

200 Insulation Selection—Cold Systems

Abstract

This section describes cold equipment that we insulate and why we insulate, types of insulation material and special concerns when insulating cold systems. It also includes a chart for choosing the insulation thickness.

Contents	Page
210 Introduction	200-2
220 Types of Insulation	200-3
230 Insulation Concerns	200-3
240 Insulation Thickness	200-5
250 Company Specification And Drawings	200-5

210 Introduction

Cold systems are those operating continuously below ambient temperature. Much of the information in Section 100 on hot systems applies to cold systems. With cold systems, however, the primary concern is often process considerations such as 1) cryogenic operations and 2) water condensation on the insulated surface causing corrosion or damage from water freezing underneath the insulation. Therefore, insulation systems for cold items tend to be more complicated and costly than those for hot items.

Reasons for Insulating

Process Considerations. Process equipment operating at temperatures below ambient will normally require insulation for process temperature control purposes. This includes lines and vessels in systems where a controlled heat-up to ambient temperature is desired. Lines and vessels operating below +80°F which require temperature control for process reasons should be insulated. The 80°F temperature is a generally applicable limit which is normally above the atmospheric dew point.

Cryogenic systems require insulation to prevent heat adsorption and icing. The operating costs to keep these systems cold and prevent product loss are very high.

Condensation. A higher temperature limit may be required where high dew point temperatures exist. Uninsulated piping or equipment which is operating below the dew point of the atmosphere will condense moisture and drip. If dripping is objectionable but installation of a standard insulation system is not desirable, the surface may be coated with a mastic insulating material which may be trowelled on such as Childer's Insul-mastic.

Personnel Protection. Cold equipment may require insulation for protection of personnel only, where operating conditions are not a factor. Cold “burns” may occur from contact with cold operating equipment, although a layer of ice will normally form on the surface and act as an insulator.

Cold Equipment We Normally Don't Insulate

Generally speaking, any piece of piping or process equipment operating at temperatures much below ambient will require insulation. However, the following cases are typical exceptions:

Compressors. Compressors in ammonia, LPG, carbon dioxide, or refrigerant services, for example, are not insulated up to the first external piping connection. Normal maintenance of compressors requires ready access so that insulation is not justified when it will be removed or damaged often.

Valves. Valves are normally not insulated from just below the packing gland to the top of the valve. This permits repacking the valve without destroying the insulation vapor seal.

Mechanical Equipment. Mechanical equipment, such as centrifuges in paraxylene plants, is not insulated for the same reasons that apply to compressors.

220 Types of Insulation

The primary requirements for cold insulation are that it has an adequate K value to prevent excessive gain of heat and that it resists moisture penetration. The most common materials satisfying these conditions are those having a foam or cellular construction of very small individual cells that are not interconnected.

The materials, as they apply to cold insulation, are briefly discussed below. Refer to Section 200 for information on test criteria and material properties. Figure 200-1 compares the critical properties for cellular glass and polyurethane foam.

Fig. 200-1 Insulation Materials and Properties for Cold Applications

Material Generic Type	Commercial Brands	K Factor (Btu-in/hr-ft ² -°F)	Compressive Strength (psi)	Density (lb/ft ³)
Cellular Glass	Foamglas, Pittsburgh Corning	0.358 at 100°F 0.333 at 50°F 0.310 at 0°F 0.289 at -50°F 0.269 at -100°F 0.249 at -150°F 0.229 at -200°F 0.209 at -250°F	100	8.5
Polyurethane ⁽¹⁾ (Foam Board)	Thermax, Celotex; PBS/800, Polymer Building Systems; TSX 2000, RMAX	0.15 at 75°F	25	2

(1) Should be double laminated with aluminum foil.

Cellular Glass Block—Foamglas (Pittsburgh Corning)

This is a hard, brittle, dark gray insulation. It is easy to cut into various sizes and has had considerable use in our plants. This has been the standard cold temperature insulating material for many years and it remains the recommended material. See Section 200 for material characteristics.

Polyurethane Foam

We no longer recommend the use of spray-applied or poured-in-place polyurethane foam insulation. However, the preformed board is satisfactory as described in Section 200.

230 Insulation Concerns

Sealing Insulation

Cold insulation systems differ from hot ones in that primary emphasis is placed on providing a water-tight vapor barrier that prevents water penetration. This vapor barrier is probably the most critical part of an insulation system because it prevents moisture from entering the insulation.

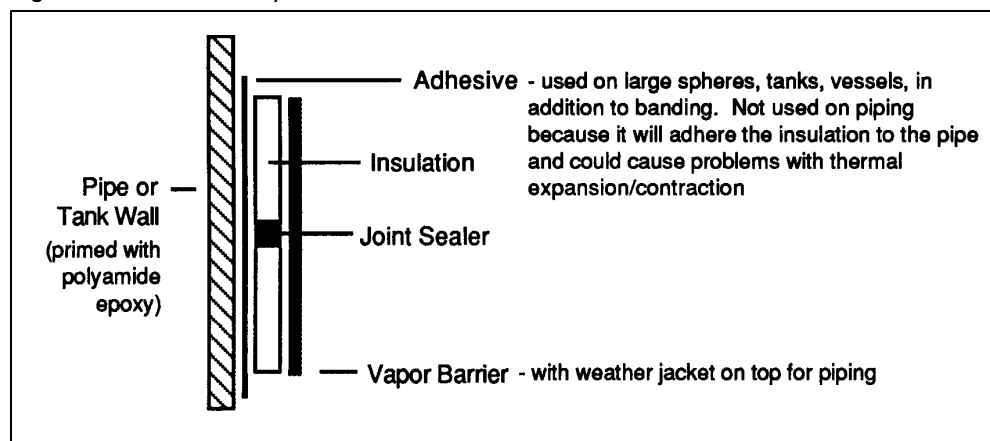
Condensation is the primary source of ice formation for equipment below 32°F. The resulting ice will expand causing the insulation to spall and crack. Once ice has begun to form, the expansion process continues until the insulation has totally failed and the surface of the pipe or equipment is covered with ice. Several techniques, when used together, will prevent the formation of ice in the insulation.

These are:

- Use of an insulation material which is impervious to moisture (i.e., cellular glass).
- Use of a vapor barrier that prevents water from coming in contact with the insulation.
- Use of joint sealers between insulation blocks.

Figure 200-2 shows a typical insulation system.

Fig. 200-2 Insulation System for Cold Lines and Vessels



Surface Preparation

It is necessary to provide surface protection against corrosion of the equipment during shutdowns or operation in the event moisture is able to penetrate through the vapor barrier. Good surface preparation consists of sandblasting the equipment and priming with polyamide epoxy (Coating System 1.4 in the *Coatings Manual's Quick Reference Guide*). Surface preparation and painting should be completed before the insulation contractor begins work at the job site.

Installation

Insulation blocks are applied using a joint sealer between all butt edges of the insulation blocks. The joint sealer should not be used between the equipment surface and the first layer of blocks. However, edges of block always should be sealed. Insulation blocks are held on with stainless steel straps.

It is important that the vapor barrier be installed correctly to ensure that no moisture penetrates into the insulation. Similarly, it is important to be sure the mating edges of blocks are sealed together to prevent ingress of moisture. Cellular glass block

insulation installed on vibrating piping, such as around compressors, should be coated on the inside with vinyl bore coating to protect the insulation from abrasion damage.

Need for Fire-Resistant Coverings

Exterior applications of polyurethane foam must always be provided with a fire-resistant protective covering with a flame spread rating of 25 or less as determined by ASTM Specification E-84. Interior applications of foam may or may not be protected as determined by the environment. The majority of polyurethane use has been, and will continue to be, on tankage which satisfies recognized spacing practices and which will not endanger neighboring equipment should a fire occur.

Low temperature process vessels and/or piping insulated with polyurethane foam and located in fire hazardous areas or in highly congested areas containing concentrated amounts of closely spaced equipment will require additional fire-resistant coverings such as aluminum or stainless steel.

240 Insulation Thickness

Section 210 discussed the reasons for insulating cold equipment. The operating costs for keeping equipment cold—especially cryogenic equipment—can far exceed the cost to heat equipment. Consequently, insulation for cold equipment is generally thicker than that for hot equipment.

Figure 200-3 gives the minimum insulation thickness for cold conservation. These data were obtained from Warren Petroleum. The design basis is given in the figure.

250 Company Specification And Drawings

The specification named below covers insulation for cold systems. The specification is in a gray tabbed section of the manual. The Company does not yet have a specification for insulation of spheres.

The drawings are also in a gray tabbed section.

IRM-MS-2634	Cold Lines, Vessels and Equipment
GD-N99784	Standard Insulation for Cold Piping
GD-N99786	Standard Insulation for Cold Vessels, Heat Exchangers and Cold Equipment
GD-N99993	Standard Insulation Item Numbers

Fig. 200-3 Minimum Insulation Thickness for Cold Conservation

Pipe/ Vessel Size, in.	Operating Temperature Range, °F						
	Above 30°F	31°F To 1°F	0°F To -25°	-26°F To -75°F	-76°F To -125°F	-126°F To -175°F ⁽¹⁾	-176°F To -225°F ⁽¹⁾
1½ & Less	1.5	2	2.5	3	3.5	4	4.5
2	1.5	2	2.5	3	4	4.5	5
3	1.5	2	2.5	3.5	4	4.5	5.5
4	1.5	2.5	3	3.5	4	4.5	5.5
6	1.5	2.5	3	3.5	4.5	5.5	6
8	1.5	2.5	3	4	5	5.5	6.5
10–12	1.5	2.5	3.5	4.5	5.5	6	7
14–16	1.5	2.5	3.5	4.5	5.5	6.5	7
18	1.5	2.5	3.5	4.5	5.5	6.5	7.5
20	2	2.5	3.5	5	6	7	7.5
24	2	2.5	3.5	5	6	7	8
30–36	2	3	4	5	6.5	7.5	8
Over 36 & Vessels	2	3	4	5.5	7	8	8
Design Basis: Type of insulation: Cellular glass with aluminum jacket Ambient temperature: 90°F Wind = 0 mph							

- (1) At very low temperatures (<-150°F) consider using a 2-layer system: 1) Polyurethane block insulation underlayer to reduce the overall thickness, and 2) Cellular glass outer layer for mechanical protection. This type of installation must be engineered on a system-by-system basis.