CHART INC.

VJ WITHDRAWAL ON NEW BULK STORAGE

CASE STUDY #12

Object:
Consideration of the Vacuum Insulated Liquid Withdrawal option for new Chart, *Super Insulated*, nitrogen bulk storage vessels.

Vacuum Insulated Withdrawal In Use

Company:
Chart Inc. is committed to providing its customers with the best cryogenic equipment solution for their specific application and is proud to offer the Vacuum Insulated Withdrawal (VJ Withdrawal) option for new Chart, *Super Insulated*, nitrogen bulk storage vessels.

Challenge:
Consider the case of a nitrogen system, for liquid use, that is designed to have liquid nitrogen in it 24/7/365, which tends to be almost all systems with a *Cryovent*. Why is a VJ Withdrawal recommended and what would be the cost to a customer if they choose to use a non-VJ Withdrawal for a liquid application?

Non-Insulated Withdrawal In Use

Solution:
The VJ Withdrawal includes a vacuum insulated Y-Pattern valve and a Chart/MVE dissimilar metal female bayonet. The bayonet is the same high quality and low thermal conductivity connection that we use on our vacuum insulated piping systems. It provides a superior transition between the vacuum insulated storage vessel and a vacuum insulated piping system.

Benefits:

1. Reduce Liquid Nitrogen Losses: Nitrogen is stored in a vacuum insulated storage vessel and is distributed to use points using vacuum insulated piping. The lowest point in the system is often the withdrawal of the storage vessel. It is a good assumption that, with a *Cryovent* in the system, that the withdrawal area will be full of liquid nitrogen 24/7/365. Without a VJ Withdrawal, ice will accumulate (to approximately a 3' diameter) and act as the insulation. The evaporation of liquid nitrogen provides the cooling to keep the ice ball. Chart estimates, under standard conditions, that it takes about 40 gallons of LN_2 per day to keep a non-VJ outlet cold. That would translate to about $7,000 in yearly losses for a typical customer.

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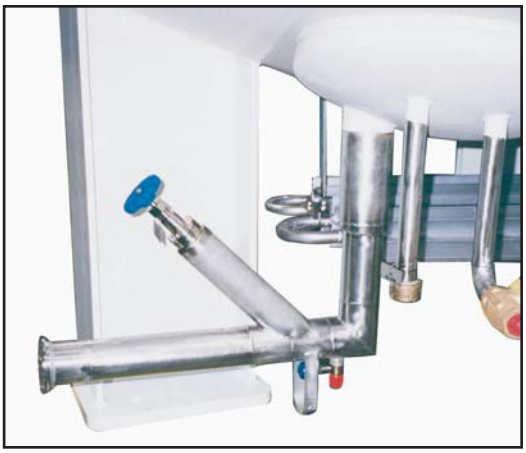

VJ Withdrawal on New Bulk Storage

2. Piping Performance: Forty gallons of evaporated liquid nitrogen represents about 3,725 scf of nitrogen gas introduced into the process piping system per day. It is often not acceptable to deliver poor quality (or liquid with a high content of gas) to most applications. Also, the flow performance could be interrupted by large slugs of gas inhibiting the liquid flow to the use point. Dealing with the abnormally high boil-off from a non-VJ insulated solution often requires the installer to design the piping system with an additional Cryovent with an upfront cost to the customer of $2,500 to $3,500. If this is not considered upfront, a VJ section may need to be replaced to accommodate a Cryovent which would likely cost well over $5,000. Costs may run higher if the customer needs to deal with the venting inside a building.

3. Maintenance: Ice accumulation on a non-VJ outlet system occurs around the liquid withdrawal of a storage vessel. Ice will encase any surrounding piping, valves, relief valves, pressure building/economizer circuits, etc. The ice will greatly increase the customer's likelihood of having a maintenance problem and a possible shutdown.

4. Safety: It is recommended that if there is a situation where a customer installs a tank without a VJ Withdrawal, that they install a redundant VJ Valve on their VJ piping system. The customer needs to be capable of accessing a liquid line shut-off to isolate their building from the full volume of liquid nitrogen in the storage vessel in case of an incident. It is probable that a non-VJ valve, full of liquid 24/7, would not be accessible because of ice accumulation. Upfront cost to the customer for the additional valve is approximately $3,500.

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