retarder on cold operating systems. Where this abuse is apparent, there is currently an ASJ/FSK jacket available using nominal 0.001" (1-mil) foil. (See photo on p. 18.)

In areas where this jacketing can get wet, additional jacketing over the factory-applied jacket must be installed.

A word of caution: If the operation of the process is dual-temperature, cycle or shut

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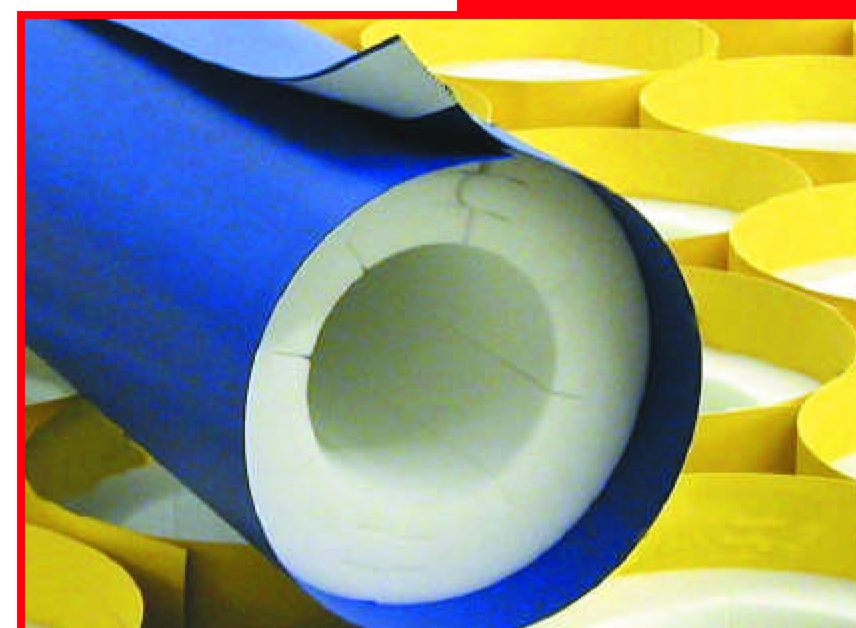

Melamine foam insulation pre-jacketed with a polyester fabric reinforced PVC covering. Photo courtesy of Accesible Products (Techlite Insulation).

down periodically, the dew point of the jacketing inner-face can be reached. When this happens, the vapor-moisture can collect between the jackets causing deterioration of the ASJ/FSK jacket or corrosion to the outside metal jacket. If this condition is a possibility, then install a single jacket. If that is not possible, and the outside jacket is metal, specify the 2.5-mil Poly/Surlyn® vapor retarder backing. The standard 1-mil poly/kraft backing will not protect the metal jacket from corroding inside out.

ASF/ FSK jacket available in 1-mil foil. Photo courtesy of Compac Corp.

Jacketing Small Tanks and Vessels

(By definition, for this article, small tanks and vessels shall be less than 40 feet in diameter.) Vertical tanks and vessels, less than 40 feet in diameter account for approximately 95 percent of all equipment. Industrial chemical and petrochemical plants are the greatest users of equipment in this size range. These sites can have more than a thousand small vessels and tanks. More than 80 percent require some type of insulation system. This accounts for an impressive amount of insulation and jacketing.

The following parameters serve as a guide for minimum jacketing on the sidewall of vertical tanks and vessels for outdoor applications. Indoor applications may be less restrictive.

- Up to 5 feet in diameter: 16-mil thick smooth rolled aluminum jacketing or 30-mil thick, smooth roll PVC jacketing; secured with minimum ½”- wide by .015 stainless-steel banding.
- Up to 10 feet in diameter: 16-mil thick smooth rolled aluminum jacketing or 16-mil thick 1¼”-deep corrugated paneling or 50-mil thick corrugated PVC paneling; secured with minimum ¾”-wide by .020 stainless-steel banding.
- Up to 20 feet in diameter: 24-mil thick 1¼”-deep corrugated aluminum panels or 50-mil thick corrugated PVC paneling. Secured with minimum ¾”-wide by .020 stainless-steel banding.
- Up to 40 feet in diameter: 24-mil thick 1¼”-deep corrugated aluminum panels or 24-mil thick galvanized aluminum; secured with minimum 1¼”-wide by .020 stainless-steel banding.

The following parameters serve as a guide for minimum jacketing on the heads of vertical tanks and vessels for outdoor applications: The metal and PVC shall be cut in gore segments.

- Up to 10 feet in diameter: 24-mil thick smooth rolled aluminum, 16-mil thick smooth galvanized aluminum, 10-mil smooth stainless steel or 40-mil thick, smooth PVC.
- Up to 30 feet in diameter: 24-mil thick smooth rolled aluminum, 16-mil thick smooth galvanized aluminum, 16-mil thick smooth stainless steel or 50-mil smooth PVC.
- Up to 40 feet in diameter: 32-mil thick smooth rolled aluminum, 24-mil thick smooth galvanized aluminum or 16-mil thick smooth stainless steel.

The metal jacketing is normally secured with sheet-metal stainless-steel screws on 4” centers at the seams. Secure the PVC by solvent welding the seams and screws where necessary.

It should be noted that recently a tank, 23 ft. 6 in. in diameter with a dome roof was successfully jacketed with PVC. This is the largest known tank roof to be jacketed with a pre-engineered PVC gore segment system. The sidewalls were jacketed with new designed 0.060-mil thick PVC corrugated panels and the head was jacketed

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23.6 diameter x 16' high with dome roof. PVC corrugated panels and PVC tank heads. Photo courtesy of Proto Corp.

with a pre-engineered 0.060-mil thick PVC segments in gore form. (See photo above.)

Jacketing Large Tanks and Equipment

Equipment such as storage tanks is a major investment to every company. Not only in terms of the initial investment, but also in the event the tank fails from external corrosion. A leakage of contents could cause an environmental disaster.

Wind conditions are one of the most critical items to consider when evaluating a jacketing system for large tanks. The tank size usually dictates the type of jacketing to be used over the insulation. Larger tanks require heavier jacketing. This is necessary to overcome high winds on large tank areas.

For example, several storage tanks, approximately 50 feet in diameter, located on a bay were subjected to a gale force wind. The tanks were insulated and jacketed with 16-mil thick rolled smooth aluminum jacketing. Upon evaluating the damage, apparently the wind was able to lift the overlapping circumferential seam of the jacket. The banding was ½"-wide steel with light duty expansion springs and was not secured to the jacket. The uplift of the jacket caused the banding to fail. In addition, the expansion springs were practically straight pieces of metal. Once the first course of jacketing failed, the succeeding courses also failed.

It was evident from the damage that the greatest force of wind was across the body of water. This was purely an under-designed jacketing system. The tank wall jacketing should have been at least 24-mil thick, deep-corrugated aluminum panels, secured with ¾"-wide by 0.020 thick stainless steel bands and heavy-duty stainless-steel expansion springs. To prevent the bands from sliding up or down, J-hooks or belt loops could be used. Finally, secure the vertical panel seams with screws on 4" centers.

Another area of concern is that usually, roofs receive the greatest damage from wind. A case in point: A new 60' diameter tank, located in the Midwest where the wind blows continually, was completely insulated to maintain temperature control of the contents. The sidewall was jacketed with corrugated aluminum paneling and the conical roof insulation was jacketed with a metal standing seam system. The owner indicated that the completed insulation work was only several weeks old, when he noticed that the metal roof jacket was vibrating violently. Upon inspection, the jacket was vibrating and there were signs of the metal jacket tearing at the standing seams in several locations. Two weeks after the inspection, I was informed that the entire roof jacketing ripped away from the tank and was scattered about the county. The loss of this roof jacketing was not the result of hurricane or gale forces but 20-mph winds, normal to this part of the country. Fortunately, no one was injured. The cause appeared to be that jacket tie-downs were not sufficient or properly distributed and that there was no attempt to flash around the roof where it overlaps the sidewall. This 2" opening at the roof overhang allowed the wind to funnel under the roof jacket which increased

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the normal wind forces, causing it to uplift, like wind would do to an umbrella. The insulation became exposed to the weather,

60' diameter x 40' high storage tank insulated with 1 1/2" thick PIR on the walls and 3" thick mineral wool on the roof. Photo courtesy of Associated Insulation.

requiring total replacement by the contractor. This failure could have been avoided by following proper design.

Study Engineering Criteria

A national document from the American National Standards Institute (ANSI) A58.1 "Minimum Design Loads for Buildings and Other Structures" addresses wind loads on roofs and walls of buildings and structures. This wealth of design information is also applicable to vertical tank wall and roof jacketing.

The document gives the expected extreme wind velocity in various areas of the country. Consider the following example: Around the gulf coast, 100 mph is typically used in the calculations, while in Cleveland, Ohio 75 mph is used. There are factors for the height of the tank roof as well as the roof pitch. There is even a wind gust factor that varies by location.

Using ANSI A58.1 as a guide, the following tank roof insulation jacket wind force is calculated. The tank is within 100 miles of the gulf coast, with a basic wind velocity of 95 mph. The tank height is 30 feet to the center of the pitched roof and the roof pitch is 20 degrees. Since tanks are circular, the windward side of the roof is the same in any direction with the greatest wind force. By calculating per ANSI A58.1, the design wind pressure on the roof is –21.3 lb./sq. ft. The minus sign indicates that the force is an uplift pressure. The design engineer must now determine that the tie-down straps, bolts, cables and any other means, to safely secure the roof jacket with an upward wind-load pressure of –21.3 lb./sq. ft.

Similarly, the tank wall jacketing can also be evaluated for wind resistance. Several companies offer a pre-engineered wall paneling and roof systems designed for tanks of all sizes. They have already engineered the systems to comply with the extreme wind and weather conditions.

The pre-engineered insulation systems for the tank sidewalls are usually composites of insulation adhered to the jacketing. The insulation for these systems is polyisocyanurate, glass fiber or mineral wool. For tanks operating up to 250°F the PIR insulation is commonly used. Above 250°F, glass fiber or mineral wool board and blanket insulation is installed.

There are two methods of insulating the vertical tank sidewalls.

- One method is with 4' x 8' panels, installed horizontally around the tank. These panels are usually 32-mil thick aluminum with an acrylic enamel finish on the outside and insulation adhered to the inside. The panels are pre-curved to the radius of the tank. They come with an elastomeric seal on the vertical locking seam and secured with 3"-wide metal banding. The compression spring assemblies on the bands are designed for severe loading.
- The second method involves 2'-wide, continuous vertical panels, manufactured to the height of the tank. The insulation is pre-adhered to jacket. The vertical seam is double rolled to make it weather proof. The panels are

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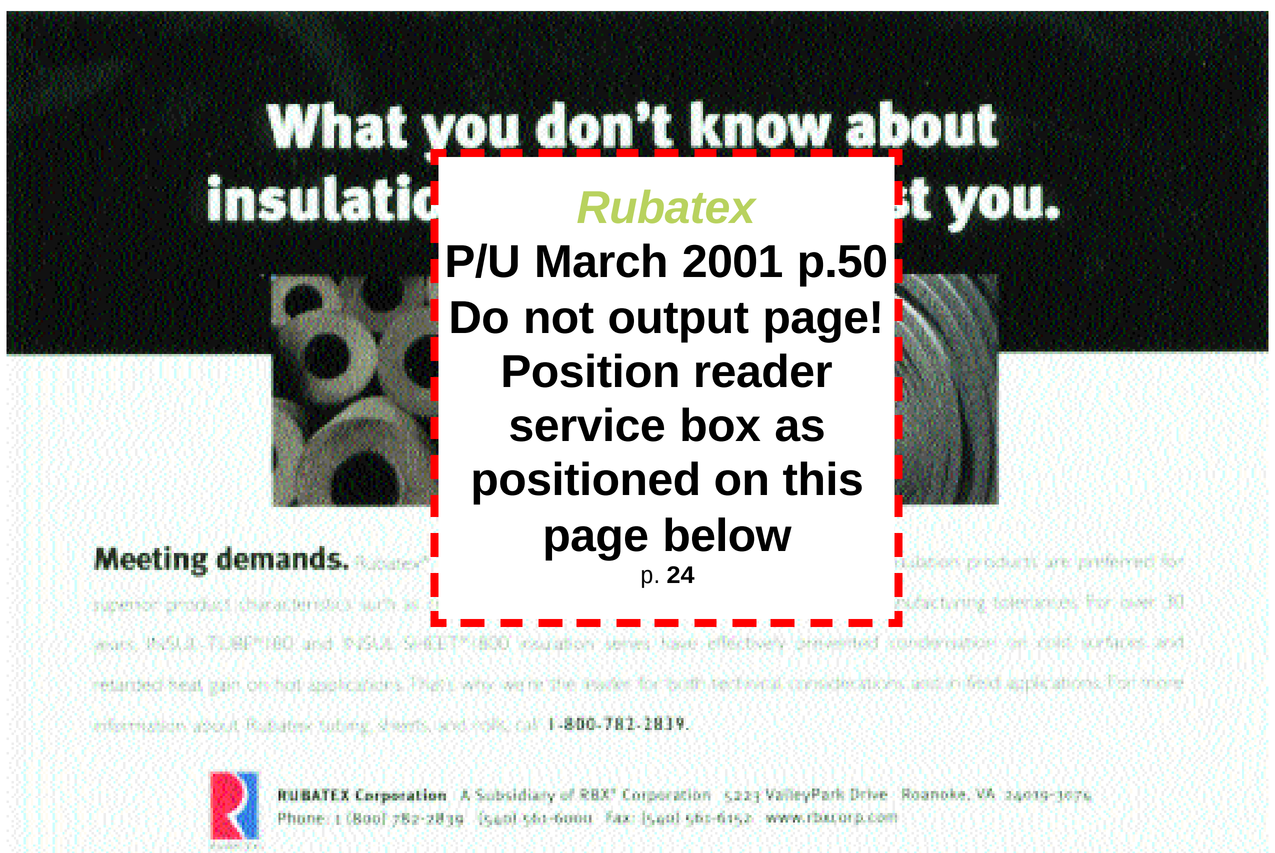
secured to the tank with metal ties held in place with metal cables wrapped around the tank.

The roof system is usually determined by the configuration and size of the roof. Cables or rods are secured to the roof, with bolting or welding. Usually the insulation is installed on the roof separately and then the jacketing is installed over the insulation. The common metal used for this application is 24-mil thick galvanized aluminum with a vapor retarder backing.

Where the tank roof is flat or conical, the jacketing may by 2'-wide metal sheeting with a doubled rolled standing seam. The seams will run parallel over the entire roof and the metal ties secure the jacketing to the cables or rods.

Where the tank roof is elliptical or has a high pitch the panel system becomes more complex. If the curvature is too great then double rolled standing seams may not be an option. In this case a series or panels must be pre-cut like gore segments and



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installed with screws at the seams.

Large tanks, and especially tanks that are heated, require expansion joints on the roof systems.

The companies that offer these pre-engineered paneled systems can be contracted to complete the entire project. However, the materials and know-how is available for installation by individual insulation contractors. Many insulation contractors have successfully installed these panel systems. These systems may be adaptable to smaller tanks. (See photo on p. 22.)

Final Notes

As you can see, many considerations go into selecting and installing jacketing. The proper selection of jacketing is as essential as the insulation. Know your environment, your surface and design parameters, and installation options before beginning work.

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