PERLITE MANAGEMENT

AIGA 032/08

GLOBALLY HARMONISED DOCUMENT

Based on CGA P -8.3
Second Edition 2005

Asia Industrial Gases Association

3 HarbourFront Place, #09-04 HarbourFront Tower 2, Singapore 099254
Tel : +65 6276 0160 • Fax : +65 6274 9379
Internet : http://www.asiaiga.org

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ASIA INDUSTRIAL GASES ASSOCIATION
3 HarbourFront Place, #09-04 HarbourFront Tower 2, Singapore 099254
Tel: +65 62760160 Fax: +65 62749379
Internet: http://www.asiaiga.org

Acknowledgement

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1 Introduction

This publication is one of a series compiled by the Compressed Gas Association, Inc. (CGA), in response to inquiries for information relating to perlite. Perlite is used as an insulation medium in cryogenic 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.

As part of the programme of harmonization of industry standards, the Asia Industrial Gases Association (AIGA) has adopted the original CGA standard P-8.3 as AIGA 032/06. This standard is intended as an international harmonized standard for the use and application by members of CGA, EIGA, JIGA and AIGA. This edition has the same content as the CGA edition except for editorial changes in formatting, units, spelling and references to AIGA documents.

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 unplanned perlite releases and incidents that could have potential for personal injury, property damage, downtime, and environmental impact.

It covers the use of perlite in cryogenic coldboxes and cryogenic bulk storage vessels and focuses on safety, design considerations, operation, maintenance, perlite handling procedures, and emergency perlite management. This publication is directed to industrial gas plant manufacturers, owners, and operators of facilities that utilize and maintain perlite as an insulation medium for cryogenic equipment. Insulating materials, such as rock 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.

NOTE—This document does not attempt to recommend or establish specific design or usage criteria, but to provide best practices. The end user shall determine the specific requirements.

3 Definitions

3.1 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.

3.2 Cryogenic

Fluid with a normal boiling point below –90 °C at 101.3 kPa absolute.[1, 2]

3.3 Perlite

Inert volcanic glass that forms a lightweight powder aggregate when expanded by heat.

NOTE—Perlite is an odorless, nonflammable, nontoxic white to offwhite silicate powder. Perlite is a highly effective insulating material used to reduce refrigeration losses or heat leak into the coldbox, which would otherwise reduce production, increase power consumption, or both.

[1] kPa shall indicate gauge pressure unless otherwise noted as (kPa, abs) for absolute pressure or (kPa, differential) for differential pressure. All kPa values are rounded off per CGA P-11, *Metric Practice Guide for the Compressed Gas Industry* [1].

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

3.4 Perlite releases

Uncontrolled spillage of perlite to the environment, which might be caused by but are not limited to the following:

- coldbox over pressurization due to equipment or process line failure, including purge gas overpressurization;
- rapid vaporization of pockets of cryogenic liquid leaked or condensed in the insulation space;
- structural failure of the insulation containment device due to operating conditions (such as vacuum) or external loading; or
- mishandling during filling or emptying operations.

4 Personnel safety

4.1 Working with perlite

Personnel involved in working with 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, low-risk material, but the recommended protective equipment 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.

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 [2].

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 fluids that can be entrained in the perlite during handling.

4.3 Coldbox entry

Entry into coldboxes involves many potential hazards, which include but are not limited to the following:

- falling into the perlite and becoming submerged;
- oxygen deficiency due to 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 condensation of air against cold surfaces;
- falling ice or blocks of frozen perlite caused by freezing of atmospheric moisture within the coldbox; and
- leakage of perlite from adjacent coldboxes via coldbox interconnections.

Never enter the enclosure until all confined space entry requirements have been met. The requirements are not defined within this publication (see AIGA 005/04 Fire hazards of oxygen and oxygen enriched atmospheres [1] and AIGA 008/04 Hazards of inert gases [2]). Consult local authorities for additional procedures.

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 should be erected.

5 Design considerations

The design of coldboxes should provide means to isolate sections of the enclosure for ease of future maintenance. Areas of potential repair/inspection should be provided with ducts to allow removal of insulation at the local area rather than the entire box.

5.1 Purge gas systems

To prevent atmospheric air from entering into the coldbox enclosure, a purge gas system should be in operation at all times (even when the process is shut down). The purge gas should be dry nitrogen or waste nitrogen with an oxygen content less than 5% by volume. Air should not be used since oxygen from air can condense in regions colder than its saturation temperature and create pools of cryogenic liquid in the perlite area.

The design of the distribution system shall result in a positive gas pressure provided throughout the insulation. There should be no areas where standing gas can accumulate. The inlet piping circuit should be sized to accommodate the volume of gas required to displace moisture due to minor leaks from the insulation space.

A purge vent may be installed to allow for purge gas to exit during normal operation.

5.2 Pressure conditions and relief devices

5.2.1 Relief devices

The pressure in the coldbox structure should be monitored to detect possible overpressure or underpressure conditions. The coldbox should be designed with a pressure relief device (PRD). The PRD will relieve the internal pressure and reduce the possibility of a coldbox perlite release. An alarm may also be activated that requires the operator to take an appropriate corrective action. The device may be located at the top of the coldbox or along the length of the structure. The design should include evaluating the physical location of the device in relation to the plant surroundings and adjacent plant equipment.

For breakaway devices, designs should incorporate a restraining mechanism to prevent endangering personnel.

To assist in monitoring casing pressure and casing purge gas purity, sample taps should be installed in the coldbox casing.

5.2.2 Pressure conditions

A positive pressure throughout the coldbox shall be maintained with the minimum required purge gas flow. All purge systems should have a physical means of demonstrating that gas is actually flowing such as a rotameter.

NOTE—Ensure that there is at least 25 mm of positive water pressure at all elevations of the coldbox.

5.3 Piping and panels

Piping within the perlite insulation space should have welded joints; mechanical joints should be avoided. Welded piping and fittings significantly reduce the possibility of leaks, which could cause liquid releases and vaporization leading to pressure increases in the insulation space and potential perlite releases. If this

is not possible, a blanket or stuffing box of rock wool should be used to isolate a potential mechanical joint leak.

Ensure that bolted panels on the coldbox or bulk storage vessel enclosure are well sealed.

5.4 Transfer systems

Perlite filling/removal nozzles should be located away from the main operating zones of the plant equipment and provide easy access for perlite handling. A flanged nozzle may be added to the coldbox at multiple levels. In addition, spectacle blinds or knife valves may be installed on each nozzle to reduce perlite spillage during attachment of the removal hose.

6 Operations and maintenance

6.1 Atmospheric check

An atmospheric check should be completed periodically to verify that the insulation gas composition is the same as the purge gas. This can indicate that there are no internal process piping leaks.

6.2 Repairs to openings

Repairs to openings in the structure such as valve and pipe boots should be performed as soon as practical to prevent the entry of moisture and air, which will degrade the efficiency of the perlite.

6.3 Ice formation

The formation of ice on coldboxes can indicate an insulation system or process failure or a piping design problem. This failure can include improperly installed perlite, inadequate coldbox maintenance, or a cryogenic gas or liquid leak. To eliminate ice buildup towards the top of the coldbox, the perlite level should be checked routinely. The insulation will settle, especially after the first fill of the coldbox, and the insulation level might 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.*

6.4 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 source for such gas jets is either process leaks or damaged or broken piping inside the coldbox.

7 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.*

7.1 Before perlite removal

Perform the following steps before perlite removal:

a) Shut down the cryogenic process;

b) Remove all cryogenic liquids from the process equipment and piping;

c) Warm the process equipment and piping (derime) to a safe working temperature;

d) After the piping and equipment have been warmed, stop the derime and depressurize the equipment to a safe working pressure;

e) Stop the nitrogen purge flow to the coldbox insulation space and physically isolate the nitrogen supply. This can be accomplished by the removal of a section of the piping or the insertion of a blind flange; and

f) Open a top manhole before removing perlite to protect against a possible casing collapse by developing a vacuum during the perlite removal process.

7.2 Coldbox perlite removal

7.2.1 Monitoring

The insulation space gas composition should be monitored continuously for the presence of excessive oxygen, combustible gases, or both. The analysis 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.

7.2.2 Removal process

To lessen the risks of uncontrolled perlite releases, removal of perlite should take place from the top of the coldbox 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 might be expelled from the casing should an uncontrolled release occur. Perlite removal nozzles should be used if they are provided. If cryogenic liquid is known to have collected in the perlite, the coldbox should not be deperlited from the bottom; flashing in a fully perlited box will result in an uncontrolled release.

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 that might lead to a hazardous atmosphere in the perlite collection bin.

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.

7.2.3 Residual perlite

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

a) Monitor the annular space for safe oxygen content;

b) Check the interior for ice blocks and remove large blocks by thawing, either mechanically or by judicious use of steam;

c) Remove residual perlite by brushing, shoveling, or, if only absolutely necessary, washing surfaces with water; and

d) Take care not to disturb or break small bore lines in the vicinity of the perlite clean-up operation.

8 Perlite installation

8.1 Packaging

For small coldboxes or where only small quantities of perlite are required, either siloed or bagged perlite may be charged directly through manholes at the top of the coldbox. Bulk shipments of expanded perlite can be made in closed-type tanker trailers equipped with a transfer hose to discharge the perlite directly into the coldbox 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.

For a large coldbox, 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.

8.2 Perlite quality

Perlite deteriorates each time it is handled. Before reuse, the perlite should be inspected for the following properties:

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

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

8.3 Filling to avoid insulation space voids

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

- Perlite may be introduced in stages to help reduce voids. First, add perlite at lower levels. Then, proceeding up the coldbox, add perlite through higher fill ports.
- Top fills are used when staged fills are not used or when topping off the insulation space.

8.4 Purge gas supply

Once the insulation space is filled with perlite, all column entry points shall be closed. The confined space is then lifted and the purge gas supply should be immediately placed into service.

8.5 Settling

After coldbox cool down and operation has commenced, settling of perlite normally occurs. The top of the coldbox 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 is most likely to be nitrogen (an asphyxiant). A self-contained breathing apparatus might be needed to ensure the safety of the inspection personnel from asphyxiating gas discharged at them from the opening. A standby person also might 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, full protection gear also might be used. If inspection personnel must break the plane of the coldbox penetration to make the inspection, a permit-required confined space entry might have to be conducted.*

9 Disposal of perlite

Disposal of perlite might 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. Non-hazardous contaminated perlite may be regulated as industrial solid waste in certain states. Check with local authorities for applicable regulations.

Non-contaminated perlite can be disposed of or recycled as governed by federal or state environmental regulations.

10 Emergency plan for perlite releases

Facilities that use perlite should have an emergency plan that addresses perlite releases. The emergency plan needs to address who is to be called if there is a perlite release. The plan should list several companies with 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.

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

a) Secure the plant processes as required;

b) Evacuate personnel and conduct a headcount;

c) Check perlite material safety data sheets for any required first aid/emergency procedures;

d) Contact emergency response agencies and offsite neighbors, as required;

e) Vacuum clean or wet sweep to avoid dusting;

f) Take necessary measures to prevent migration of any spilled perlite into a waterway via wind or storm water releases;

g) Secure adjacent processes from perlite ingestion; and

h) Contact qualified cleanup and perlite disposal contractors.

11 References

Unless otherwise specified, the latest edition shall apply.

[1] AIGA 005/04 - Fire hazards of oxygen and oxygen enriched atmospheres. www.asiaiga.org

[2] AIGA 008/04 - Hazards of inert gases. www.asiaiga.org