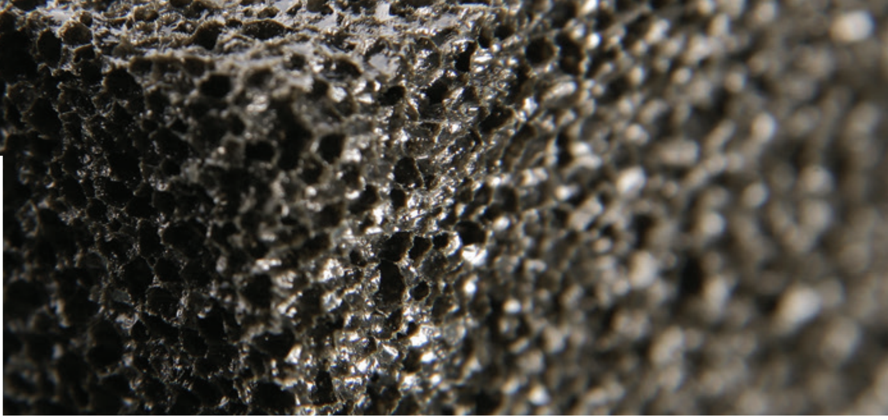


FOAMGLAS®

TECHNICAL NEWSLETTER

DESIGN CONSIDERATIONS FOR PIPE SUPPORTS AND THE INFLUENCE ON THERMAL PERFORMANCE

The choice of insulation material is critical to the long-term viability of a project. The same is true for determining the appropriate method for supporting insulated piping.

The industry has used three approaches to address the use of pipe hangers and supports for insulated piping: insulate the pipe, insulate the support device or insulate both. However, with each approach, system design should be carefully studied. Failure to consider how the pipe will interact with the support device can negate the performance of the insulation system and result in wide ranging consequences for the building or facility in which the system is contained.

There are distinguishable points to avoid, most notably that the insulation on a pipe hanger or saddle can be crushed when the pipe is installed. This naturally leads to inefficiencies within the insulation system and can ultimately lead to compromised integrity of the piping system.

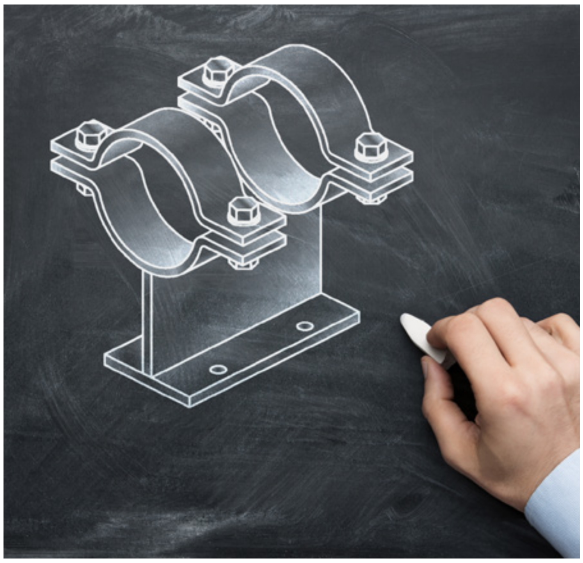
To avoid setbacks, specifiers must consider several issues, and be aware of the complex relationship between insulation system pipe and support. This newsletter will discuss the techniques, methodology and design factors required for successful pipe support installation and continued insulation efficiency.

WHAT ARE PIPE SUPPORTS AND HANGERS?

A pipe support or pipe hanger is a component that transfers the load from a pipe to the supporting structures. The load includes the weight of the pipe itself, the content that the pipe carries, the pipe fittings fixed to the pipe, the insulation system, and finally, for external applications, possible snow and ice loads. The main functions of a pipe support are to anchor, guide, absorb shock, and support a specified load.

Pipe supports are typically made from a rigid material, such as wood or high-density insulation materials with protective shields.

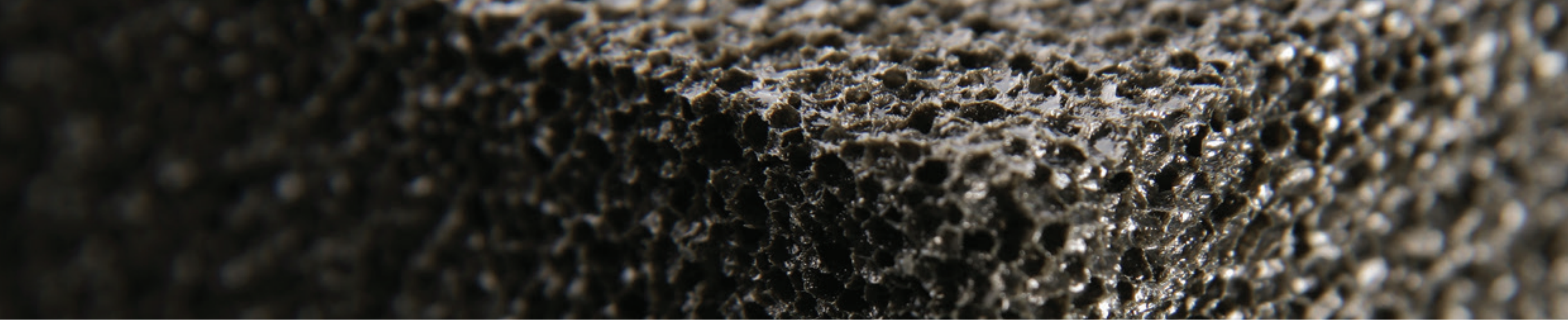
They are used in high and low temperature applications with load and operating conditions as their main design considerations. The compressive strength of the support resting on the shield must uniformly support the pipe insulation (i.e, no point loading), and must not damage the insulation and keep coatings or vapor-retardant jacketing intact. The ideal pipe insulation support prevents direct transfer of moisture or heat from the shield to the actual pipe.



INSULATED PIPING AND METHODS OF SUPPORT

There are basically two methods of supporting insulated piping that is installed above ground. The method chosen reflects function, pipe diameter or working space.

- The piping may be supported directly with hangers or pipe saddles. Neither of these requires the insulation to bear any of the load of the insulated piping.
- The piping may be supported on the exterior of the insulation, requiring either that the insulation bears the weight of the insulation and piping, or that a load-bearing insert be provided to prevent loads from being transfered through the insulation material.



PIPING SUPPORTED DIRECTLY

Pipe hangers that are installed in direct contact with the surface of the pipe, such as a pipe clamp, should have insulation applied over the hanger as well as the pipe. Cold piping supported by direct contact hangers should be insulated, to the maximum extent possible, to prevent condensation on the pipe and pipe hangers. Hot piping supported by direct contact hangers should have the hanger insulated for personnel protection as appropriate for the operating temperature and exposure conditions.

Pipe saddles are commonly used on large diameter piping where the load is exceptionally heavy or when contraction-expansion movement is expected. Pipe saddles are welded to the pipe and are used in conjunction with roller supports or on beam supports. Where possible, pipe saddles should be sized to be flush with the insulation material. If rollers are used and suspended from above, hanger rods should be spaced to allow clearance for the insulation. Insulation may be inserted into the void between the pipe and saddle if desired.

PIPE SUPPORTED ON INSULATION EXTERIOR

It is desirable to avoid breaks in the insulation system. Ideal designs should avoid thermal "shorts" which could lead to hot spots on hot systems, and condensation and icing problems on cold systems.

To eliminate those conditions, insulated piping is often supported using clevis hangers, and rolled metal insulation protection shields or "cradles" on the outside of the insulation.

CALCULATING PIPE SPAN ON PIPES SUPPORTED ON INSULATION EXTERIOR

Several factors govern the pipe span and size of the cradle (length, rolled width and thickness). Following are the formulae to make the necessary calculations:

Maximum span limited by pipe stress

$$l = \sqrt{S \times (Z \div W)}$$

Where:

l = maximum allowable span between supports in m or ft
S = maximum allowable pipe stress, in MPa or lb/in²
Z = section modulus of pipe, in cm³ or in³
W = uniform weight of pipe, contents, insulation, in kg/m or lb/ft

Maximum span limited by pipe deflection

$$l_2 = \frac{(384\ E \times I \times \delta)}{[5 \times (w \times 10^{10})]}$$

Where:

l_2 = maximum allowable span between supports limited by pipe deflection
δ = maximum deflection at the center of the span, measured in mm or in.
w = uniform weight of pipe, contents, insulation, in kg/cm or lb/in.
E = modulus of elasticity of pipe, in MPa or lb/in²
I = area moment of inertia of pipe, in mm⁴ or in⁴

The span lengths are typically calculated from these equations to limit deflection (δ) of a pipe insulated with FOAMGLAS® cellular glass to less than 3.8 mm (0.15 in.)

CALCULATING CRADLE SIZE AND STRESS ON THE INSULATION/PIPE INTERFACE.

Cradle design is based on a maximum bearing capacity that is calculated by applying a safety factor (typically 5) to the compressive strength. For standard grade FOAMGLAS® ONE™ material (compressive strength of 620 kPa / 90 psi) this would give a maximum bearing value of 124 kPa (18 psi) which would translate to a maximum bearing value of 1.3 kg/cm², allowing up to 3.8 mm (0.15 in.) deformation in the cradle area without adversely affecting the insulation

A 120° arc has been established as the effective bearing contact angle for insulation in clevis hangers. Use a 30° contact angle for rollers or point load applications – which include rollers, flat beams, legs of a channel welded together to form a truss, and structural tees. The insulation/pipe interface is the surface of greatest stress and the surface on which the 1.3 kg/cm² (20 lb/in²) limit applies. Cradles should cover the bottom 180° of insulation to facilitate installation and retention.

ENGLISH:

$$AL = 0.01745 \times R \times \alpha$$

SI:

$$AL = 2 \times R \ \sin(\alpha/2)$$

The following equations are used to calculate stress on the insulation/pipe interface:

Arc length

Where:

AL = Arc length, measured in cm or in.
R = outer radius of pipe, in cm or in.
α = contact angle (120°)

Contact area of interface

Where:

CA = Contact area of insulation/pipe interface, measured in cm² or in²
SL = Shield length, in cm or in.
AL = Arc length, in cm or in.

$$CA = (SL) \times (AL)$$

$$S = Ws/CA$$

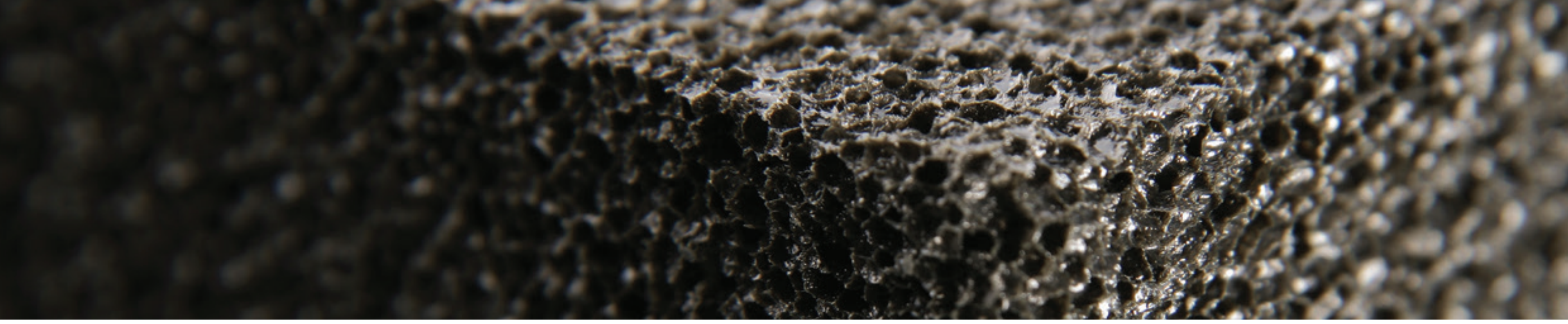
Maximum allowable insulation stress

Where:

S = Maximum allowable insulation stress
Ws = Weight of span including pipe, insulation, and contents, in kg or lbs
CA = Contact area of insulation/pipe interface, measured in cm² or in²

Other design factors to consider in sizing and applying pipe cradles for insulated piping

- The addition of any components to the pipe span such as valves, meters or fittings will require calculations to ensure that the allowable stress at the insulation/pipe interface in the cradle area has not been exceeded. If the above conditions cannot be met to limit stress on the insulation/pipe interface to the maximum acceptable level, the span between supports may be reduced, and cradle dimensions recomputed.
- The width of the cradle, before rolling, should be one-half (1/2) the circumference of the insulated piping, including the insulation jacketing or finish. Radius of curvature must accommodate finish and allow uniform fit of the segments of insulation bearing load. Uniform fit should provide the lower segment with adequate surface for proper load distribution. Force fitting or inadequate clearance for the load-bearing segments can result in damage to the insulation in the support area.



- A mastic finish may be used under a pipe cradle. If metal jacket is used over an insulation system without a finish, the outer surface of the insulation in the area under the cradle may be coated with a mastic to provide more uniform bearing, prior to application of the metal jacket.
- When excessive movement is expected, such as in steam systems, above 93 °C (200 °F), a direct contact pipe saddle may be used. However, pipe saddles that are installed in direct contact with the service piping, are generally not recommended for use on cold piping that requires a vapor barrier, or in shallow trench, vault, and tunnel systems where flooding may occur.
- Typically, clevis hangers and rollers are only available up to 609 mm (24 in.) in diameter. On lines where the outer diameter of the pipe and insulation exceeds 609 mm (24 in.), a support designed by qualified engineers with provisions for movement is recommended. Typically these are clamshell type construction with high density insulation material inserts and slide plates welded to the support structure.

COMMON MISTAKES AND THE CONSEQUENCES

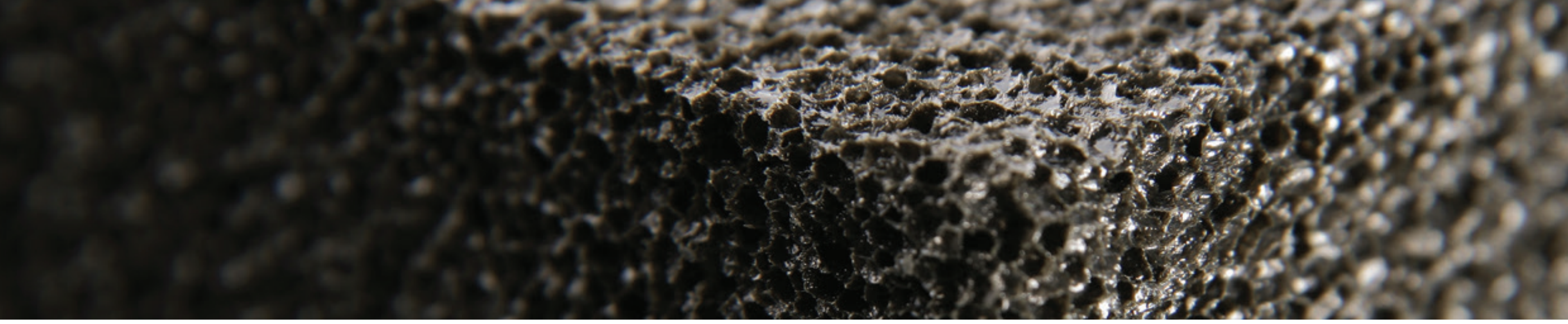
Not clearly defining the pipe support's cradle dimensions can lead to several issues that could compromise the mechanical performance of the entire pipeline.

Should one or several insulated pipe supports settle considerably or fail, it will create geometrical changes in the steel pipeline which may result in significant stresses, particularly near nozzles, flanges and fittings.

Calculation methods to determine the cradle dimensions have been developed and enable the designer to choose the correct dimensions in relation to other factors, such as the distance between the cradle, the load, and the type of capping materials.

Penetrations, pipe hangers, supports and gaps/joints all represent significant design and application problems for hot work, as well as for cold work. In both cases, they can be potential paths for moisture entry as well as sources of air leakage via induced natural convection. This can eventually lead to issues with energy loss and the formation of corrosion. Corrosion at pipe supports is one of the most common causes of external piping corrosion failures in processing environments and can seriously endanger the structural integrity of the pipeline.

Finally, a common mistake is not using the correct insulation material for a particular support. Ensure that the insulation material is suitable for the demands of the system and code requirements. Only closed-cell insulation should be allowed in below-ambient conditions. Also evaluate the flame and smoke ratings, which will differ for some materials depending on the insulation thickness.



FOAMGLAS® CELLULAR GLASS INSULATION FOR PIPE SUPPORTS

Choosing the wrong type of insulated pipe supports can lead to high operating costs, heat loss, corrosion under insulation (CUI), and a several other issues.

For insulated pipe supports and hangers, the choice of an insulating material such as FOAMGLAS® cellular glass, which has a high compressive strength, enables the designer to avoid direct short circuits or at least to reduce these instances substantially. The purpose of avoiding thermal short circuits is because they could result in substantial heat transfer and condensation in low temperature applications. This condensation could be detrimental since the water, due to gravity, will tend by to penetrate the hanger box.

The impermeable nature of FOAMGLAS® insulation helps to ensure that the mechanical performance is not affected by the influence of moisture in liquid or vapor form. This will mitigate risks associated with corrosion and help to maintain the integrity of the insulated pipe support over the lifetime of the installation. From an economic point of view, FOAMGLAS® insulation will keep its thermal efficiency over time as it is not susceptible to cell aging or decreasing thermal performance due to moisture penetration. This will help to eliminate hot or cold spots and help ensure that the overall system can run economically and operating costs are kept at a minimum.

FOAMGLAS® insulation is most suited to use in "dead weight load" support applications where the pipe is resting in a band style hanger, or on a rolled plate cradle. It is not suited for use in guides, (spider or cryogenic service) where thermal forces (live loads) can be in a magnitude much greater than simple dead weight load.

We can conclude that, installation of piping in hangers or other supports while achieving insulation efficiency requires many considerations regarding the types, sizes, weights and lengths of the equipment involved. Choosing an impermeable material with a high compressive strength such as FOAMGLAS® insulation will help limit many issues related to energy efficiency and mechanical performance. In addition to supplying high-performing insulation and accessory products for dedicated pipe support systems, we also can provide the expertise necessary to assist with design and proper installation, which helps enable systems to function effectively which will positively affect your installation's overall life cycle cost.

FIBERGLAS™ | FOAMGLAS® | PAROC® | THERMAFIBER® | FOAMULAR®

OWENS CORNING FOAMGLAS

Pittsburgh Corning LLC
ONE OWENS CORNING PARKWAY
TOLEDO, OHIO, USA 43659

For web-based Sales and Technical Service inquiries, please visit
www.foamglas.com

To contact by phone or email:

Industrial & Commercial Sales
Americas
+1 800-327-6126

Asia-Pacific
Singapore: + 65 9635-9184
China: +86 (0) 21 6101 7179
Japan: +81 3 6365 4307

Europe, Middle East & Africa
+32 13-661-721

Technical Services
Americas & Asia Pacific
+1 800-327-6126
foamglastechnical@owenscorning.com

Europe, Middle East & Africa
+32 13-611-468
Industry.tech@owenscorning.com

Pub. No. 10024809