Chemically Speaking LLC

Cryogenic Liquids Notes

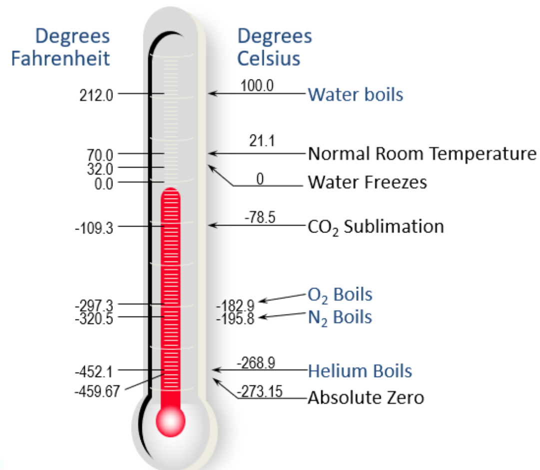
Sept 2022

Under DOT, CGA and IFC the current definition is a compressed gas with a boiling point below - 130ºF (-90ºC)

The following gases are handled like cryogenic liquids but by definition are refrigerated liquids because their boiling points are above -130ºF (90ºC)

Liquid Carbon Dioxide -109.3ºF (-78.5ºC)

Liquid Nitrous Oxide -127.4ºF (-88.5ºC)



	BP Temp @ 1 atm		Liquid Density @ BP		Latent Heat of Vaporization		Gas Density @ 70F (21C)		Gas from Liquid
Name	**ºF**	**ºC**	**lb/ft3**	**kg/m3**	**btu/lb**	**J/kg**	**lb/ft3**	**kg/m3**	**vol/vol**
Air	-318	-194	54.6	875	88.2	205.0	0.075	1.20	728
Argon	-303	-186	87.0	1393	70.2	163.2	0.103	1.65	842
Carbon Monoxide	-313	-192	51.1	819	92.8	215.7	0.073	1.17	706
Fluorine	-307	-188	94.1	1507	74.1	172.2	0.098	1.57	961
Helium	-452	-269	7.8	125	10.3	23.9	0.010	0.16	754
Hydrogen	-423	-253	4.4	71	192.7	447.9	0.005	0.08	850
Methane	-259	-162	26.5	424	219.2	509.5	0.042	0.67	636
Nitrogen	-320	-196	50.5	808	85.7	199.2	0.072	1.15	696
Oxygen	-297	-183	71.3	1142	91.7	213.1	0.083	1.33	861

Key Cryogenic Codes/Standards

IFC Chapter 55, "Cryogenic Fluids" Chapter 58 and Chapter 63 all refer to NFPA 55 for flammable and ANSI/CGA P-18 for inert

NFPA® 55, "Compressed Gases and Cryogenic Fluids Code"

ANSI/CGA P-18, "Standard For Bulk Inert Gas Systems"

CGA M-1, "Medical Gas Supply Systems"

NFPA 99, Standard for Health Care Facilities

To maintain cold temperature, liquid must be vaporized constantly.

Liquid can be

- Asphyxiant (N_2, He)
- Flammable (H_2)
- Oxidizer (F_2, O_2)
- Toxic (F_2, CO)

Cryogenic burns

- can come from liquid or vapors from the liquid
  - eyes
  - skin
- can come from un-insulated lines or equipment
  - hands and feet

Embrittlement of materials

- carbon steel
- plastics and rubber

Freeze out contaminants

- moisture plugged lines

Provide adequate ventilation

Use proper personal protective equipment

Proper system design

system compatible with product, temperature and pressure

protect areas of system where liquid can accumulate with pressure relief devices

Cold embrittlement of carbon steel. Copper, aluminum, pyrex glass and stainless steel are compatible

Large expansion volumes

Cooling a gas increases the vapor specific gravity

Liquid Nitrogen

The most common cryogen, many uses

Cryotherapy, Ice Cream

Liquid Oxygen

Liquid oxygen dewars on fresh fish trucks to keep them alive during transport

Liquid oxygen spills onto asphalt can be reactive.

Concrete pad at tanker offloading
Liquid oxygen portable breathers

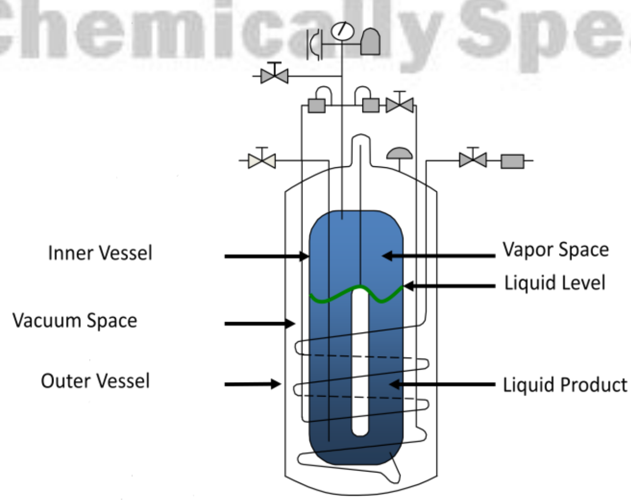
A personal breather is filled from a larger mother tank by the user

Medical gas supply companies use pickup trucks with a dewar to fill the mother tanks at the residence

Liquid Helium
Coldest known material
Superconductivity

Dewars
Sir James Dewar, a Scottish chemist and physicist. He is best known for his invention of the vacuum flask, which he used in conjunction with research into the liquefaction of gases

Closed type
A pressurized, double-walled, insulated portable container used to hold either a cryogenic liquefied gas or refrigerated liquefied gas. (large thermos bottle)



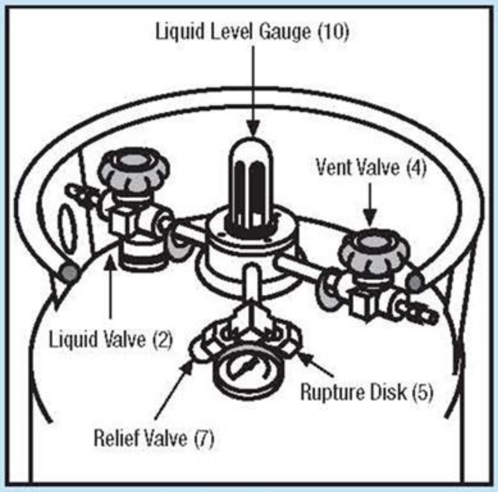


Figure 5
Low Pressure
Liquid Container Components

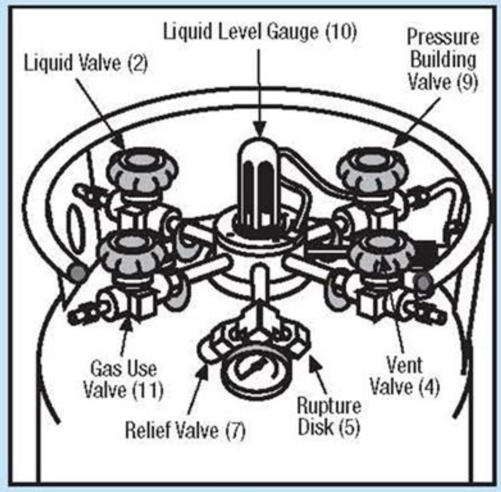


Figure 6
High Pressure
Liquid Container Components

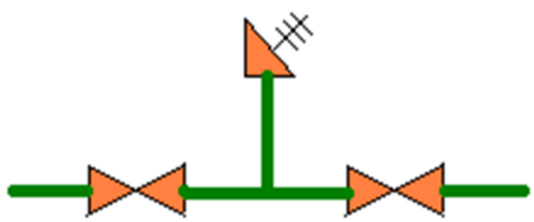
Vent valve to allow air to vent while filling
Liquid valve to draw off liquid from the bottom
Gas (use) valve to draw off gas from vapor space
Pressure Building Valve

- Allows liquid to exit bottom of cylinder, through a tube that is in insulation space
- As it does this, it heats up due to heat from the outside of the cylinder and converts back into a gas
- This expansion to vapor increases the pressure
- The gas is piped back into vapor space at the top, which provides pressure to force out gas or liquid

Pressure building coil might develop a frost line on the exterior of the dewar wall
To maintain cold temperatures a cryogenic cylinder will vaporize some liquid. This will vent periodically from the cylinder through a spring loaded pressure relief device

Dewar outlet connections must be tamper proof

When dispensing liquid through a piping system, pressure relief valves must be installed where ever liquid can be trapped



Helium dewars are designed differently because air can solidify and plug the opening

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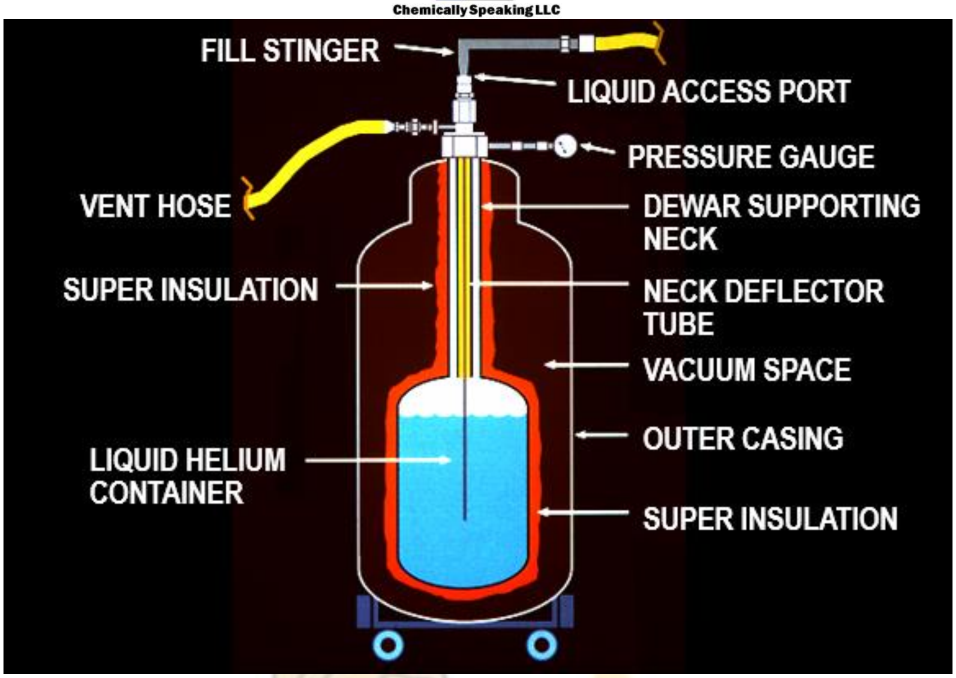


Some Carbon dioxide dewars are refilled in place

Microbulk

Dewars that are fixed and can be refilled by tanker

Made to DOT Specification

Flat base that does not require special foundation

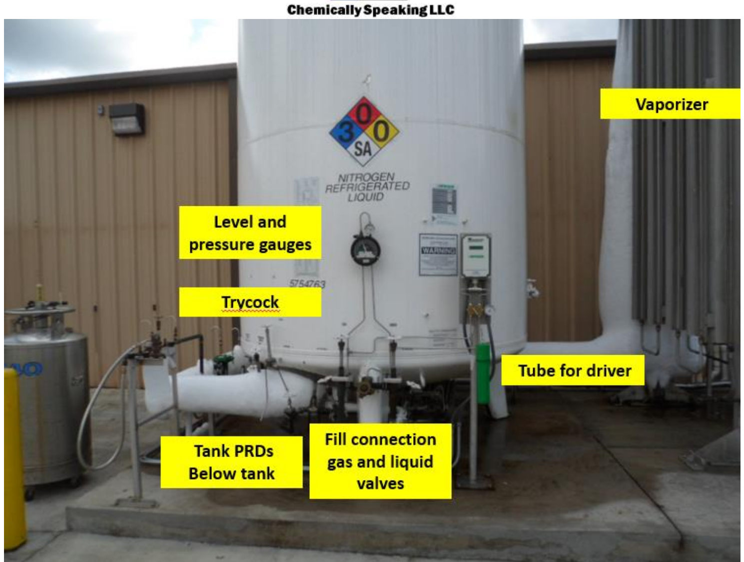
Deliver liquid or gas

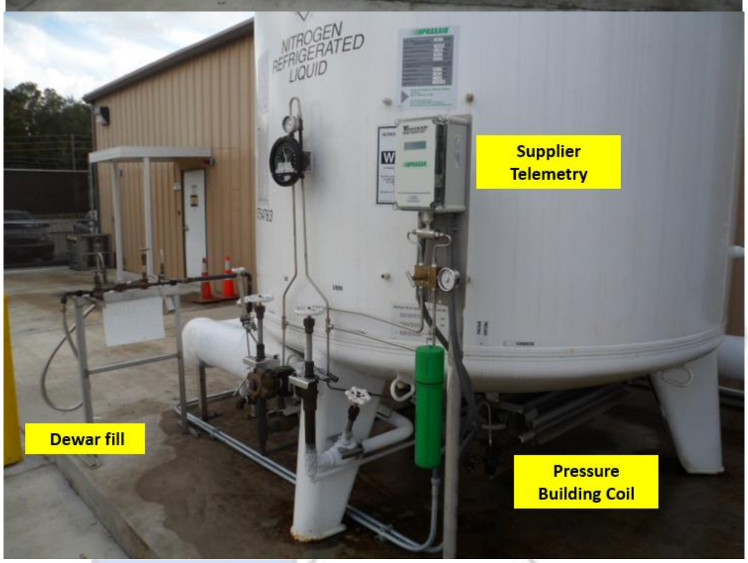
230-1500 liters
Nitrogen or Argon

Fixed Tank

Fixed Tanks are made to ASME specifications
Horizontal or vertical

- Pressure relief
- Vacuum Gauge
- Trycock
- Vaporizer
- Pressure Building Coil
- Fill connection

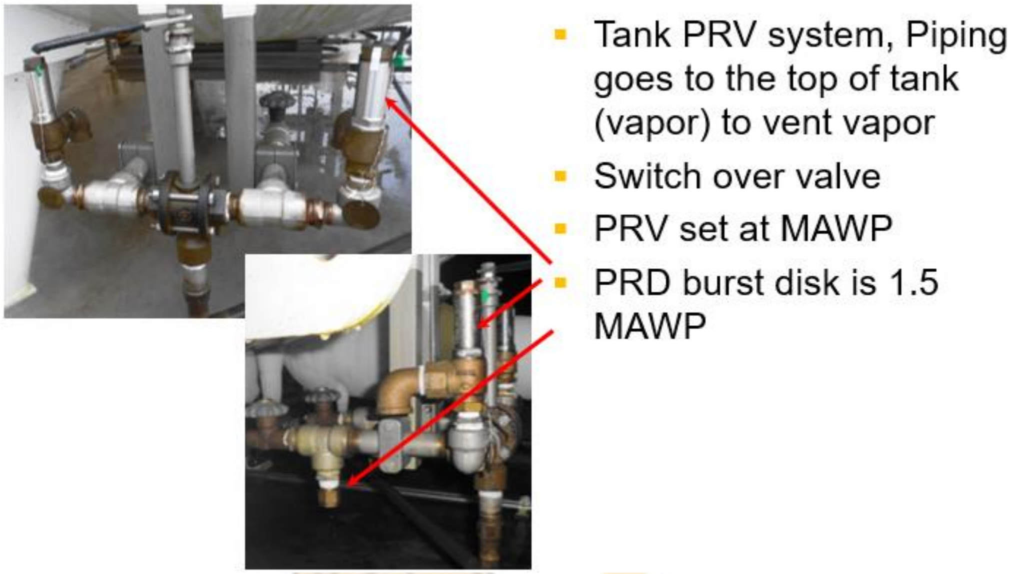




PRV's are tested and adjusted at the manufacturer to relieve at a specified pressure, These are then wired and sealed

To change this setting requires the wire seal to be broken

Level expressed as inches water column. Actual level is dependent on cryogenic liquid and temperature of the liquid



Gas and liquid fill valves, CGA Fill Connection
Depending on tank conditions, the driver can fill into gas or liquid phase or both
During filling the driver opens the Trycock valve.
The piping to the valve is placed at the maximum fill level of the tank. When the liquid reaches this level, liquid will come out of the tube and the driver stops filling the tank.

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