FOAMGLAS®

Pittsburgh Corning

CHILLED WATER
Issues and Challenges

The FOAMGLAS® Insulation Solution

The design and specification of insulation on a chilled water distribution network might be considered routine by some engineers and designers. Yet, a survey by HPAC Engineering magazine revealed that almost one out of 10 of respondents had been involved with a failed chilled water insulation project within the previous 12 months.

Insulation Efficiency

Water vapor intrusion is the single-most destructive force for an insulation system. During construction, relative humidity in a building can reach close to 100%. Because of this, most insulation system failures begin during construction because air-conditioning systems are typically turned on before the building is completely enclosed, thereby creating a vapor drive to the cold piping and equipment.

FOAMGLAS® insulation is 100% impermeable and will not fail before the building is built.

Fire Safety

Fire is probably the most serious of all safety issues in any public or occupied building. During a fire, some insulations burn at an incredible rate while popping flaming embers into the air and emitting lethal gasses such as carbon monoxide, carbon dioxide, hydrochloric acid, nitrous oxides, formaldehyde and acrylonitrile. That's why it is important to have an insulation that will not burn or give off toxic smoke.

Corrosion

For corrosion to occur, conditions that include water, oxygen and temperature need to be in place. Chemical presence will also contribute to corrosion. Wet insulation provides a perfect environment of water and oxygen for metal corrosion to occur. Many organic insulations contribute to the added property of chemical attack, accelerating the corrosion process. In commercial buildings, repairing corroded pipes often requires the removal of drywall, ceiling tiles and other items which block pipe access.

FOAMGLAS® insulation is not organic, will not absorb water and contains no corrosive chemicals.

Cost-Longevity

The price of a chilled water system is usually dictated by:

- Insulation type
- Insulation thickness
- Application specifications
- Insulation finish

There is no value in compromising quality in a chilled water system. Improperly designed systems can lead to dripping condensation, wet ceiling tiles and damage to anything below including furniture, electronics and slippery floors. The cost to remove and replace a failed system is often 3-5 times the initial cost and can be even greater. Wet insulation can also contribute to mold growth, another costly problem when remediation is involved.

Insulation is very much an investment in your building and should be designed to last the life of the building.

FOAMGLAS® insulation stands the test of time and will last for many years. We have case studies which illustrate this unparalleled field history.

Determining Potential Moisture Intrusion

No matter where your chilled water system is located—indoors, outdoors, underground, above ground, subject to high or low humidity, or in conditioned or non-conditioned surroundings—there is a potential for moisture penetration into the insulation system. It is never a good practice to install a permeable insulation on a below-ambient system. While systems in all areas of the country are subject to moisture damage, there are certain "bands" more prone to degradation. The following map illustrates moisture intrusion potential across the United States:

Design vs. Real-World Performance

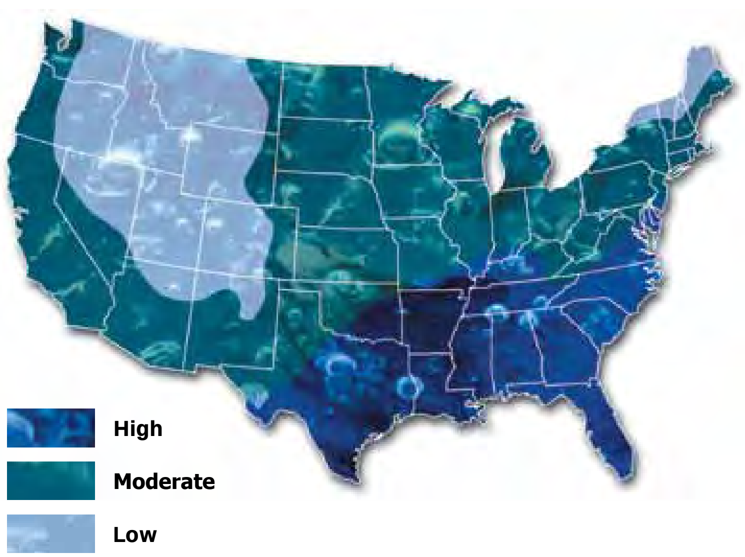
System design should maintain the outer surface temperature of the insulation above the dew point for the likely range in ambient air conditions.

Pittsburgh Corning offers computerized services for determining required insulation thickness to prevent surface condensation. A variety of techniques provide insulation thicknesses of adequate accuracy for most applications. However, any method will be only as good as the design and specification in ambient conditions. Designers are cautioned that calculating average ambient conditions for a particular location may provide quite reasonable insulation thickness values, but this is likely to result in a number of days during which sweating and dripping of condensate occur.

Vapor Barrier Myth

Vapor drive can never be reduced to zero. Applying a so-called vapor "barrier" over insulation will not solve the problem. Thus, the term vapor barrier has more or less been replaced by vapor "check" or "retarder."

If your insulated cold piping is exposed to ambient or non-conditioned air, it should receive special attention. When cold piping operates year-round, a constant vapor drive exists. In permeable type insulations, moisture inevitably accumulates, regardless of vapor retarders, jackets, and vapor sealing of joints and fittings. If the insulation absorbs just 4% moisture, it will lose 70% of its thermal efficiency. Wet insulation acts as a thermal conductor rather than an insulator.



FOAMGLAS® Insulation Meets All Challenges

FOAMGLAS® cellular glass insulation is a lightweight, rigid insulating material composed of millions of completely sealed glass cells, each an insulating space. This all-glass, closed-cell structure provides an unmatched combination of physical properties ideal for piping and equipment below or above ground, indoors or outdoors, at operating temperatures from -450°F to +900°F (-268°C to +482°C). Billions of square feet have been installed throughout the world in thousands of industries and operations because it is:

FOAMGLAS® Insulation is completely impermeable to moisture, noncombustible, dimensionally stable and offers high compressive strength among other attributes.

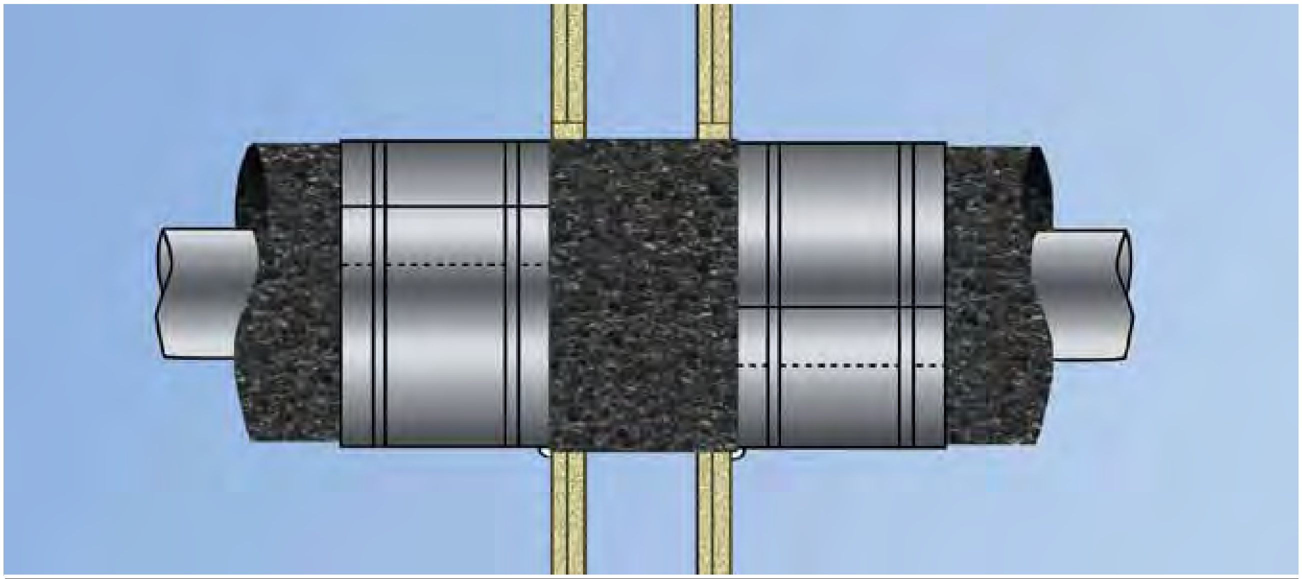
- Resistant to water in both liquid and vapor forms
- Noncorrosive
- Noncombustible/nonabsorbent of combustible liquids
- Resistant to most industrial reagents
- Dimensionally stable under a variety of temperature and humidity conditions
- Superior compressive strength
- Resistant to vermin and microbes
- Fiber, CFC and HCFC free

FOAMGLAS® insulation's diverse properties results in a unique and unmatched combination of benefits, proven by in-the-field performance:

- Constant, long-term energy efficiency provides low, predictable energy costs
- Enhanced process control allows improved, consistent product quality
- Minimal maintenance/repair/replacement of insulation or facility infrastructure reduces life cycle costs
- Corrosion resistance and fire resistance protects the insulated equipment, and helps minimize subsequent plant shutdown time
- Virtual elimination of the potential for auto-ignition from absorbed combustible liquids or fire from condensed low-temperature gasses
- Proven durability for underground and exterior installations
- Manufacturing of FOAMGLAS® insulation puts no stress on the atmosphere's ozone layer, while its long-term thermal efficiencies reduce energy demand and the effects of burning fossil fuels on the environment

FOAMGLAS® Insulation is the obvious choice when there are fire and smoke concerns in commercial buildings.

Through-Penetration Fire Stop Systems



The FOAMGLAS® Insulation fire-stop system is simple and relatively inexpensive.

Because it is all-glass and inherently noncombustible, FOAMGLAS® insulation will not add any fuel to the fire and will not produce any toxic fumes.

There are currently numerous UL-approved through-penetration fire-stop systems using FOAMGLAS® insulation are available through several fabricators/distributors located throughout the country. The approved systems use 1-1/2 to 3-inch-thick insulation. The maximum pipe size tested for these applications is 20 inches.

If your insulated cold piping is exposed to ambient or non-conditioned air, it should receive special attention. When cold piping operates year-round, a constant vapor drive exists under humid air conditions. In permeable type insulations, moisture inevitably accumulates, regardless of vapor retarders, jackets, and vapor sealing of joints and fittings.

For a listing of UL Through-Penetration Fire-Stop Approved Systems, please search the UL Database at http://www.ul.com/database/index.htm.

Once on this page, click on "Fire Resistive Assemblies and Systems" to access the individual system information page. Then, type the System Number in the designated box exactly as it appears (with hyphens, lower case is acceptable) and submit.

FOAMGLAS® Insulation has a 3-hour fire-stop rating and will not add any fuel to a fire or toxic smoke.

The FOAMGLAS® Insulation Solution

Importance of Compatible Accessories

Regardless of the amount of time spent on analyzing a particular insulation's ability to meet your needs, if quality, compatible accessories are not used, the dependability of the system could be placed at unnecessary risk. Accessory products are often viewed—incorrectly—as commodities with little differentiation among competitive products, and are often selected as an afterthought. Also, the contractor sometimes changes the choice of accessories at the last minute—and this is often unknown to the end user. PC® accessories are known as being among the best for complimenting a "top-knotch" insulation system.

SEALANTS:

Locally applied at the jobsite, sealants are utilized at joints, metal jacketing laps and around protrusions. Sealants prevent water vapor entry on low- and intermediate-temperature and cyclic systems. Their function, however, is not to mask poor-fitting insulation.

Butyl and MS Polymer Based sealants are appropriate for use with FOAMGLAS® insulation because of their durability and low-temperature flexibility. Contact Pittsburgh Corning for specifications and recommendations for appropriate PC® sealants for your chilled water applications.

JACKETING:

Jacketing provides mechanical protection on either above- or below-ground installations and can act as a weather or vapor retarder. Jacketing can be made of metal, single-layer plastic or laminates incorporating various materials.

Metal jacketing is commonly used for outdoor, above-ground systems and is not a vapor retarder. A major concern with using metal jacketing is its inability to provide vapor retarder protection, especially on vertical runs. Once water enters these systems, it may be impossible to remove.

On piping and equipment with operating temperatures below ambient, highly reflective materials with low emissivity such as unpainted metal jacketing will decrease heat gains. As a result, the surface temperature will be reduced and the potential for condensation will increase. When designing below-ambient insulation systems for maximum condensation protection, less reflective materials with a higher emissivity such as painted metal, PVC, ASJ or mastic should be selected for the outer surface of the insulation system.

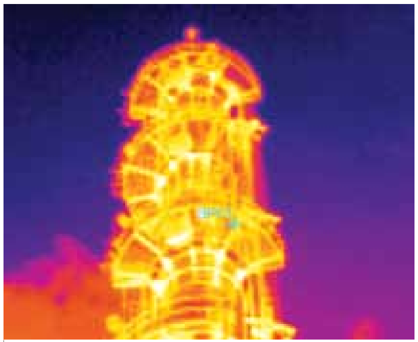
Plastic jacketing comes most commonly in the form of solid polyvinyl chloride (PVC). This is usually seen on indoor, above-ground installations.

Laminate jacketing consists of any non-cellulous multiply laminated fiberglass reinforced polypropylene, PVC, or vinyl faced/metalized film backed Jacket. Formats include: (1) all service jacketing (ASJ), with a low flame-spread- treated kraft paper, usually a glass fiber scrim and aluminum inner face, (2) vinyl/ scrim/foil jacketing (VSF), (3) polypropylene, scrim and foil (PPSF), a combination with very low flame spread that is more economical than VSF and (4) PVC/scrim/foil.

Accessories such as sealants and jacketing are key to a system's overall performance.

For most indoor insulation systems, laminates are the preferred jacketing. For permeable insulation systems, they are much less than perfect as a vapor retarder. Because FOAMGLAS® insulation is impervious to water vapor, an additional vapor retarder—such as a laminate jacketing—is not required. Laminate jacketing, however, is commonly applied to indoor FOAMGLAS® insulation systems for cosmetic purposes only.

On underground systems, special bituminous-containing laminates are available. Their primary function is to provide a waterproof membrane and to absorb the shock of soil and rock overburden when the insulated pipeline is direct buried.



Thermal imaging can identify hidden problems.

Testing Methods

When analyzing test results for insulation performance, it is important to use the appropriate test methods for determining performance in a chilled water system:

ASTM E-96

(Standard Test Methods for Water Vapor Transmission of Materials)

There is both a "wet cup" and a "dry cup" method to perform this test, which measures water vapor permeability. The "dry cup" method measures materials at 0% relative humidity (RH) on one side and 50% on the other side. The "wet cup" method measures materials at 100% RH on one side and 50% RH on the other side. The "wet cup" method of testing is more indicative of chilled water piping applications in humid climates. FOAMGLAS® insulation has a permeability that is thousands of times less than that of organic foam. Even when tested under "dry cup."

When analyzing test results for insulation performance, it is important to use the appropriate test methods for determining performance in a chilled water system:

Chilled water insulation should be selected based on ASTM E-96 "water method" test values. These values are not always provided by the manufacturer.

ASTM E-84

(Standard Test Method for Surface Burning Characteristics of Building Materials)

This test observes the comparative surface burning characteristics of building materials—versus red oak and inorganic reinforced cement board. "Flame spread index" is a comparative, numerical measure relating to the progress of a flame zone. "Surface flame spread" is the advancement of flame away from an ignition source across a specimen's surface. "Smoke developed index" is a comparative classification based on smoke observation.

FOAMGLAS® insulation is 100% glass and contains no binders. Glass will not burn. Therefore there is no smoke or flame propagation with FOAMGLAS® insulation. FOAMGLAS® insulation has a "flame spread" rating of 0 and a "smoke development" rating of 0 when tested according to ASTM E-84.

Value-Added Services From Pittsburgh Corning

In addition to industry-leading insulation and accessory products, Pittsburgh Corning offers a number of valuable client services:

- Worldwide Availability—With multiple plants in the United States and Europe, Pittsburgh Corning can uniquely provide consistency of supply, millions of units of unequaled capacity and ready availability.
- Technical Service—Pittsburgh Corning's Technical Service Staff provides product, application and materials testing, standardized and customized specifications, on-site customer assistance and installation guidance. A network of local sales representatives and distributors are available for consultation and problem resolution.
- Energy Analysis Service—To simplify your insulation specification process, Pittsburgh Corning offers an Energy/Economic Analysis Service and our exclusive Energy Analysis Report (EAR). Developed with customer-specific data subjected to computer analysis and other calculations, EARs assist systems designers in specifying the proper insulation thicknesses for:
  - condensation control
  - process control
  - outlet temperature
  - thickness recommendations due to different type of jacketings

To order an energy analysis report, please log on to: www.foamglas.com/industry/en/technical_services/energy_analysis_report

- Energy Survey Service—Assists in the planning for building renovations and also identifies deteriorating insulation systems. It helps to determine payback periods for reinsulated systems. This will evaluate the performance of existing thermal insulation on piping and equipment. They are conducted on-site and can result in:
  - energy savings
  - condensation-ice control

These are free services offered to prospective clients.

The FOAMGLAS® Insulation Solution

National Institutes of Health
The NIH in Washington is also one of the largest chilled water facilities in the world, consisting of 55,000 tons of installed chilled water capacity—more than 10 linear miles of chilled water piping supply and return lines in its utility tunnel network and trench systems. Considering the capital investment that NIH made in its chilled water system, the selection of insulation plays a critical role in the ability of the system to operate efficiently and maintenance-free. System designers chose FOAMGLAS® insulation because it is moisture resistant and acts as a vapor barrier to protect the chilled water piping.

MD Anderson Cancer Center
The University of Texas MD Anderson Cancer Center is located in hot, humid central Houston, and has been using FOAMGLAS® insulation for decades, particularly on chilled water distribution lines.

According to the engineering staff at MD Anderson, "The only insulation that is acceptable for chilled water facilities here is FOAMGLAS® insulation."

According to the engineering staff, the reason is simple: "The product is glass, it's recyclable, it's impermeable to moisture and it can even be installed on wet pipe. If insulation is permeable to moisture, it will not be used for chilled water piping here at MD Anderson."

In addition, FOAMGLAS® insulation is environmentally friendly and offers lower life-cycle costs than other materials because of its proven long-term performance.

MD Anderson Cancer Center in Houston.

Chilled water piping at NIH.

Capitol Visitors Center

In August 2002, construction began on the 580,000 square-foot Capitol Visitor Center (CVC), which officially opened to the public in December 2008. Because the facility's entire piping system is located underground in tunnels, there were design challenges for both the immediate and long-range future operation of the system. The designers specified FOAMGLAS® cellular glass insulation in thicknesses from 2" thick on the chilled water lines to up to 4" thick on the steam lines. FOAMGLAS® insulation was chosen because it is all glass and cannot absorb moisture, ensuring long-term thermal efficiency and protection against corrosion and other failures. Additionally, because of its composition, it cannot burn and won't contribute to flame or smoke spread, an important factor for any building occupied by people.

Capitol Visitors Center in Washington D.C.

Dublin Airport

Over the past decade, passenger traffic at Dublin airport has increased twofold, making it the 8th largest airport facility in Europe for international traffic. Recently, an additional increase in passenger traffic prompted a significant redevelopment of the existing airport facilities. Fire safety and sustainability were important considerations in the expansion effort, which led to the selection of FOAMGLAS® insulation for internal and external pipe work in the terminals, piers and energy center. As the centerpiece of the airport redevelopment, Terminal 2 comprises 96,875 square feet of retail and catering space, 58 check-in desks, and new baggage handling and energy center facilities. Approximately 8 miles of FOAMGLAS® piping insulation has been applied since construction began in 2007. Much of the pipe work was pre-insulated offsite and brought in as modules, which were easily and quickly lifted into place. The compressive strength of FOAMGLAS® made this process possible without compromising the insulation system.

Chilled water piping at Dublin International Airport.

Greater Pittsburgh International Airport

When the $750 million Greater Pittsburgh International Airport was built, it was a great improvement over the older, existing facility. The 3.2 million square-foot complex includes three major buildings and seven underground tunnels for utility service, baggage handling and passenger transportation. Two criteria were deemed most important when selecting the insulation for chilled water lines: impermeability for thermal protection and performance; and compressive strength for protection against physical abuse. As a result, FOAMGLAS® insulation was installed on a total of 64,000 lineal feet of piping throughout the entire airport complex, ranging in diameter from 24 inches to 3/4 inch. According to the specifer, the need for the benefits of FOAMGLAS® insulation isn't exclusive in the south and its high humidity conditions. She said that many northern locations have the same humidity problems. Pittsburgh has an average relative humidity of 50 percent. While Jacksonville, Fla., may have much higher temperatures, the average relative humidity is also 50 percent.

Specifier Information

Physical and Thermal Properties of FOAMGLAS® Insulation

PHYSICAL AND THERMAL PROPERTIES OF FOAMGLAS® ONE™ INSULATION				
PHYSICAL PROPERTIES	ASTM			EN ISO
	SI	ENGLISH	Method	Method
Absorption of Moisture (Water % by Volume)	0.2%	0.2%	C 240	EN 1609 EN 12087
	Only moisture retained is that adhering to surface cells after immersion			
Water-Vapor Permeability	0.00 perm-cm	0.00 perm-in	E96 Wet Cup Procedure B	EN 12086 EN ISO 10456
Acid Resistance	Impervious to common acids and their fumes except hydrofluoric acid			
Capillarity	None			
Combustibility & Reaction to Fire	Noncombustible - will not burn Flame Spread 0 Smoke Development 0		E 136 E84	EN ISO 1182 (Class A1)
Composition	Soda-lime silicate glass – inorganic with no fibers or binders			
Compressive Strength, Block	620 kPa	90 psi	C 165 C 240 C 552	EN 826 Method A
	Strength for flat surfaces capped with hot asphalt.			
Density	120 kg/m^3	7.5 lb/ft^3	C 303	EN 1602
Dimensional Stability	Excellent—does not shrink, swell or warp			EN 1604 (DS 70/90)
Flexural Strength, Block	480 kPa	70 psi	C 203 C 240	EN 12089 (BS450)
Hygroscopicity	No increase in weight at 90% relative humidity			
Coefficient of Linear Thermal Expansion	9.0 x 10^{-6}/K 25ºC to 300ºC	5.0 x 10^{-6}/°F 75°F to 575°F	E 228	EN 13471
Maximum Service Temperature	482˚ C	900˚ F		
Modulus of Elasticity, Approx.	900 MPa	1.3 x 10^5 psi	C 623	EN 826 Method A1
Thermal Conductivity	W/mK 0.040 @ 10°C 0.042 @ 24°C	Btu-in/hr.ft^2.°F 0.28 @ 50°F 0.29 @ 75°F	C 177 C 518	EN 12667 EN 12939 ($\lambda_{D\ (90/90)}$ ≤ 0.041 W/mK @ 10˚ C)
Specific Heat	0.84 kJ/kg.K	0.18 Btu/lb.°F		
Thermal Diffusivity	4.2 x 10^{-7} m^2/sec	0.016 ft^2/hr		

Note: FOAMGLAS® ONE™ is manufactured to meet or exceed the minimum requirements of *ASTM C552-07 Standard Specification for Cellular Glass Insulation* (or most recent revision). Unless otherwise specified, measurements were collected using ASTM guidelines at 24°C (75ºF) and are average or typical values recommended for design purposes and not intended as specification or limit values. Values under EN ISO are declared as limit values under the specific set of standard test conditions. Properties may vary with temperature. Where testing method or reporting values differ between ASTM and EN ISO methodologies, values are denoted within parentheses in the EN ISO column.

Recommended Thickness of Pittsburgh Corning FOAMGLAS® Insulation for Chilled Water Systems

Jacketing: ASJ, PVC, Painted surfaces

	75°F Ambient Temperature			80°F Ambient Temperature			85°F Ambient Temperature			90°F Ambient Temperature		
PIPE	RT	HG	RH	RT	HG	RH	RT	HG	RH	RT	HG	RH
0.5	1.5	2.9	92%	1.5	3.3	92%	1.5	3.8	91%	1.5	4.2	90%
1	1.5	3.2	91%	1.5	3.7	90%	1.5	4.2	90%	1.5	4.7	89%
2	1.5	3.8	90%	1.5	4.3	89%	1.5	4.9	88%	1.5	5.5	88%
3	1.5	4.2	89%	1.5	4.8	88%	2	4	90%	2	4.4	89%
4	1.5	4.4	88%	1.5	5	88%	2	4.2	89%	2	4.7	89%
6	1.5	4.8	87%	1.5	5.5	86%	2	4.5	89%	2	5	88%
8	1.5	4.8	87%	1.5	5.5	86%	2	4.7	88%	2	5.2	88%
10	1.5	4.7	87%	1.5	5.4	86%	2	4.6	88%	2	5.	88%
12	1.5	4.8	87%	1.5	5.5	86%	2	4.7	88%	2	4.2	88%
16	2	3.9	89%	2	4.5	88%	2.5	4.1	89%	2.5	4.6	89%
18	2	4	89%	2	4.6	88%	2.5	4.2	89%	2.5	4.6	89%
24	2	4	89%	2	4.7	88%	2.5	4.2	89%	2.5	4.8	88%
30	2	4.1	89%	2	4.	88%	3	3.6	90%	3	4	90%
36	2	4.1	88%	2.5	3.8	89%	3	3.6	90%	3	4.1	90%

Cradle Schedules

Nominal Pipe Diameter in (mm)	Insulation Thickness in (mm)	Cradle Thickness in (mm) for Clevis Hangers	T Cradle Thickness in (mm) for Point Load and Roller Applications	L Cradle Length in (mm)	Span ft (m)
1/ 2 to 1 (21 to 33)	1 1/2 to 3 (39 to 76)	14 GA/0.0747 in (1.89)	1/4 / 0.25 in (6.35)	12 (305)	7 (2.13)
1 1/2 to 2 (48 to 60)	1 1/2 to 3 1/2 (39 to 89)	14 GA/0.0747 in (1.89)	1/4 / 0.25 in (6.35)	12 (305)	10 (3.04)
2 1/2 to 2 (73 to 89)	1 1/2 to 4 (39 to 102)	12 GA/0.1046 in (2.65)	1/4 / 0.25 in (6.35)	12 (305)	12 (3.65)
3 1/2 to 4 (102 to 114)	1 1/2 to 4 1/2 (39 to 114)	12 GA/0.1046 in (2.65)	1/4 / 0.25 in (6.35)	12 (305)	14 (4.27)
5 & 6 (141 to 168)	1 1/2 to 4 1/2 (39 to 114)	10 GA/0.1344 in (3.41)	1/4 / 0.25 in (6.35)	12 (305)	17 (5.18)
8 & 12 (219 to 324)	1 1/2 to 5 1/2 (39 to 140)	10 GA/0.1344 in (3.41)	*	18 (457)	20 (6.10)
14 to 20 (356 to 508)	1 1/2 to 6 (39 to 152)	3/16 /0.187 in (4.74)	*	24 (607)	20 (6.10)
22 to 24 (559 to 619)	1 1/2 to 6 1/2 (39 to 165)	3/16 /0.187 in (4.74)	*	24 (607)	20 (6.10)

Cradle/shield material ASTM A 1011 Galvanized Carbon Steel. Table based on spans for ASTM A53 Grade A Carbon Steel pipe, maximum allowable stress in tension 12,000 psi. For conditions not covered in this table, contact Pittsburgh Corning.

For more information about physical and thermal properties, as well as other important technical issues, visit us on the web at: www.foamglas.com/industry

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