IRogel® Z

Installation Manual

PIPE INSULATION FOR COLD SERVICE

Pakan aerogels®

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Pakan Aerogels® recognizes that performance of our state-of-the-art IRogel® Z insulation materials depends on the total thermal integrity of our system. Therefore, we have developed recommended guidelines for installing IRogel® Z flexible insulation

All of the procedures described in this manual have been field-proven in conjunction with installation partners.

We are constantly striving to develop new application procedures and insulation systems to make our products stand above our competition with quicker delivery times, simpler logistics, and more reliable installation.

We stand behind our products and are willing to work with you to develop application procedures to suit your project-specific execution plan.

For specialized training or recommendations regarding our application procedures, call 0982147620670, visit www.irogel.com, or scan below with mobile device QR reader.

Contact Us

Safety First

IRogel® Z materials are engineered with safety and performance as our top priorities. Pakan has performed extensive EH&S testing and found our materials to be safe. Our IRogel® Z insulation products are made of synthetic amorphous silica impregnated into a non-woven flexible fabric substrate. Synthetic amorphous silica is not considered to be a health hazard and, according to the U.S. EPA, "there should be no concerns for human health." The silica used in our products is produced synthetically, not mined, and as such contains no crystalline silica.

Handling of IRogel® Z blankets will produce dust. Workplace exposure to all dusts should be controlled with standard industrial hygiene practices. IRogel® Z dust exposure may produce a sensation of dryness to skin and irritation to eyes, skin, and respiratory track. For worker comfort when working with IRogel® Z, we recommend the use of dust masks, safety eyewear, and work gloves. IRogel® Z dust can be washed from the skin and clothing using soap and water. Please follow the recommended safety and handling guidelines outlined in our Safety & Handling Guidelines manual, which is .available on request. For complete health and safety information, please see SDS sheets on our website

Material Handling

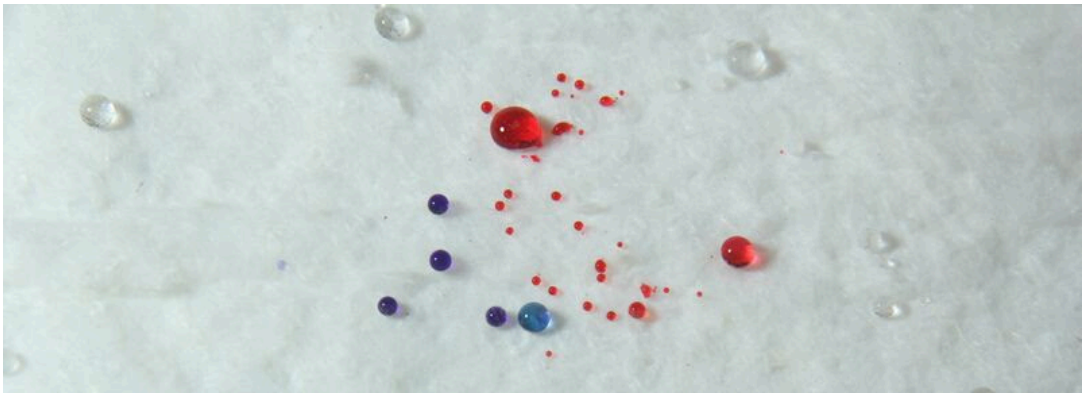
IRogel® Z insulation when shipped in full rolls is typically 1 m wide. Rolls can be moved manually with the use of an metal pipe or wooden 2x4 placed through the center of the roll and picked up from either end, or by using a pallet jack or forklift. Rolls can also be purchased in crates. Rolls should always be placed or stacked on their sides and should never be positioned upright on their ends as this may damage the exposed ends of .the roll

Preparation and Storage

IRogel® Z insulation materials should be stored in a clean, dry and protected environment. If the material is stored in an outdoor setting, it should be placed on pallets and thoroughly covered with a waterproof tarp or plastic sheeting. Although the aerogel material is hydrophobic, all necessary measures should be taken to protect it from the weather.

To prepare for installation:

- Ensure that pressure testing of piping and fittings has been completed prior to installing insulation
- Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry
- Ensure that insulation is clean, dry, and in good mechanical condition. Wet, dirty, or damaged insulation is not acceptable for installation
- Determine pipe size, pipe length, and number of layers of IRogel® Z blanket required for the application



NOTE: More information on above sections can be found in our Safety & Handling Guidelines manual, which is available on request.

Optimal Work Setup

. To achieve the most productive work environment for use with IRogel® Z insulation, we suggest the following setup

Bulk Cutting Area

This area will be used for cutting IRogel® Z materials from full rolls into lengths required for the application, as well as cutting any preformed parts required to ease the installation process. This area should be setup in a covered and protected area. This area should contain several tables to accommodate the roll width and cutting length required for each component being worked. The roll of IRogel® Z insulation should be located at the front of the table where it can be placed on a roller rack with a tube placed though the roll. Please refer to the Recommended Cutting Tools chart below for suggested tools for this application. Parts should be placed on pallets and covered, bagged, or wrapped in plastic before bringing to work area.

Work Area

Ideally the material should be placed as close to the work area as possible. Remove the materials from the packaging and distribute to the work location. Please refer to the cutting tools chart below for suggested tools for field applications.

Material	Cutting Tool (FIELD or SHOP)					
	Scissors	Box Cutter	Pizza Wheel/ Electric	Slitter	Heated Knife	Dremel Oscillating Tool With MM430 blade
IRogel® Z	FIELD	FIELD	FIELD	SHOP	SHOP	SHOP

Cold Installation Overview

This installation guide provides design and installation guidelines for the use of IRogel® Z as thermal insulation and/or passive fire protection. It applies to piping and equipment operating at below-ambient service temperatures.

This guide references several accessory products for the complete installation of a Cryogenic insulation system. Descriptions, product names, manufacturers, and usage limitations for these recommended materials and accessories can be found in Appendix A.

.Expansion and contraction joints are not necessary with the IRogel® Z insulation system

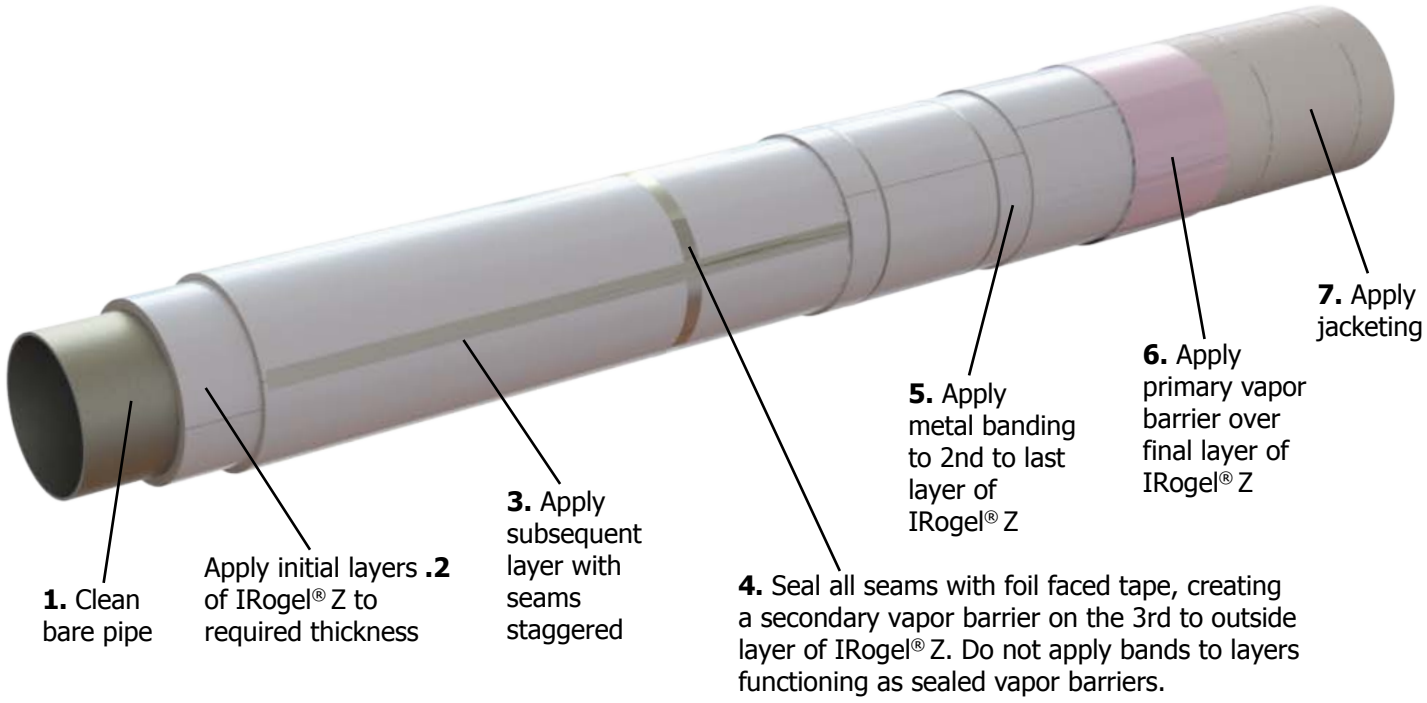


Figure 1.

Cold Installation Overview cont'd.

Vapor Barriers

- Applya primary vapor barrier consisting of a sheet mastic membrane or mastic over the final outermost layer of IRogel® Z.
- Forpiping or equipment operating below -40°C (-40°F), install a secondary vapor barrier two layers beneath the primary vapor barrier by sealing all seams of the IRogel® Z with foil faced tape (see Figures 1 and 2.
- Donot apply stainless steel bands directly to either the primary or secondary vapor barriers.
- Followthe schedule below for proper installation of vapor barriers and banding.

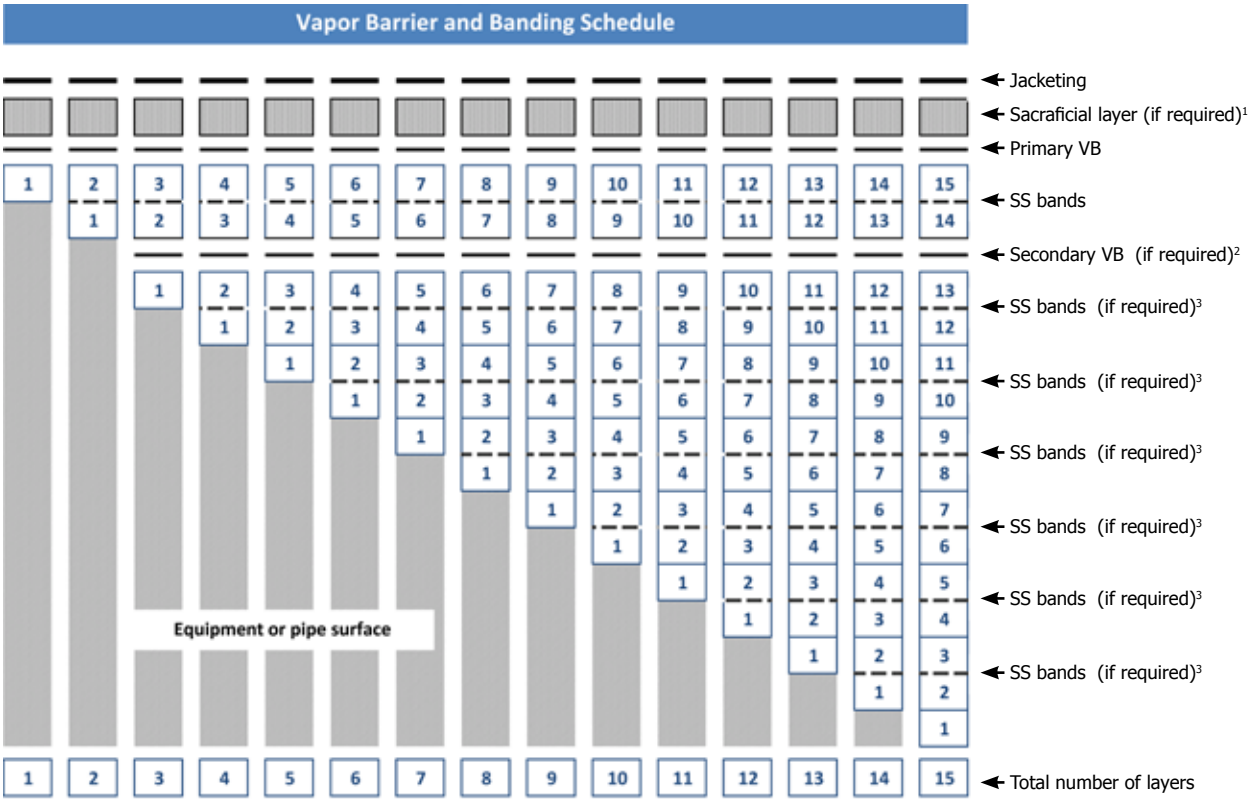


Figure 2: Vapor barrier and band locations for IRogel Z installations of 1 to 15 layers.

Notes:

1. *The sacrificial layer is only necessary when screws or rivets in the jacketing could puncture the vapor barrier.*
2. *The secondary vapor barrier is required only for service below -40 °C (-40 °F).*
3. *Intermediate stainless steel bands are only required on vertical piping and vessels, and for insulation that is also to serve as passive fire protection.*

Cold Installation Overview cont'd.

Vapor Stops

Toensure end-to-end integrity of the vapor barrier , install vapor stops at all insulation terminations and penetrations, • . and on either side of all flanges, valves, hangars, and supports. See Appendix A for acceptable vapor stop materials

Tiethevapor stop into both the secondary (where required) and primary vapor barriers with a minimum lap of • . mm (1.5 in), as illustrated in Figure 3 38

. Constructallliquid- or paste-applied mastics and sealants with a membrane reinforcement •

Whenvapor-stopping over the cut ends of the IRogel® Z, it may be necessary to smooth over the ragged surface • .(with a "bridge" layer of tape or IRogel® Z (see example in Figure 3

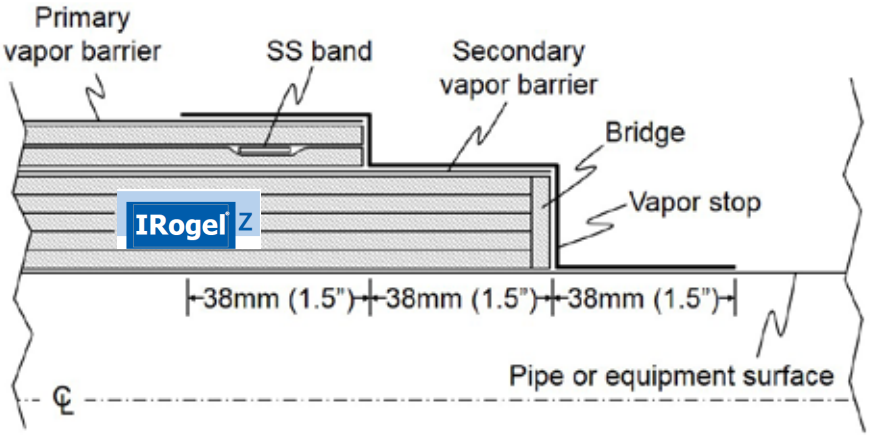


Figure 3: Typical vapor stop detail on a 7-layer termination, showing the tie-ins with both the primary and secondary vapor barriers.

Installing IRogel® Z for Passive Fire Protection

- When designing for both thermal insulation and passive fire protection, use the greater of the two thickness requirements.
- Use stainless- or galvanized steel jacketing for situations where the thermal insulation is also to be used as passive fire protection.
- Where the insulation is to serve as passive fire protection, install additional intermediate banding over every second layer as shown in Figure 2. Space the bands 450 mm (18 in) apart.

Cold Installation Overview cont'd.

Securing the IRogel® Z

- Place19 mm (¾ in) stainless steel bands around the second-to-last layer of IRogel® Z, between the primary and secondary vapor barrier layers. Space bands 450 mm (18 in) apart.
- Onvertical piping and equipment, install additional intermediate banding over every fourth layer. Space bands 450 mm (18 in) apart.
- Donotapply stainless steel bands directly to either the primary or secondary vapor barriers.
- Followbanding instructions in Passive Fire Protection section above if installing IRogel ® Z for passive fire protection.

Jacketing and Finishing

- IRogel® Z is compatible with all forms of jacketing, including metal cladding, PVC, mastic glass-mastic, glass reinforced plastic (GRP), and polymeric and asphaltic membrane systems. Refer to site specifications for jacketing installation procedures.
- Screws an drivets should be avoided unless absolutely necessary.
- Inareas where screws or rivets are necessary to secure the jacketing (i.e., vessel heads), apply a sacrificial layer of 25 mm (1 in) polyolefin foam or alternative material (see Appendix A) to prevent puncture of the primary vapor barrier. Discrete strips – oriented to allow drainage – are preferred over full-area coverage.

Single Layer Installation

Cut the IRogel® Z blanket to the length required for a complete wrap. The cut length may be determined by either wrapping a scrap piece around the pipe and marking the place where it overlaps. Either a butt joint or lap joint is acceptable for the longitudinal seam. .1

Place the IRogel® Z on the pipe and wrap it around the circumference of the pipe. The starting edge of the IRogel® Z can be held in place by hand or with a strip of .halogen-free spray adhesive .2

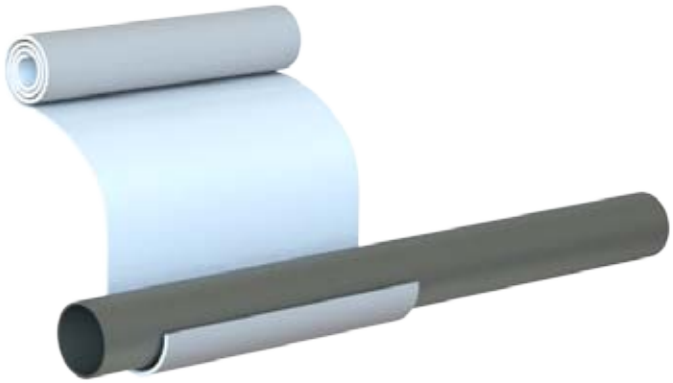
Once wrapped around the pipe, the IRogel® Z may be held in place using fiber-reinforced tape, , wire .halogen-free spray adhesive, or banding .3

Single layer of IRogel® Z showing a lap joint. When using a lap joint, it is good practice to orient the overlap with a downward-facing watershed. .4

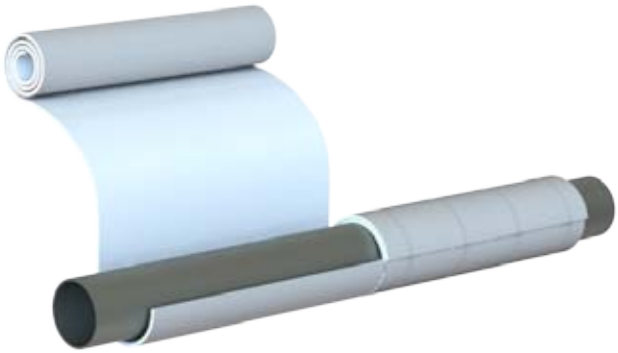
Single Piece Multi-Wrap Installation

.1 Multiple layers can be installed by using one continuous piece of IRogel® Z insulation and overlapping it. First, cut the IRogel® Z blanket to the length required. Adding the lengths from the individual layers together. For ease of handing, it is recommended that the maximum length of IRogel® Z be .(no longer than 3.3 m (10 ft

.2 Align the leading edge of the IRogel® Z with the long axis of the pipe and wrap around the pipe. The starting edge of the IRogel® Z can be held in place by .hand or with a strip of halogen-free spray adhesive



3. Overlap and continue around the circumference to achieve the multi-layer application.



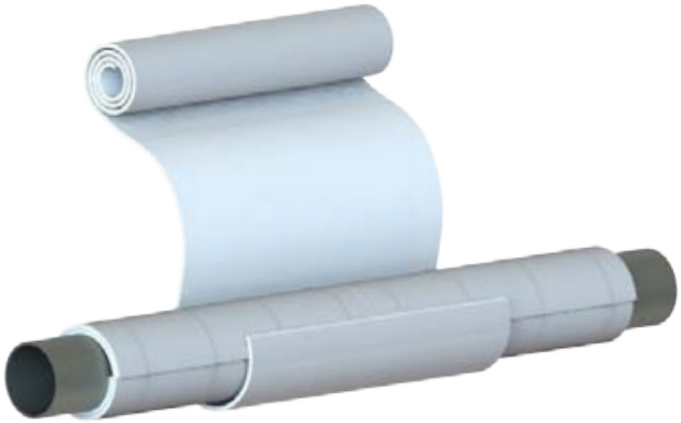
.4 Once wrapped around the pipe, the IRogel® Z may be held in place using fiber-reinforced tape, , wire .halogen-free spray adhesive, or banding

5. Follow the instructions on pages 6-8 for the proper installation of vapor barriers and vapor stops.

6. Finish with jacketing per site specifications.

Multi-Layer Installation

For applications that require the use of multiple layers of IRogel® Z insulation, all circumferential and longitudinal **.1** . (joints shall staggered by a minimum of 100 mm



Once wrapped around the pipe, the IRogel® Z insulation may be held in place using fiber-reinforced tape, wire, **.2** halogen-free spray adhesive, or banding.

3. Follow the instructions on pages 6-8 for the proper installation of vapor barriers and vapor stops.

4. Finish with jacketing per site specifications.

Small Bore Pipe - 15 to 100 mm (½ to 4 in) NPS

For piping smaller than 100 mm (4 in) NPS, we suggest the use of V-grooved, cut-to-length materials. Another option is to use 5 mm (0.2 in) materials, as they are more lexible than their 10 mm (0.4 in) counterparts. Contact Pakan Aerogels at 0982147620670 or www.irogel.com for details on local suppliers of pre-fabricated V-grooved material
. accessories

V-Groove

1. V-grooved pipe cover comes pre-cut to the particular pipe size and insulation thickness so that each layer comes to a perfect, butted closure.

2. For multi-layer applications, align the grooves for better laydown, but stagger the longitudinal seams.

Pipe Fittings

Pipe Ends

. Install the IRogel® Z blanket past the pipe end to the same distance as required for the thickness of the insulation

. Cut plugs from the IRogel® Z to the diameter of the opening and install to match the thickness

Install vapor barriers as required.

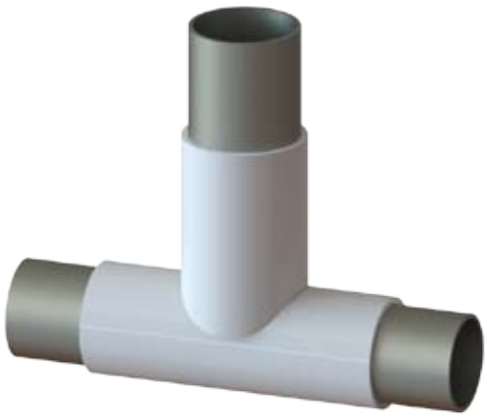
Reducers

Install the IRogel® Z blanket to the same thickness as would be required for the piping using the same layout pattern as . would be required for the metal cladding less the required overlaps

Install each layer in a staggered fashion, then install vapor barriers as required.

Tees

Install the IRogel® Z blanket using the same techniques as would be used for installing the cladding. Staircase the insulation joint. Contact Pakan Aerogels at 0982147620670 or www.irogel.com for details on local suppliers of .pre-cut tees



45- and 90-Degree Elbows

Suggested Elbow Chart				
Pipe Size (NPS)		**Elbow Type**		
mm	inches	Pre-Cut	Gored	Stove Pipe
15 – 40	$^1/_2$ – $1^1/_2$	√		√
50 – 150	2 – 6	√	√	
200 – 300	8 – 12	√	√	
350 – 600	14 – 24	√	√	
650 – 900	26 – 36	√	√	
950 – 1,200	38 – 48	√	√	

The instructions on the following pages cover three types of elbows available for use with IRogel® Z materials and installation suggestions.

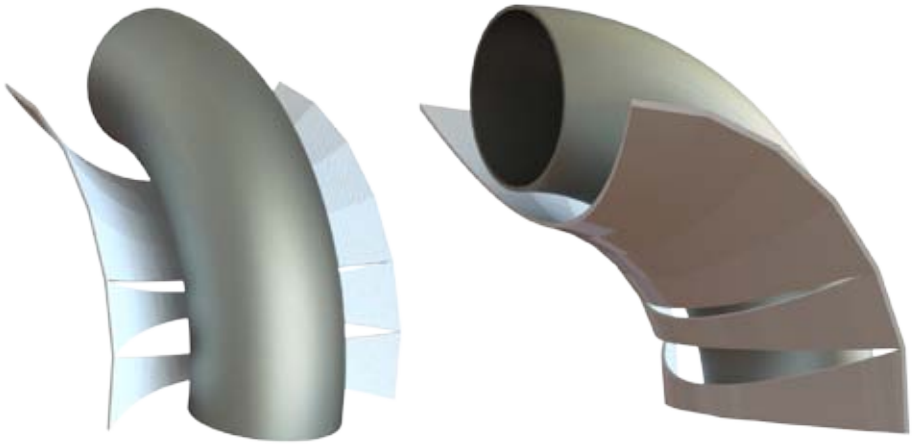
Contact Pakan Aerogels at 0982147620670 or www.irogel.com for details on local suppliers of pre-.fabricated elbows and accessories

45- and 90-Degree Elbows

Single-Piece Elbow Fittings

Pre-fabricated elbows for piping NPS 200 mm (8 in) and smaller are based on a reverse gore-style pattern that gathers in the throat and is closed along the heel. Larger elbows are constructed of individual gores that get applied one at a time in the field.

1. Place the middle of the fitting along the inside (throat) of the pipe fitting.



45- and 90-Degree Elbows

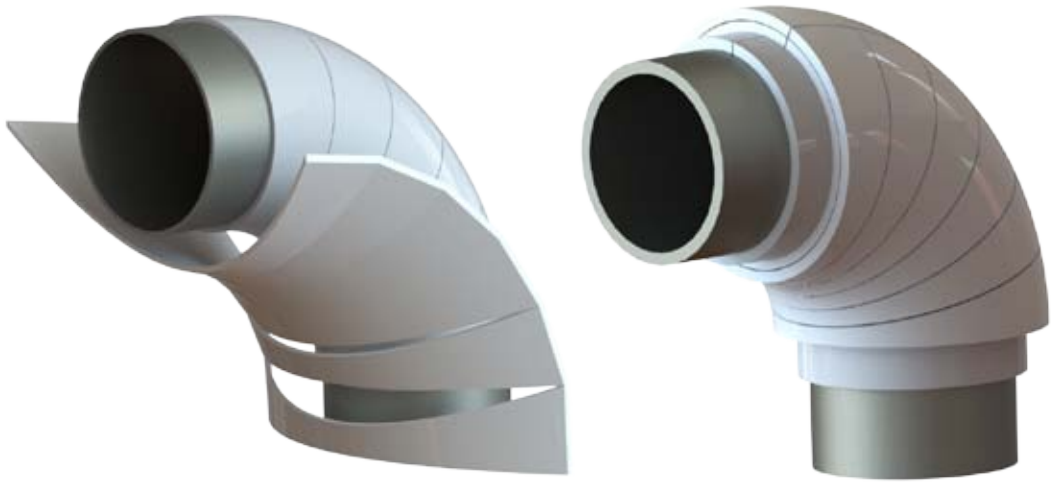
2. Tightly wrap material around to the heel, aligning the seam with the centerline of the fitting.

It is important that the IRogel® Z material is tight to the elbow. Work excess material around the fitting towards the back side of the fitting until the butt joint is closed tightly. Apply fiber-reinforced tape, wire, or outward-clenching staples to secure each gore. **.3**

45- and 90-Degree Elbows

4. Once all gores are secured, push material from both ends of the fitting cover to ensure all seams are tightly closed.

5. Apply all subsequent layers in a similar fashion. Note that the seams in some layers are specifically engineered to not line up with the ones beneath it. Also note that in multi-layer fittings, the inner layers will often have an extended tangent to provide a ship-lap joint for the adjacent line insulation.



6. Follow the instructions on pages 6-8 for the proper installation of vapor barriers and vapor stops.

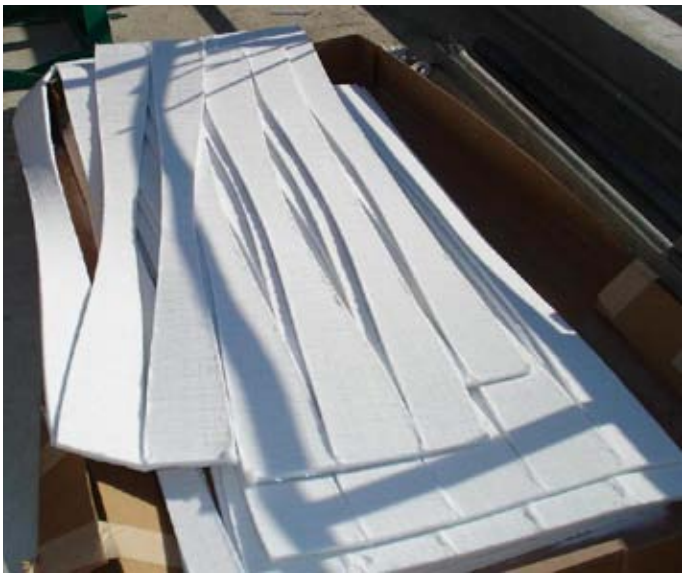
7. Finish with jacketing per site specifications.

45- and 90-Degree Elbows

Gored Elbow Fittings

This style of elbow can be cut by the contractor using the same principles that are used to fabricate metal gored elbow, minus the overlaps.

Cut the IRogel® Z blanket to the required length and cut as per the gore pattern. Install each layer, staggering the seams where possible. This can be achieved by slitting one of the gored sections down the center to create half a gore. This half section will be used for the starter and finisher of the staggered layer. The gored elbow may also be achieved by separating the pre-cut elbows and installing one gore at a time.



Stove Pipe

We recommend that this style of elbow only be used on small bore piping where the fabrication of the above elbow styles can't be done due to limited elbow throat space. In order to fabricate this elbow, we recommend that the pre-formed pipe covering be cut at a 45-degree angle with the sections adjoined in the elbow to form the 90-degree elbow.

Valves and Flanges

This section gives the general techniques for insulating flanged valves. Because of the variety in valves shapes and designs, some modifications to these instructions may be necessary.

1. Install vapor stops on adjacent line insulation on either side of the valve.

2. Convert the complex valve shape into a series of simple cylinders by filling all void spaces with mineral wool, glass fiber or Cryogel Z. This should include filling the area between the vapor stops and the flange face to a depth that is 20 mm (0.8 in) thinner than the adjacent line insulation.

3. Install two layers of Cryogel Z over the void-fill material, building it up to the same thickness as the adjacent IRogel Z line insulation.

4. Build up the shoulders on either side of the flanges with IRogel Z to achieve the same diameter as the flange face, making sure the width of the shoulder covers the vapor stop completely.

Valves and Flanges

Measure the distance between the two outer faces of the IRogel Z shoulders to determine the width of the valve body insulation. **.5**

Install the valve body insulation making sure to stagger the cutout on each wrap of IRogel Z. Build up the valve body insulation to the same thickness as the adjacent line insulation. Attachment of IRogel Z may be done with tape, wire, halogen-free spray adhesive, or .banding **.6**

Insulate the bonnet area with IRogel Z. Alternate body- and bonnet-insulation every second layer to eliminate through-seams. Apply foil-faced tape to 3rd to .last layer, thereby creating the secondary vapor barrier **.7**

8. Secure the 2nd to last layer with banding.

Valves and Flanges

9. Apply the final layer of Cryogel Z. Apply a primary vapor barrier over the final layer of Cryogel Z. Install a vapor stop down to valve stem.

.10 Finish with jacketing per site specifications. Once , installation of the IRogel Z insulation layers is complete the finished valve should resemble below.

Filling Cracks and Voids

Filling small cracks and voids can be achieved by by using mineral wool or glass fiber or by delaminating the IRogel® Z to a workable thickness and pushing it into the crack with the use of a knife. For larger cracks and voids, it is recommended that strips or sections be cut from a blanket and added. When delaminating, take care not to shred the material causing it to loosen the IRogel® Z material from the section. It is not recommended that it be shredded into fiber in order to do this, as this will cause the loss of aerogel from the material.

Appendix A: Insulation Materials and Accessory Suppliers

Table 1: Insulation, fire-protection and accessory materials and suppliers

System Component	Insulation System Material Description	Manufacturer / Brand Names	Applicable Surfaces
Insulation and/or Passive Fire Protection	mm (0.2 in) thick IRogel Z blanket 5	Pakan Aerogels / IRogel Z	All
	mm (0.4 in) thick IRogel Z blanket 10	Pakan Aerogels / IRogel Z	Piping ≥100 mm (4 in) NPS; all vessels, and equipment
	V-grooved aerogel blanket		Piping <100 mm (4 in) NPS
	Pre-cut elbows		All short-radius, long radius, socket-weld, and swept elbows
Joint Sealing Tape	Foil-faced butyl tape, 50-100 mm (2-4 in) wide		For application temps at or above 15°C (59°F), or when using cold weather surface primer
	Foil / Polyester Laminate, 50-100 mm (2-4 in) wide		For application temps at or above -18°C (0°F)
Optional Sheet Mastics	1.2 mm (0.050 in) foil-faced butyl sheet		All
Cold Weather Surface Primer	SBR		For use when low ambient temperatures reduce surface tack on tapes and sheet mastics
Vapor Stop Sealant	Hypalon rubber vapor barrier coating		For process temperatures down to -40°C (-40°F)
	Cryogenic vapor barrier coating		For process temperatures down to -196°C (-320°F)

Appendix A: Insulation Materials and Accessory Suppliers cont'd.

Table 1: Insulation, fire-protection and accessory materials and suppliers

System Component	Insulation System Material Description	Manufacturer / Brand Names	Applicable Surfaces
Vapor Barrier Mastics	Hypalon rubber vapor barrier mastic		All
Membrane Reinforcement	Glass or polyester open-weave cloth		All
Elbow Covers	Pressed aluminum jacket covers sized for aerogel thicknesses		All short- and long-radius elbows up to 900 mm (36 in)
Spray Adhesive	Halogen-free spray adhesive (can or bulk)		All
Strapping Tape	12 mm (1/2 in) wide fiber-reinforced packing tape		All
Mechanical Standoff Layer	HDPE membrane, 20mm (0.75 in) dimples		All

For specialized training or recommendations regarding our application procedures, call .982147620670, visit www.irogel.com, or scan below with mobile device QR reader

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