Princeton CryoTech
Cryogenic Delivery and Storage Systems

SPECIFICATION FOR VACUUM INSULATED PIPING

Part 1 – General

1. Submittals

    a. After award of contract and before executing any manufacturing, shop drawings and specifications shall be submitted to the customer for approval. Submitted information shall be sufficient to establish compliance with specifications and contract requirements. Manufacturing will not start until the customer or their representative approves these drawings.

2. Delivery and Storage

    a. Equipment and materials shall be properly stored, adequately protected and carefully handled to prevent damage before and during installation.

    b. Best efforts will be made to keep Equipment and materials away from elements during shipping and storage, preventing moisture from entering the inner carrier pipe.

Part 2 – Products

1. Vacuum Insulated Pipe

    a. Inner Carrier

        i. The design and manufacturing of the VIP shall be in accordance with ASME B31 .3 - Chemical Plant and Petroleum Piping and latest applicable addenda for 150 PSI

            1. In compliance with the requirements of ASME B31 .3, 5% of the inner, carrier pipe butt welds will be radiographically tested and shown to be acceptable

            2. In compliance with the requirements of ASME B31 .3, each section of VIP will be pressure tested. The pressure test may be pneumatic at 110% of design pressure

        ii. Inner pipe material shall be TP304/L, SA312 stainless steel welded pipe, schedule 5.

        iii. Inner carrier line shall include bellows sections to relieve the thermal stresses from the relative movement of the inner line.

        iv. Inner pipefittings, including elbows, tees and reducers, shall be type 304 stainless steel, ASTM A403/SA403. The fittings shall comply with ASTM B16.9.

        v. Size shall be specified on drawings.

    b. Vacuum Jacket

i. Shall be designed in accordance with ASME Code for Unfired Pressure Vessel, Section VIII for an internal vacuum and external atmospheric pressure with the assembly at ambient temperature.

ii. Material shall be TP304/L, SA312 stainless steel welded pipe, schedule 5 with a bright annealed finish

iii. Jacket elbows shall be a mitered design manufactured in house. Jacket tees shall be a branch tee design manufactured in house. Elbows and tees will be manufactured from the standard jacket material, 304 stainless steel, ASTM A312 welded pipe, schedule 5 with a bright annealed finish

c. Vacuum Annulus

i. The inner carrier shall be supported within the jacket by a support system designed to absorb thermal loads on the inner pipe when partially or completely filled with product, to minimize heat leakage, withstand loading (A, B, and C below) during shipping and loading, and (D) during and after installation

1. Three "G" load applied vertically downward

2. Three "G" load applied vertically upward

3. Two "G" load applied horizontally, longitudinally, or laterally combined with one "G" load vertically downward.

4. Meet uniform building code for Zone 3 seismic requirement

ii. The inner line shall be "super insulated" with alternate layers of aluminum foil or double aluminized Mylar and cryogenic grade spacer paper.

iii. Each spool shall have molecular sieve and a hydrogen converter installed in the vacuum annulus for the purpose of removing the majority of vacuum contaminants released by out gassing.

iv. Each spool shall be equipped with a combination evacuation/relief valve port complete with a Hastings DV-6R vacuum transducer for monitoring the vacuum level without breaking the vacuum annulus.

v. Heat shall be applied during the pumping to accelerate out gassing. Means shall be employed on the vacuum pumping system to prevent oil from back-streaming into the spool vacuum space. Spools to be sealed at less than 10 microns.

vi. All welds shall be leak-tested with a helium mass spectrometer calibrated to a sensitivity of 1X10 -9 standard cc/second and shown to be leak free.

vii. Each spool shall be tested over a two day period with the spool isolated from the pump at ambient temperature. The pressure in the annular space shall be measured every 24 hours and recorded. The spools will be accepted if:

1. There is a pressure rise of eight microns or less. A pressure rise greater than eight microns will require one additional day of vacuum retention. The line shall be considered acceptable if the third day's reading indicated the vacuum is stable.

2. The maximum stabilized pressure before shipping is 35 microns.

d. Bayonet Connections

i. Pipe sections, 2" pipe size and smaller, shall be connected through bayonet connections

ii. Bayonet connections will either utilize dissimilar metals or close fit

1. For bayonets that incorporate dissimilar metal technology in their construction, the nose of the bayonet shall be constructed of "INVAR 36" and the receiver shall be constructed of stainless steel.

2. Close fit bayonets will be machined such that a small gap between male and female will provide the heat path necessary to reduce sweating or frosting at the clamp.

iii. Each bayonet will have an O-Ring as a secondary seal.

iv. Each bayonet will be secured with a V-Band Clamp.

e. Gas Traps

i. Internal gas traps for the carrier line shall be incorporated into drop (use point) sections that will be used intermittently.

ii. Gas traps eliminate the need for vacuum jacketed components below the trap.

f. Pressure Ratings

i. Carrier pipe design pressure – 150 psig

ii. Annular relief setting – 5 psig

2. Vacuum Jacketed Valves

a. Valves can be placed on use point drops to enable shutoff of system for service or maintenance to the equipment being served by the liquid nitrogen. Valves on these drops would be vacuum insulated, y-pattern design.

b. Valves can be placed on major branches to allow system isolation to facilitate future system expansion or serviceability of the pipe system or equipment being served by the liquid cryogen. These valves shall be vacuum insulated and may be either Y-pattern or T- pattern design. Pneumatic actuators may be used to allow remote operation of these valves.

c. Valve body, extension tube and stem are type 304 stainless steel. Valve uses a soft seat made from Kel-F. Bonnet is nickel-plated brass. O-ring seals in bonnet are Viton.

d. Valves are rated for Cryogenic service.

e. Actuated valves will use pneumatic actuators. Actuators are typically fail closed, air to open, however special valve considerations can be taken if required by customer. Actuators are normally controlled with a 3-way, electric solenoid valve.

3. Cryovent

a. The pipe system should have an adequate number of cryovents installed in adequate locations, as specified by the pipe designer.

b. Cryovent inlets utilize bayonet connections to eliminate icing.

c. Cryovent outlets are typically non-insulated threaded fittings, but can be built with a bayonet connection to connect to vacuum insulated vent piping.

d. Typical cryovents will continuously vent cold nitrogen vapor, creating an ice ball on the outlet of the cryovent.

i. Cryovent can be piped away and insulated, or

ii. Cryovent can be placed outdoors in a safe location where ice will not cause an unsafe situation.

iii. Cryovent can be placed outdoors and fitted with a cryovent heater to reduce the possibility of ice formation.

4. Safety Relief Valves

a. The cryogenic pipe system shall incorporate relief valves as necessary to protect the piping from overpressure.

b. Relief valves are installed between points at which the flow can be stopped (valves, check valves, regulators, etc,).

c. The relief valves are installed on vacuum jacketed risers to reduce the heat input and potential for frost

5. Oxygen Safety

a. Any rooms with a point of use for liquid nitrogen should contain an oxygen monitor to detect any oxygen deficient atmospheres.

b. The oxygen monitor should have a digital display, visible strobe warning, and loud audible horn warning.

Part 3 – Manufacturing

1. Manufacturing facility will have ISO-9001 :2000 approved quality system. The quality system must be audited and registered by a certified inspection agency.

2. Manufacturing facility will have an ASME "U" stamp certification. This "U" stamp certification indicates the approved implementation of systems and requirements related to the manufacture of ASME pressure vessels.

3. Design, materials, fabrication, welding and inspections will comply with ASME B31.3 – Chemical Plant and Petroleum Refinery Piping (most current version).

4. Inner and outer piping will be constructed using ASME & ASTM standards for stainless steel welded and/or seamless pipe, tubing, and corrugated metal hose.

5. All welding procedures and welding personnel are qualified per ASME Section IX, welding and brazing qualifications.

6. Traceable inspection and material reports for all components that see pressure can be documented, if asked for before manufacturing at additional cost.

Part 4 – Installation

1. Installation to be performed by either a representative of the pipe manufacturer, or by qualified pipe fitters under the supervision of the representative of the pipe manufacturer.

2. Installation to be performed in accordance with pipe manufacturer's published Installation Guide, where applicable.

3. Vacuum annuluses shall be tested before and after installation to ensure vacuum carrier has not been breached.

4. The pipe manufacturer's representative shall ensure that safety relief devices are placed throughout the system where applicable before line is charged.

5. If applicable, welded field joints to be performed by local welders qualified in stainless steel TIG welding.

6. No welding to the outer jacket of any spool is permitted. Welding against the outer jacket will result in vacuum loss. Welding to the outer jacket of an evacuated spool voids the warranty for the spool.

Part 5 – Testing

1. Testing shall be performed by the representative of the pipe manufacturer.
2. Vacuum annuluses to be tested after installation, ensuring pipe integrity before charging.
3. If the system can be isolated at all ends, including use point drops, cryovents, branches, and supply inlet, then pipe can be pressure tested:
    a. Attach a certified gauge to the pipe where appropriate for viewing
    b. Introduce pressure with nitrogen gas, or supply LN2.
        i. If using nitrogen gas, introduce nitrogen gas to the lines at the desired pressure.
        ii. Typical pressure test to be performed at 1.25 times normal working pressure, or other appropriate pressure.
        iii. Do not pressure test above 135 psig, as this may begin to lift factory set safety relief devices.
        iv. Leave pressure on for no less than (1) hour, while checking for pressure drops

Part 6 – Approved Manufacturers

1. Approved LN2 Pipe Design and Supply Group
    a. Princeton CryoTech, Inc

        6191 Kellers Church Road

        Pipersville, PA 18947

        (800) 232 2796

2. Approved LN2 Pipe Manufacturers
    a. Chart Industries
    b. Technifab