



PERLITE MANAGEMENT

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PREFACE

As part of a program of harmonization of industry standards, the Asia Industrial Gases Association (AIGA) has published AIGA 032, "*Perlite Management*", jointly produced by members of the International Harmonization Council and originally published by Compressed Gas Association (CGA) CGA P-8.3, "*Perlite Management*".

This publication is intended as an international harmonized standard for the worldwide use and application of all members of the Asia Industrial Gases Association (AIGA), Compressed Gas Association (CGA), European Industrial Gases Association (EIGA), and Japan Industrial and Medical Gases Association (JIMGA). Each association's technical content is identical, except for regional regulatory requirements and minor changes in formatting and spelling.

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NOTE—Technical changes from the previous edition are underlined.

1 Introduction

Perlite is used as an insulation medium in cryogenic enclosures such as coldboxes, cryogenic liquid tanks, field-erected flat bottom tanks, and pipe ducts where perlite is filled into the annular spaces between the inner and the outer shells.

2 Scope

Perlite is nontoxic and nonflammable; however, the nature of the material and the large quantities involved require the use of special operations, handling, and safety procedures. This publication provides guidance for reducing the risks of uncontrolled perlite releases and incidents that have potential for serious personnel injury, property damage, downtime, environmental impact, and consequences outside the perimeter of the plant.

It covers the use of perlite in cryogenic enclosures and focuses on safety, perlite handling procedures, and emergency perlite management. This publication is for industrial gas plant manufacturers, owners, and operators of facilities that use and maintain perlite as an insulation medium for cryogenic equipment. Insulating materials such as mineral wool or vermiculite and other synthetic silicates are not covered in this publication. This publication does not cover hazards related to toxic and flammable gases.

Information regarding design considerations, operation, and maintenance of cryogenic enclosures is contained in AIGA 079, *Safe Design and Operation of Cryogenic Enclosures* [1]¹.

This publication does not attempt to recommend or establish specific design or usage criteria but provides best practices. The end user shall determine the specific requirements.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

3.2 Technical definitions

3.2.1 Coldbox

Cylindrical or rectangular enclosure, typically metal, surrounding the distillation columns and other cryogenic equipment.

NOTE—The space between the columns and the inner coldbox shell is filled with insulation material, typically perlite.

¹ References are shown by bracketed numbers and are listed in order of appearance in the reference section.

3.2.2 Cryogenic

Temperatures less than $-130\text{ }^{\circ}\text{F}$ ($-90\text{ }^{\circ}\text{C}$).

3.2.3 Perlite

Inert volcanic glass that forms an odorless, nonflammable, nontoxic lightweight powder aggregate when expanded by heat.

NOTE—It is a highly effective insulating material used to reduce refrigeration losses or heat leak into the cryogenic enclosure.

CAUTION: *Since it is a lightweight powder, it can become an asphyxiation hazard if inhaled or if submerged in perlite.*

3.2.4 Perlite eruption

Rapid, uncontrolled displacement of perlite within the insulation space that can result in a violent perlite release.

NOTE—It is commonly caused by the rapid vaporization of pooled cryogenic liquid in the perlite that has suddenly been warmed, moved, or physically disturbed and can happen any time after liquid has pooled.

3.2.5 Perlite releases

Uncontrolled spillage of perlite to the environment.

3.2.6 Purge gas

Moisture-free, oil-free inert gas.

NOTE—For purge gas purity requirements, see AIGA 079 [1].

4 Personnel safety

4.1 Working with perlite

Operations and maintenance personnel involved in working with equipment that contains bulk perlite shall be trained in the safe and correct methods of handling perlite and its characteristics. This training shall be recorded. Installation and removal work crews shall be experienced in perlite handling and should be supervised.

4.2 Personal protective equipment

Expanded perlite is a nontoxic material, but the recommended personal protective equipment (PPE) should be used as required for the particular task. Overalls, gloves, and hard hats should be used to prevent skin irritation.

Perlite is lightweight and becomes airborne very easily. If perlite enters the eyes or respiratory tract, it can cause serious irritation. Eye protection shall be used to provide protection due to the dusting of handled perlite. For more information on PPE, see AIGA 066, *Selection of Personal Protective Equipment* [2].

CAUTION: *If insulation enters the eyes, do not rub them. Flush the eyes immediately with water.*

If personnel must work in or enter an area with a high concentration of airborne perlite, they shall use a dust mask or full-face air-purifying respirator equipped with dust filters (NIOSH-approved or equivalent) in accordance with Title 29 of the U.S. *Code of Federal Regulations* (29 CFR) Part 1910 [3]. Refer to the safety data sheet (SDS) for information on regulatory exposure limits.

CAUTION: *A perlite product can contain crystalline silica, which is considered to be a nuisance dust. Inhalation of high amounts of any nuisance dust over long periods can overload the lung clearance mechanism and make the lungs more vulnerable to respiratory disease.*

Other safety considerations deal with the cryogenic liquid that can be entrained in the perlite during handling.

4.3 Cryogenic enclosure entry

Entry into cryogenic enclosures shall only be undertaken under a safe work permit process, as entry involves many potential hazards, which include but are not limited to the following:

- Falling into the perlite and becoming submerged and asphyxiated;
- Oxygen deficiency due to the release of residual nitrogen purge gas or condensation of oxygen against cold surfaces;
- Oxygen enrichment due to leakages of oxygen-enriched liquid or liquid oxygen or from vaporization of condensed air formed against cold surfaces;
- Oxygen enrichment due to a process leak that saturates the perlite with gaseous oxygen;
- Frostbite caused by contact with cold surfaces;
- Falling ice or blocks of frozen perlite caused by freezing of atmospheric moisture within the cryogenic enclosure;
- Sudden oxygen-enriched or -deficient atmospheres caused by trapped oxygen or nitrogen that can be released when perlite is disturbed during removal or maintenance activities;
- Danger of perlite eruption caused by liquid pooled in the perlite, which can suddenly vaporize at any time even before the coldbox equipment has been warmed up (sometimes many days after the initial warm up); and
- Leakage of perlite from adjacent coldboxes via coldbox interconnections.

Never enter the enclosure until all confined space entry requirements have been met. In addition to any company requirements, applicable local and national regulations shall be met, for example, OSHA requirements in 29 CFR Part 1910 [3].

Whenever possible, remove all perlite and sweep or wash down the casing to eliminate dust and slippery surface hazards. When a person is required to work on or above a perlite mass, an adequate working platform or alternative safety measures such as use of harnesses shall be used.

5 Inspections and precautions during operation

5.1 Cryogenic enclosure atmospheric check

An atmospheric check should be completed periodically to verify that the insulation gas composition is the same as the purge gas and verify that process gases have not leaked into the cryogenic enclosure. The use of oxygen monitors only indicates the presence or absence of oxygen.

NOTE—For argon production plants where hydrogen is used to remove oxygen in the crude argon, it is possible for the hydrogen to leak into the coldbox. Periodic analysis of the coldbox annular space atmosphere for hydrogen should be performed.

5.2 Cryogenic enclosure annular space pressure check

Cryogenic enclosure annular space pressure should be checked periodically against design values. Low pressure can indicate inadequate purging and high pressure can be due to a leak.

5.3 Ice formation

External ice formation can result from:

- cryogenic gas or liquid leak;

- entry of ambient air or water due to:
 - improper sealing of penetrations into cryogenic enclosure
 - inadequate cryogenic enclosure maintenance resulting in cracks, corrosion, etc.
 - inadequate purging;
- insufficient and/or improperly installed insulation; and
- poor quality insulation.

The perlite level should be checked periodically when a problem is suspected (for example, a visible frost spot), and/or during routine cryogenic enclosure maintenance. The insulation will settle, especially after perlite is added to the cryogenic enclosure, and the insulation level could need to be topped off.

CAUTION: Use caution when checking the perlite level. The insulation space contains perlite and the purge gas, which is an asphyxiant.

5.4 Perlite abrasion

Perlite is abrasive. When entrained in a gas jet, perlite can cut through metal piping and equipment, damaging the equipment and allowing perlite to enter the process. The primary sources for such gas jets are either process leaks or damaged or broken piping inside the cryogenic enclosure. Even small gas leaks can result in even larger openings in the process piping and equipment or adjacent process piping and equipment. These leaks can ultimately become so large that a major perlite release or a catastrophic failure can occur if the leak is not addressed.

For additional information, see AIGA 079 [1].

6 Perlite removal

CAUTION: Take steps to reduce the number of personnel in the work area. If possible, rope off the area and post warning signs to keep nonessential personnel away.

6.1 Before perlite removal

Before perlite removal, perform the following steps in the order listed:

- a) Shut down the cryogenic process;
- b) Drain all cryogenic liquids from the process equipment and piping;
- c) Warm the process equipment and piping to a safe working temperature;

CAUTION: At a minimum, precautions shall be taken to protect personnel from perlite eruption in the event of liquid pooling due to a leak, engulfment, cryogenic exposure, and asphyxiation.

- d) Depressurize the equipment to a slight positive pressure to prevent perlite entry into the process in case of a leak while allowing safe access for personnel when entering the cryogenic enclosure;
- e) Stop the purge gas flow to the cryogenic enclosure insulation space and physically isolate the purge gas supply. This can be accomplished by the removal of a section of the piping or the insertion of a blind flange;

For HYCO facilities, all flammable and toxic materials shall be purged from the coldbox and process piping.

- f) Check the annular space pressure and atmospheric composition and, if possible, check at different elevations of the coldbox; and
- g) Open a top manhole before removing perlite to protect against a possible casing collapse by developing a vacuum during the perlite removal process.

6.2 Cryogenic enclosure perlite removal

6.2.1 Monitoring

The insulation space gas composition should be monitored continuously for the presence of excessive oxygen, combustible gases, or both. The composition should be checked along the height of the coldbox. If a high concentration (oxygen greater than 5% when purging with nitrogen or greater than 23% when purging with dry air) is detected, the manhole should be closed and a purge reinstated. Continue the purge until the oxygen concentration in the vent gas drops below these levels.

6.2.2 Removal process

To lessen the risks of uncontrolled perlite releases, removal of perlite should take place from the top of the cryogenic enclosure and proceed downward. This reduces both the potential for perlite bridging (agglomeration of the powder into a solid mass) and the amount of perlite that can be expelled from the casing should an uncontrolled release occur.

Perlite releases and eruptions can be caused by, but are not limited to, the following:

- Cryogenic enclosure overpressurization due to equipment or process line failure, including purge gas overpressurization;
- Local overpressurization due to rapid vaporization of liquid that can occur when cryogenic liquid is pooled in the perlite, and the perlite is physically disturbed or the pool of liquid is suddenly warmed;
- Structural failure of the insulation containment device due to operating conditions (such as vacuum), embrittlement, or external loading;
- Mishandling during emptying operations (for example, rapid removal of perlite, removal from incorrect location, opening of a cryogenic enclosure panel below the perlite level, unexpected flowing of perlite from areas adjacent to the section or enclosure being emptied); and
- Sudden collapse of the bridged perlite.

Perlite removal nozzles should be used if they are provided. If not present during the removal process, consideration should be given to adding nozzles. For more information on placement of nozzles, see AIGA 079 [1]. If cryogenic liquid is known to have collected in the perlite, the perlite should not be withdrawn from the bottom of the coldbox; flashing of liquid in a fully perlited coldbox can result in a perlite eruption.

In order to detect cryogenic pooling or leaks, continuous monitoring of the oxygen level in the perlite being removed shall be considered.

An open-top perlite collection box should be used if perlite is removed using equipment not designed for oxygen service (for example, vacuum blowers found on commercial vacuum trucks). This allows for degasification of the perlite (escaping gas or vaporizing liquid) and prevents a possible oxygen-enriched atmosphere, which is a fire hazard.

Proceed cautiously if the perlite is suspected of containing cryogenic liquid or is saturated with cryogenic gases, which can lead to a hazardous atmosphere in the perlite collection box.

The insulation space pressure at ground level and at the level from which perlite is being withdrawn should be monitored using a manometer or gauge. If the pressure starts to increase, it can be an indication of an imminent perlite release and perlite removal should be stopped immediately.

6.2.3 Residual perlite

When the majority of perlite has been removed, residual perlite removal could be required. If removal of residual perlite requires entry into the cryogenic enclosure coldbox, follow regulatory and safety procedures including the following:

- Comply with the applicable safe work permit process;

- Monitor the annular space for safe oxygen content;
- Check the interior for ice blocks and remove large blocks by thawing, either mechanically or by judicious use of steam;
- Take care not to disturb or break small bore lines in the vicinity of the perlite clean-up operation; and
- Remove residual perlite by brushing, shoveling, or if only absolutely necessary, washing surfaces with water.

7 Perlite installation

Prior to insulating a cryogenic enclosure, the insulation space shall be inspected and any materials or items not part of the equipment design shall be removed such as scaffolding, tools, temporary pipe supports, adhesive tape, wood, miscellaneous containers, etc.

7.1 Packaging

Where small quantities of perlite are required, either siloed or bagged perlite can be charged directly through manholes at the top of the cryogenic enclosure. Bulk shipments of expanded perlite can be delivered in closed-type tanker trailers equipped with a transfer hose to discharge the perlite directly into the cryogenic enclosure or into the annular space of a tank. The tanker shall be equipped to prevent moisture entry into the perlite during transport. The inside of the tanker should be clean.

Where large quantities of perlite are required, expansion “popping” of the perlite ore at the plant location can be more efficient. A knowledgeable contractor should complete this operation and provide all the necessary equipment and services.

7.2 Perlite quality

Perlite deteriorates each time it is handled. Before use, the perlite should be inspected for the following properties and compared to the values of the manufacturing specifications:

- loose density;
- compacted density;
- particle analysis;
- free moisture content; and
- organic material content.

NOTE—If the perlite is reused, there is normally some attrition and the cryogenic enclosure should be topped off with fresh perlite.

WARNING: *When reusing perlite, it is important to confirm the material has not been contaminated especially with hydrocarbons or moisture during handling and storage. In an oxygen-enriched atmosphere, the presence of hydrocarbons can lead to an energy release, which can result in death or serious injury.*

CAUTION: *Higher perlite compacted density can restrict the movement of piping and tubing that can lead to leak or failure. The perlite compacted density can also restrict gas flow to the cryogenic enclosure overpressure devices that can lead to failure of the cryogenic enclosure, which can result in death or serious injury.*

7.3 Filling to avoid insulation space voids

There are several methods to fill cryogenic enclosures without creating pockets or insulation voids:

- Perlite can be introduced in stages to help reduce voids. For coldboxes, first add perlite at lower levels. Then proceed up the coldbox, adding perlite through higher fill ports;

- Top fills are used when staged fills are not used or when topping off the insulation space; and
- When practical, vibration equipment or rubber mallets used to tap on the cryogenic enclosure exterior can be used to induce perlite settling, thus avoiding pockets or voids.

7.4 Purge gas supply

Once the insulation space is filled with perlite, all column entry points shall be closed and the purge gas supply should be immediately placed into service. For more information on purge gas operations and troubleshooting, see AIGA 079 [1].

7.5 Settling

After process equipment inside the cryogenic enclosure has cooled down and operation has commenced, settling of perlite normally occurs. The top of the cryogenic enclosure should be inspected and topped off with additional insulation as necessary.

CAUTION: Use caution when checking the perlite level. The insulation space is pressurized with the purging gas, which can be nitrogen (an asphyxiant). Safety precautions shall be taken. A self-contained breathing apparatus (SCBA) could be needed to ensure the safety of the inspection personnel from asphyxiating gas discharged at them from the opening. A standby person could also be needed in the event of an emergency. Depending upon the size of the opening used to make the inspection and the potential for falling into the cryogenic enclosure, fall protection gear can also be used. If inspection personnel break the plane of the cryogenic enclosure opening to make the inspection, a confined space entry permit is required.

8 Disposal of perlite

Disposal of perlite could be governed by federal or state environmental regulations. If contamination is suspected, conduct appropriate testing to determine whether the material is hazardous or not, as defined by applicable federal or state hazardous waste regulations. If contamination is confirmed, dispose of the perlite in accordance with applicable regulations.

Noncontaminated perlite can be disposed of or recycled as governed by federal or state environmental regulations.

9 Emergency plan for perlite releases

Facilities that use perlite shall have an emergency plan that addresses perlite releases. The emergency plan shall address who is to be called if there is a perlite release. The plan may list companies with clean-up capabilities and local disposal sites. Many landfills require prior approvals so that when disposal is required, the paperwork has already been completed and perlite can be accepted quickly.

The emergency plan shall be reviewed periodically to ensure that the information is accurate and up to date. Personnel shall receive training on the emergency plan and shall be notified when substantive changes to any emergency response procedures are made.

At a minimum, the emergency plan shall include the following procedures:

- a) Secure the area where the release occurred;
- b) Evacuate personnel from where the release occurred;
- c) Assess the size and magnitude of the release;
- d) Implement containment based on the assessment (for example, to prevent perlite migration into waterways, storm water, public highways, and adjacent processes or equipment);
- e) Contact emergency response agencies and offsite neighbors, as required;
- f) Vacuum clean or wet sweep to avoid dusting;

- g) Contact qualified clean-up and perlite disposal contractors; and
- h) Check a perlite SDS for any required first aid/emergency procedures.

10 References

Unless otherwise specified, the latest edition shall apply.

[1] AIGA 079, *Safe Design and Operation of Cryogenic Enclosures*, Asia Industrial Gases Association, www.asiaiga.org

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[2] AIGA 066, *Selection of Personal Protective Equipment*, Asia Industrial Gases Association, www.asiaiga.org

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[3] *Code of Federal Regulations*, Title 29 (Labor), U.S. Government Printing Office. www.gpo.gov