



MicroBulk Systems

Equipment for Cryogenic Service

MICROBULK SOLUTIONS | SYSTEM DESIGN | MANUFACTURING | TRAINING | INSTALLATION | SERVICE



MicroBulk Systems Product Catalog
www.MicroBulk.com

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Innovative Design, Technology & Reliability

Across Chart, we pride ourselves on designing innovative products with advanced technology and high reliability to enhance customer value. Our understanding of our customer's business needs and end-use applications has helped us achieve a wide product portfolio of solutions. We provide the right product for the application – driving a competitive advantage for our customer and our company.



Innovative Design

Our integrated MicroBulk advantage is based on a system that incorporates patented and proven innovative technologies. Every component is designed, built and tested to create the safest and most reliable MicroBulk delivery system available today.



Installation Ready

Only Chart allows you to custom build your Perma-Cyl® MicroBulk Storage System to match your customer's application and your business operation. With over 10 sizes and three pressures, there's a Perma-Cyl model to meet your requirements.



Telemetry Capable

The Cyl-Tel® Liquid Level Gauge is designed exclusively for the Perma-Cyl system. Packed with user-friendly features, the Cyl-Tel gauge is ready to work with many remote monitoring systems.



Marketing Services

Our sales process doesn't stop with the equipment supply. We offer electronic sales tools, customized literature, marketing assistance and sales training to make our authorized partners positioned for growth in the MicroBulk market.

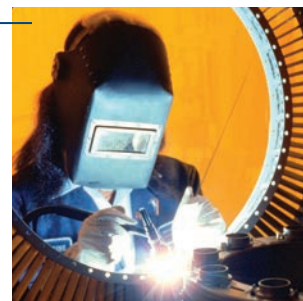
When you choose Chart, you get single-source accountability from the integrated MicroBulk system through business support.

MicroBulk Applications

Metal Fabrication

Welding – GMAW/MIG, GTAW/TIG and Laser Beam Welding

Metal fabrication uses many different welding processes for the wide range of materials, thickness and product applications. Many of these unique and specialized welding processes use inert shielding gas or the combination of gases to obtain the maximum weld quality and optimized productivity. For single gas or mixed gas requirements, MicroBulk provides you with all the benefits of bulk, such as an uninterrupted gas supply – in an economical compact package.



Cutting – Laser, Oxy Fuel and Plasma

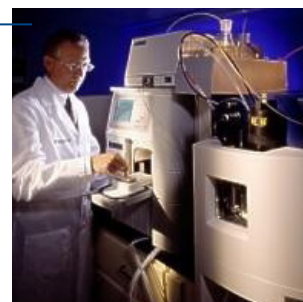
All thermal cutting techniques utilize gases to assist in the cutting process. High-pressure nitrogen and oxygen are used as an assist gas to rapidly remove the molten metal from the cut zone or burn it away during the laser cutting process. To maintain maximum laser uptime and achieve the best cut quality, it is critical that the gas supply be uninterrupted and the required pressures and flows for the material and thickness being cut are maintained. Oxy Fuel and Plasma cutting processes have similar requirements. Only Chart offers an engineered “High-Pressure, High-flow Package” to customize your Perma-Cyl® MicroBulk Storage System for these demanding applications.



Analytical / Laboratory

ICP/ICP-MS – Inductively Coupled Plasma/Mass Spectrometry GC – Gas Chromatograph

A sufficient flow of high-purity argon gas is required for ICP/ICP-MS systems to repeatedly process material samples trouble-free. With Chart's all stainless steel Pura Perma-Cyl option and MicroBulk's short delivery chain, you can be assured of getting the proper purity of argon necessary for peak equipment performance. Similarly, GC's get the same benefits with a Perma-Cyl system in nitrogen service. And with MicroBulk and telemetry, you get a continuous supply of uninterrupted gas so you never have to change cylinders or restart a sample test from a gas outage.



Biological Storage and Research

A sufficient supply of high-quality liquid nitrogen is needed to keep valuable biological samples stored indefinitely. Any interruption in supply can result in the loss of many years of research. With the optional vacuum-insulated liquid withdrawal valve and bayonet on the Perma-Cyl system, you get a continuous supply of quality liquid to your freezer – reducing liquid losses and giving you more control. Adding telemetry to the liquid supply, allows you and your gas supplier to monitor the Perma-Cyl liquid level via the internet for added security. For requirements that prohibit a permanent installation, the Perma-Cyl 230 caster base model is an excellent choice.



MBE – Molecular Beam Epitaxy

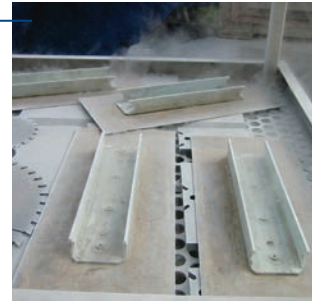
Chart Inc. provides vacuum insulated closed loop LN₂ piping systems utilizing liquid/vapor phase separators and triaxial feed/coaxial return piping to provide low pressure, ultra-pure LN₂. In a closed loop system, the LN₂ is recirculated back to the phase separator via return pipes connected to the phase separator from the tool. These pipes are designed to flow LN₂ back to the head space inside the phase separator reusing the LN₂ in a continual loop, providing completely wetted surfaces within the cryoshrouds, while maintaining constant LN₂ temperatures at low pressure with minimal gas. The gas is then vented to the atmosphere, leaving pure LN₂ at the desired temperature to be delivered to the cryoshroud.



Metal Processing

Heat Treating, Cryotempering, Thermal Spray Coating

Heat treating and cryotempering processes are dependent on the quality of the nitrogen gas and liquid supply to maintain production at peak performance. With the MicroBulk system directly piped to the equipment or conveniently transported with the caster base Perma-Cyl® model, these applications are assured of a consistent supply of nitrogen with minimal operator intervention. In the thermal spray coating process, oxygen or argon is used at high pressure and high flows. With the Perma-Cyl VHP ZX coil option, your gas supply will exceed these requirements and provide long-term trouble-free service.



Medical

Oxygen Therapy, Hyperbaric Chamber, Cryotherapy

Medical applications have some of the most stringent gas requirements and the MicroBulk system meets these requirements with NF grade availability. Liquid oxygen for respiratory therapy is easily and safely dispensed from a Perma-Cyl system into the Liberator® and Stroller style systems to lower distribution costs. Similarly, the Perma-Cyl system is an excellent solution as the main oxygen gas supply for hyperbaric chambers. NF grade nitrogen can also be supplied for gas applications to operate pneumatic surgical tools and supply liquid for medical uses such as cryotherapy.



General Processing

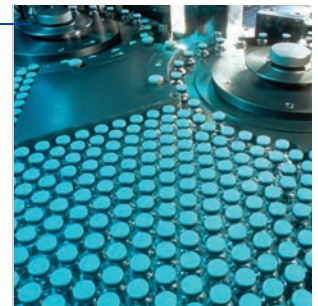
Food and Beverage Packaging

In beverage packaging, liquid nitrogen is used to create a positive pressure in non-carbonated drinks to improve the containers rigidity for lower-cost handling. Additionally, this process eliminates oxygen to improve the products shelf life. For food packaging, nitrogen gas yields the same benefits and when combined with carbon dioxide and carbon monoxide for processing meat, a longer shelf life of the desired red color is maintained. The Perma-Cyl system gives you optimum control of your liquid and gas supply for maximum production uptime.



Purging and Blanketing

Inert purging and blanketing with nitrogen or argon gas is a common processing step in many manufacturing applications. These range from pharmaceutical to chemical to the wine industry, and they require a secure supply of gas for optimum processing results. With a dedicated Perma-Cyl tank and the optional telemetry system, you are assured of a continuous, oxygen-free gas supply because cylinder change outs are eliminated.



Electronic Manufacturing and Testing

Electronic grade manufacturing requires an Ultra High Purity gas stream void of contamination. The Pura Perma-Cyl system is built with all stainless steel construction from the internal vaporizer to the exterior plumbing to maintain gas purity. And with the MicroBulk delivery system, the reduced handling results in higher purity over conventional cylinder supplies. In a related business, printed circuit board testing performed in liquid nitrogen-powered environmental test chambers require quality liquid at the point of use. For intermittent uses or small chambers, the Perma-Cyl series offers a variety of options to customize the installation for optimum benefits.



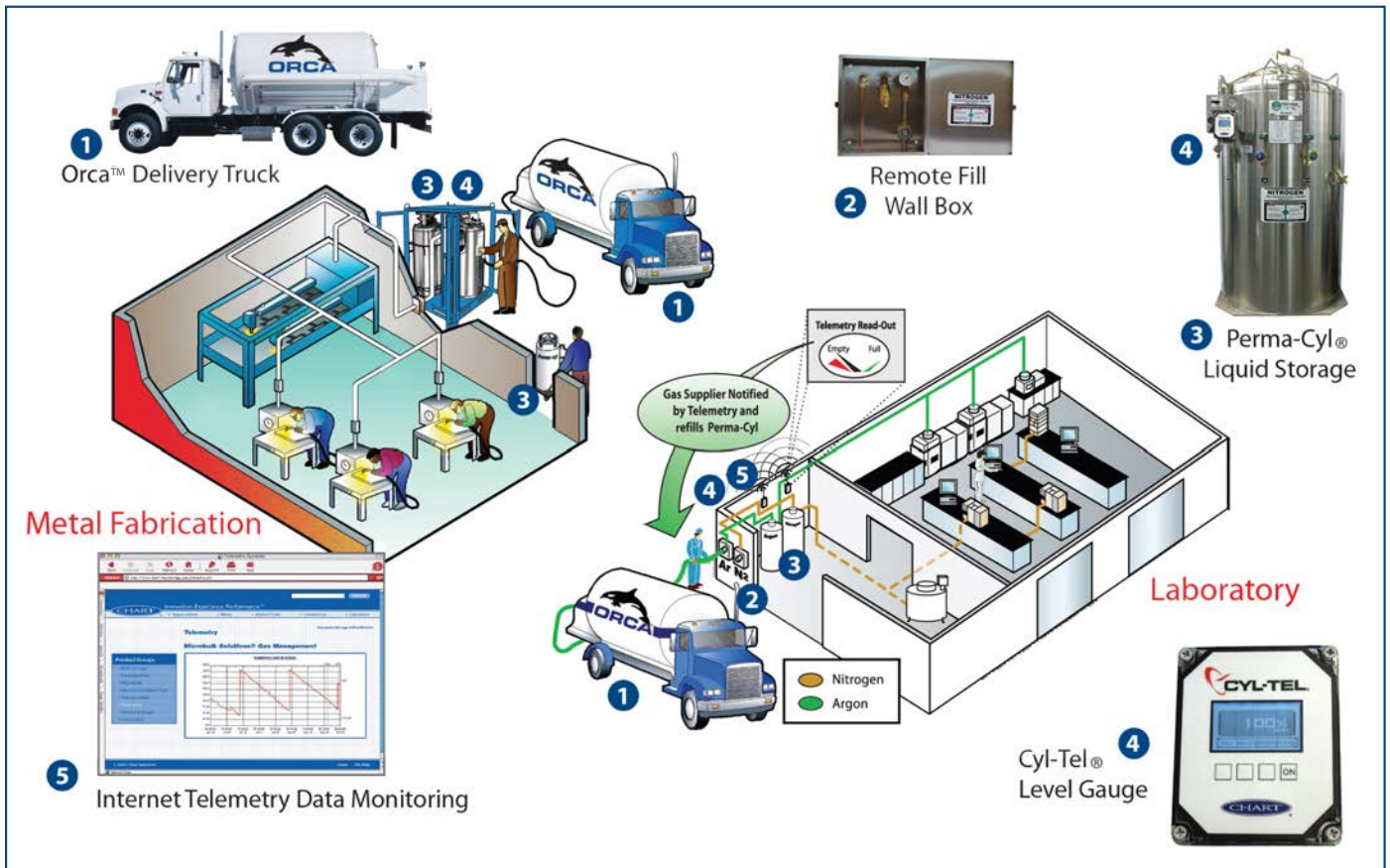
Engineered for Efficiency—Built to Last

At Chart we have always taken pride in developing the best thermal insulation system possible in our MicroBulk storage tanks. Years of experience have driven us to engineer our multi-layer Composite Super Insulation™ system to achieve the ultimate thermal protection in our MicroBulk storage equipment. Providing the best insulation system to protect your valuable gases from harsh ambient conditions results in lower pressure rise and lower losses, yielding better gas utilization. Our Super Insulation and Chart Vacuum Technology® is at the core of why Chart storage tanks are recognized around the world as the premier cryogenic MicroBulk storage tank.



A Turnkey Approach

Chart engineers work closely with our customers to ensure that the total system is designed properly, making the MicroBulk system as effective as possible. Chart's turnkey approach ensures consistent, quality liquid to keep your system operating at peak efficiency. Built for long-term integrity and industry leading efficiency, these systems give our customers the highest performance at the lowest operating cost, while providing a single point of contact.



1. Liquefied gases are delivered to the customer's facility with the Orca™ MicroBulk Delivery System. Key controls and components on the Orca unit allow the driver to safely and quickly deliver the proper amount of liquid accurately into the Perma-Cyl® MicroBulk Storage System or small bulk tanks.
2. When the Perma-Cyl storage vessel is installed indoors, an external wall box can be added for remote filling. This allows the gas delivery to safely take place without the driver entering the building in most installations.
3. Liquefied gases are stored at ultra-cold temperatures in the vacuum-insulated Perma-Cyl tank. Customized controls for the application on the Perma-Cyl tank maintain the vessel at the proper delivery pressure and deliver gas or liquid on demand.
4. The Cyl-Tel® Liquid Level Gauge accurately monitors the cryogenic liquid level and is telemetry-ready for remote monitoring or connection to customer monitoring systems.
5. Telemetry systems allow the gas supplier to remotely monitor the Perma-Cyl liquid level to maximize delivery efficiency without the risk of product outages.

The Perma-Cyl® Storage System Built for Your Application

The Perma-Cyl® MicroBulk Storage System allows small users to enjoy the benefits of on-site gas delivery. Gone are the hassles, waste, and expense of full-for-empty gas cylinders. Using Perma-Cyl storage tanks, there are no cylinders to change, no residual gas losses*, no back, hand or foot injuries from handling cylinders, and no lost or damaged cylinders.

The Perma-Cyl system is reliable, efficient, and more economical than comparable transportable cylinders. Designed for a higher level of thermal efficiency, they can hold their gas contents longer with lower pressure rise than other similar sized vessels. Their extraordinary thermal quality limits product losses during extended periods of little gas use.



The innovative Perma-Cyl system incorporates a top fill float designed to allow single-hose filling without losses. It automatically shuts off the Orca™ MicroBulk Delivery System for a safe and reliable fill.

Perma-Cyl® Benefits

- The first fill-at-site solution for packaged or cylinder gas users
- Fast filling capable
- Single hose no-loss/low-loss filling
- Automatic fill shutoff when used with Orca system
- Extended holding times
- Telemetry ready with Cyl-Tel® Liquid Level Gauge

The Perma-Cyl® Advantage

- Sizes, pressures and configurations to meet most applications
- Capacities from 230 liters to 5500 liters (60.8 gal to 1350 gal)
- Pressures from 235 psig to 500 psig (16.2 barg to 34.5 barg)
- Patented automatic fill shut-off feature with optional fill box allows for remote filling from outside the building or compound when a Perma-Cyl system is installed indoors
- The Orca system automatically safely stops the fill process when the Perma-Cyl system is full
- Patented Cyl-Tel gauge supports remote alarms or telemetry communications
- High-pressure high flow models for laser assist applications
- Combination pressure control regulators with micrometer adjustment knob or screw
- Outdoor or indoor installation and operation
- Horizontal configuration available on the 3000 HP/VHP model
- Top and bottom fill with auto shut off available on some models
- Integrated pallet base standard on some models
- Vacuum jacketed bayonet for liquid withdrawal available on some models

*In normal low-pressure applications.



Pat. Nos. - 5,787,942 • 5,954,101

Chart Exclusive -
Internal top float assembly assures a safe, efficient and reliable fill.

Build Your Own Perma-Cyl®

Custom build your Perma-Cyl MicroBulk Storage System to match your customer's application and your business operation.

Features & Benefits of customizing your Perma-Cyl tank

Perma-Cyl tank operating and relief valve pressures match the application

- Select the ideal operating pressure for your customer's product delivery
- Select the ideal relief valve pressure for your customer's optimum hold time and your asset flexibility requirements

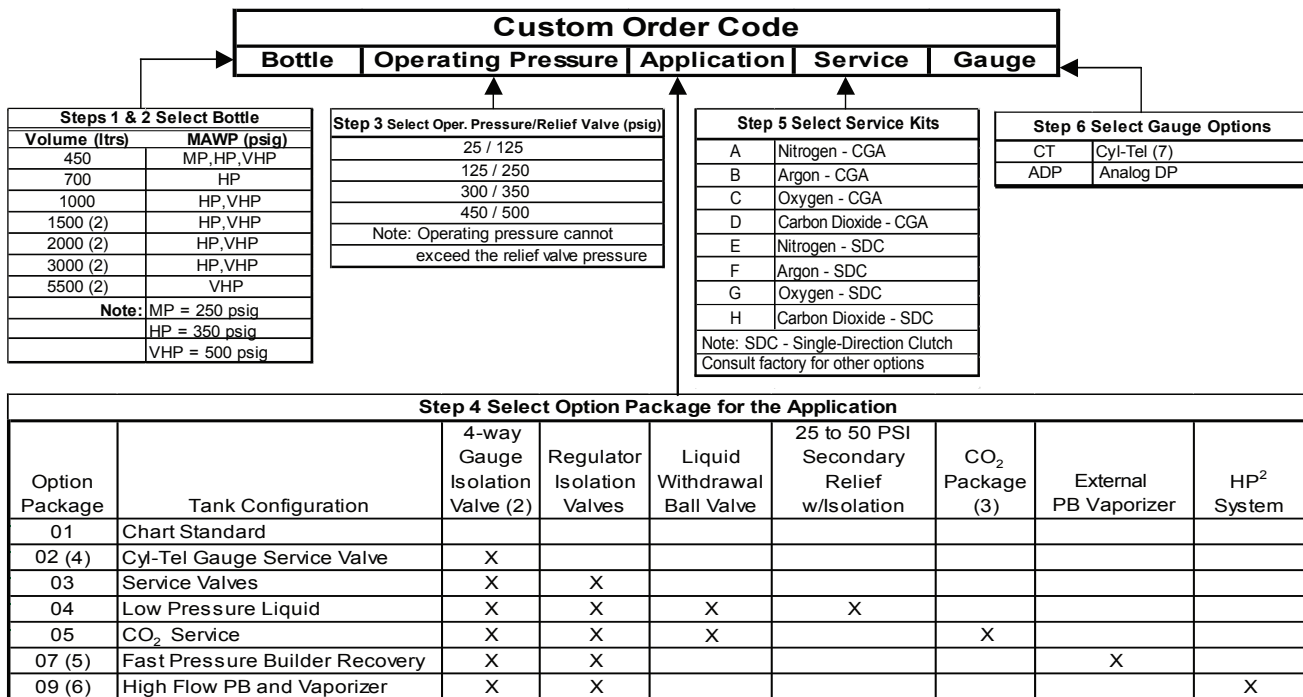
Optional features available to isolate key controls

- Reduce on-site maintenance time and costs
- Perma-Cyl tank is "installation ready" for direct shipment to customer site
- Reduce pre-installation time, costs and unnecessary shipping
 - Eliminate tank inventory (1)

How to Build Your Perma-Cyl

1. Select bottle Volume.
2. Select bottle MAWP.
3. Select Operating Pressure / Relief Valve Setting.
4. Select Application Package.
5. Select Service Kit.
6. Select Gauge Option

The Chart Industries Tank Sizing App can assist you in this process – it's that simple!



Notes:

- (1) Target ship date: Five working days or less ARO providing the bottle is in stock.
- (2) Models 1500, 2000, 3000 and 5500 come standard with integral fork-lift/lab metal base.
- (3) CO₂ Package includes: Standard restaurant fill fitting, CO₂ standard top fill tube, patented optional Sure-Fill™ CO₂ Tank Filling System (for complete fill of any size tank) and regulator isolation valves.
- (4) Standard on 1500, 2000, 3000 and 5500 models.
- (5) Option Package is only available on 1000, 1500, 2000 and 3000 HP models.
- (6) Option Package is standard on 2000, 3000 and 5500 VHP models.
- (7) Cyl-Tel® Liquid Level Gauge comes standard on all 450L and larger Perma-Cyl tanks.

SPECIFICATIONS

MODEL	230L MP,LCCM Sq/Rnd Base w/Casters	230L HP,LCCM Sq/Rnd Base w/Casters	265L MP,LCCM Sq/Rnd Base w/Casters	265L HP,LCCM Sq/Rnd Base w/Casters	450L HP Plate Base	450L MP Plate Base	450L VHP Plate Base	700L HP Plate Base	1000L HP/VHP Plate Base	1500L HP/VHP Pallet Base	2000L HP/VHP Pallet Base	3000L HP/VHP Pallet Base	3000L HP/VHP Horizontal Forklift Base	5500L VHP Pallet Base
CAPACITY (Liters)														
Gross	240	240	276	276	450	450	450	688	1,056	1,550	2,042	2,911	2,911	5,434
Net	230	230	265	265	420	420	420	645	950	1,455	1,945	2,707	2,707	5,110
CAPACITY (Gallons)														
Gross	63.4	63.4	72.9	72.9	118.9	118.9	118.9	181.8	279.0	409.5	539.5	770	770	1,435
Net	60.8	60.8	70.0	70.0	111.0	111.0	111.0	170.4	251.0	384.4	513.9	715	715	1,350
MAWP														
psig	230	350	230	350	350	250	500	350	350/500	350/500	350/500	350/500	350/500	500
barg	15.9	24.1	15.9	24.1	24.1	17.2	34.5	24.1	24.1/34.5	24.1/34.5	24.1/34.5	24.1/34.5	24.1/34.5	34.5
MAXIMUM PRE-SET OPERATING PRESSURE														
psig	125	300	125	300	300	125	450	300	300/450	300/450	300/450	300/450	300/450	450
barg	8.6	20.7	8.6	20.7	20.7	8.6	31.0	20.7	20.7/31.0	20.7/31.0	20.7/31.0	20.7/31.0	20.7/31.0	31.0
DESIGN SPECIFICATIONS														
DOT/ASME	DOT	DOT	DOT	DOT	DOT/ASME	ASME	DOT/ASME	ASME	ASME	ASME	ASME	ASME	ASME	ASME
STORAGE CAPACITY (1)														
Nitrogen														
SCF	5,024	4,734	5,769	5,769	8875/10332	10,332	7922/10332	15,860	24,350	35,790	47,847	66,592	66,592	125,000
Nm ³	142	134	152	152	271/272	272	271/272	449	689	1,013	1,257	1,750	1,750	3,540
Oxygen														
SCF	6,244	5,930	7,186	7,186	11124/12760	12,760	11124/12760	19,600	30,070	44,220	59,089	82,239	82,239	154,900
Nm ³	177	168	189	189	315/336	336	315/336	554	850	1,250	1,553	2,161	2,161	4,386
Argon														
SCF	6,073	5,763	6,982	6,982	10812/12478	12,478	10812/12478	19,160	29,400	43,220	57,786	80,425	80,425	151,700
Nm ³	172	163	183	183	306/328	328	306/328	542	832	1,223	1,519	2,115	2,115	4,296
CO₂														
SCF	N/A	4,615	N/A	5,306	8312/8200	N/A	8312/8200	12,608	19,960	29,340	38,048	52,954	N/A	N/A
Nm ³	N/A	130.7	N/A	150.3	235/232	N/A	235/232	357	564	830	1,000	1,390	N/A	N/A
Lbs	N/A	528	N/A	607	951/938	N/A	951/938	1,442	2,283	3,356	4,352	6,058	N/A	N/A
THERMAL PERFORMANCE (2) (NER%/Day)														
N ₂	1.8%	1.8%	2%	2%	1.9%/1.6%	1.6%	1.9%/1.6%	1%	1%	1%	1%	1%	1%	.7%
O ₂ -Ar	1.12%	1.12%	1.4%	1.4%	1.2%/1%	1%	1.2%/1%	.62%	.62%	.62%	.62%	.62%	.62%	.43%
CO ₂	N/A	.6%	N/A	.7%	.6%/1.5%	N/A	.6%/1.5%	.3%	.3%	.3%	.3%	.3%	N/A	N/A
GAS DELIVERY RATE (LIN/LAR/LOX)														
SCF/H	400	400	400	400	575	575	575	660	960	1,350	1350/2000 ³⁾	1350/2000 ³⁾	2,000	3500/5000
Nm ³ /h	10.5	10.5	10.5	10.5	15.1	15.1	15.1	18.6	25.2	35.4	35.4/52.4	35.4/52.4	52.4	99/141
GAS DELIVERY RATE (CO₂)														
SCF/H	N/A	133	N/A	133	192	N/A	192	220	320	450	450/667	450/667	N/A	N/A
Nm ³ /h	N/A	3.8	N/A	3.8	5.4	N/A	5.4	6.2	9.0	12.7	12.7/17.5	12.7/17.5	N/A	N/A
Lbs/H	N/A	22	N/A	22	22	N/A	22	25	36	51	51/76	51/76	N/A	N/A
DIMENSIONS														
Diameter														
in	26	26	26	26	30	30	30	42	42	48	48	59	59	80
mm	660	660	660	660	762	762	762	1,067	1,067	1,219	1,219	1,499	1,499	2,032
Height														
in	61.8/62	61.8/62	64.6/64.8	64.6/64.8	69	69	69	62.5	82	92/91	118.5/119.5	122/122.5	71	119
mm	1570/1575	1570/1575	1641/1646	1641/1646	1,753	1,753	1,753	1,588	2,083	2337/2311	3,010/3,035	3099/3112	1,803	3,023
Tare Weight														
lbs	300	340	340	340	688*	605*	812*	1,250*	1500/1750*	2200/2500**	2600/2950**	3300/4250**	3800/4250**	9100**
kg	136	154	154	154	312	274	368	567	680/794	998/1134	1179/1338	1497/1928	1724/1928	4128

All specifications are subject to change without prior notice.

1) Values are based on net capacity at 0 psig (0 barg) for ASME vessels. CO₂ vessels are based on net capacity at 300 psig (20.7 barg). DOT vessels are per code.

2) Values are based on gross capacity.

3) Optional 3,500 SCF/H (92 Nm³/h) flow kit available.

All dimensions are measured from the floor to the top of the highest plumbing component.

Patents: 5,787,942 • 5,954,101 • 6,542,848 - Other Patents Pending

DOT- Department of Transportation, 4L Code

ASME- American Society of Mechanical Engineers, Section VIII, Division 1

Contact Factory for Canadian Approvals.

* Weights do not include lab base option. (base option: 265 lbs)

** Weights include lab bases.

Perma-Cyl® 3000 Horizontal MicroBulk Storage System

Chart has developed a horizontal version of the popular Perma-Cyl® 3000 HP and VHP MicroBulk Storage System. This new product offering has the same performance as our 3000 HP and VHP, but in a package that is easily delivered on a flatbed truck and short enough to fit behind a 6' fence. It also utilizes our new FlexFill™ Piping Option technology.

The horizontal Perma-Cyl is built on a base that can be properly anchored in all seismic zones and allows for easy forklift access on all sides. This tank also has lifting lugs for crane operation.

The FlexFill piping option is a top and bottom fill circuit that replaces the top float assembly so the driver can control the tank pressure while filling the Perma-Cyl. This new design maintains the auto shut-off feature with the Orca™ MicroBulk Delivery System for a safe and reliable fill. The FlexFill option uses technology adopted from our LNG fueling system which allows for a ventless fill. This patented automatic delivery system simulates the same process drivers have used for years to safely fill Perma-Cyl storage tanks with a single hose. The new FlexFill feature works with all Orca models, both new and existing.

**The FlexFill tank is presently not approved for service with CO₂.*



Product Advantages

- Nominal capacity of 3,000 liters (715 gal)
- Pressures up to 350 psig (24.1 barg) or 500 psig (34.5 barg)
- Gas supply rate up to 2,000 scfh (52.4 Nm³H)
- All 304 stainless steel tank construction
- Patented automatic fill shut-off with optional fill box for remote filling from outside the building
- Orca unit automatically safely stops the fill process when Perma-Cyl system is full
- Patented Cyl-Tel® Liquid Level Gauge supports remote alarms or telemetry communications
- Separate pressure builder and economizer regulators
- Outdoor or indoor installation and operation

Perma-Cyl® 450 ZX VHP Portable High-Performance MicroBulk Storage

The Perma-Cyl® 450 ZX VHP is designed and built with a rugged internal support system for mobility full of liquid within its protective metal pallet. Unlike the Mega-Cyl™ Liquid Cylinder Series, the Perma-Cyl 450 ZX VHP features the internal float and spray system for single-hose auto shut off with the Orca™ MicroBulk Delivery System. With the on-board external aluminum heat exchanger, the Perma-Cyl 450 ZX VHP is rated at a flow rate of 2000 SCFH while sustaining 420 to 450 psig.

The Perma-Cyl 450 ZX VHP vessel is bolted to a dedicated metal pallet for full protection and transportability with an overhead crane or forklift. The portable design makes the Perma-Cyl 450 ZX VHP the ideal quick-response solution for demanding industrial gas applications, like laser-assist gas.

Product Advantages

- Internal Perma-Cyl top fill float assembly for single-hose auto shut off with the Orca unit
- Rugged internal support system allows full mobility full of product
- High flow external aluminum vaporizer and pressure builder system provides up to 2000 SCFH at 420 to 450 psig
- Metal pallet incorporates forklift slots and crane lifting lugs while protecting plumbing and tank during transportation and application use
- Pallet has durable exterior coating for maximum corrosion resistance



Perma-Cyl® 2000 CO₂ HP Fast Fill MicroBulk Storage for CO₂ Service

The Perma-Cyl® 2000 CO₂ HP MicroBulk Storage System is specifically designed for CO₂ service. One notable performance improvement is the fast fill feature – at least three times the fill rate over our standard Perma-Cyl Series from a typical beverage delivery truck. The upsizing and redesign of the top fill eductor circuit reduces the overall fill time, and also reduces the amount of vent gas during delivery for a more efficient fill. Other new design features include larger internal pressure builder and vaporizer coils, allowing for faster pressure recovery and increased gas flow rates. Dedicated pressure builder and economizer regulators also contribute to this improved performance.

The Perma-Cyl 2000 CO₂ HP comes with many of the standard features found on the Perma-Cyl Series for easy installation and fast start up. The Perma-Cyl Series is well known for holding its liquefied gas contents for long periods of time without venting, thus limiting product loss during periods of little or no gas use.

Product Advantages

- The better alternative to full-for-empty cylinders
- Fast, efficient fills
- High-performance vaporizer
- Cyl-Tel® Liquid Level Gauge
- Ergonomic instruments and controls
- Long life, low maintenance



Perma-Cyl® 5500 VHP High Capacity – High Pressure MicroBulk Storage System

The innovative Perma-Cyl® 5500 VHP MicroBulk Storage System is designed for configuration to any LIN, LAR or LOX gas application and is engineered to supply up to 5000 SCFH at 450 psig delivery pressure. With our industry-exclusive *configure to order* plumbing, you can build your own Perma-Cyl 5500 VHP system to meet your business and your customer's needs.

The Perma-Cyl 5500 VHP system comes with many of the standard Perma-Cyl features including the FlexFill™ Piping Option and the dual safety tree. Additionally, this model comes with a standard external PB vaporizer and an optional side-mounted vaporizer rated at 3500 SCFH.

Product Advantages

- Fast, accurate fills
- Cyl-Tel® Liquid Level Gauge
- Easy to use instruments and controls
- Long life, low maintenance
- Application ready
- Easy economical installation

Product Options

- Analog liquid level gauge (Replaces Cyl-Tel®)
- Phase line tees with isolation valves for remote telemetry
- New larger high-flow flare fill fitting
- Bulk 1½" CGA fill fitting
- 3500 SCFH mounted vaporizer*
- 5000 SCFH free standing Thermax® vaporizer*



**Process vaporizers do not come standard. Customer must specify either the 3500 SCFH hang on style, the 5000 SCFH stand alone, or the vaporizer can be supplied by the customer.*

Mixed Gas Skid MicroBulk Gas Blending System

Chart's improved Mixed Gas Skid is a pre-fabricated blending system that provides a reliable source of high-precision mixed gas in a safe and secure package. The system includes options that make it flexible and capable of handling a wide range of gas blends required in welding and other applications. The Mixed Gas System's pre-engineered simplicity provides higher interconnecting piping integrity, faster start up time, and reduced installation costs. This system also features all the advantages of Chart's MicroBulk Solutions.™

Product Advantages

- Provides a turnkey solution: two vessels, pressure control manifolds, a mixer, and an emergency HP cylinder mixed gas reserve (HP bottles not included)
- Pre-fabricated reduces installation time and costs
- Provides versatility and on-site filling using Chart's Orca™ MicroBulk Delivery System
- Two standard size skid packages to select from
- Transported by pallet jack, forklift or overhead crane
- Thermco® world class mixer provides high quality and proven reliability
- Gas mixer supports two gas sources and a mixed gas output of 0-50% CO₂ in argon
- Provides a regulated source of pure argon gas
- Excellent solution for emergency back-up or temporary requirements
- Gas connection ½" FPT



Skid Package	Primary Gas Source	Second Gas Source
Small Skid	Perma-Cyl 450 HP DOT	Perma-Cyl 230 HP RB
Large Skid	Perma-Cyl 1000 HP	Perma-Cyl 450 HP DOT

Perma-Cyl® with FlexFill™ Top & Bottom Fill Option

The new FlexFill™ Piping Option has a top and bottom fill circuit in place of the top float assembly so the driver can control the tank pressure while filling the Perma-Cyl® MicroBulk Storage System. The FlexFill option uses technology adopted from our LNG fueling system which allows it to safely go liquid full. Once the Orca meter senses a flow rate reduction, the pump is automatically shut down. This patented automatic dispensing system simulates the same process drivers have used for years to safely fill Perma-Cyl storage tanks with a single hose.

The FlexFill feature is critical for applications like laser assist gas and medical gas supply where a significant drop in downstream pressure during the Perma-Cyl® refill could result in equipment alarms. The new FlexFill feature works with all Orca models, both new and existing units.

*The FlexFill tank is presently not approved for service with CO₂.

Product Advantages

- Allows top & bottom filling for accurate pressure control in Perma-Cyl system during refill
- Provides the same safe, single hose, no-loss, auto shut-off fill with the Orca™ MicroBulk Delivery System similar to the top fill float design
- Backward compatible – works with new and existing Orca delivery units without modifications
- Available on 1000 HP/VHP, 1500 HP/VHP, 2000 HP/VHP, 3000 HP/VHP, and 5500 VHP models



Pat. No. - 6,128,908

Cyl-Tel[®] Liquid Level Gauge

Cyl-Tel[®] Gen 5 is a digital electronic liquid level gauge designed specifically for the Perma-Cyl[®] MicroBulk Storage System. The Cyl-Tel gauge has been updated to Gen 5 to include the latest in electronic and differential pressure measurement technologies. The new design includes: accurate liquid level reading using differential pressure, a graphical display, and a simplified logic with nine selectable units of measure that eliminates the need for lookup charts. The Cyl-Tel gauge is telemetry-ready with built in outputs, which eliminate the need for additional boards and is completely compatible to most current telemetry system requirements.

Product Advantages

- Standard on 450 L and larger Perma-Cyl tanks (optional on smaller models)
- Improves customer readability by eliminating calibration charts
- Programmable to tank model or by tank geometry
- Telemetry-ready outputs compatible with many systems, including cellular
- Truly Telemetry-ready with standard pulse and voltage outputs (and optional 4-20mA with interface board); as well as 3 alarm (digital) outputs
- Power: Battery (2 x 1.5V Long Life Lithium) powered or optional 12Vdc adapter (for continuous power on)
- Built-in additional analog input port (0-5V) for optional pressure sensor connection



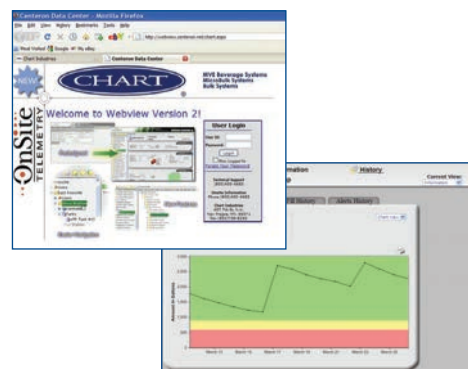
Pat. No. - 6,542,848

OnSite TelemetrySM System

The OnSite TelemetrySM System is the only integrated telemetry solution for distribution. It provides distributors the access to levels, tank pressure and line pressure at customer locations via the Internet. Centralized reports, information management tools and integrated fleet routing/scheduling software allows distributors to operate more efficiently.

Product Advantages

- Accurate, up-to-date measurements of liquid levels
- Self-administered system for maximum service and flexibility
- Account customization for best cost/benefit
- Up to four data ports per call
- Tank and line pressure readings for troubleshooting capabilities
- Email, pager or cell phone alarm capability
- Analog telephone line based
- Easy integration with other gas markets



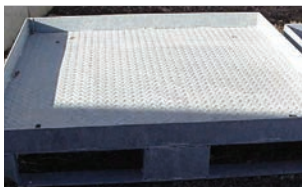
Options and Accessories engineered to enhance Perma-Cyl® system installations in any application.



Exterior stainless steel wall box for remote filling of the Perma-Cyl storage vessel.



Optional external pressure build vaporizer coil for high-pressure, high flow gas applications. (Optional on 1000 VHP, 1500 VHP, 2000 HP & 3000 HP models)



Lab/pallet base is designed to catch or drain water — galvanized coated for corrosion resistance. (Optional on 450 & 1000 models /standard on 1500, 2000, 3000 & 5500)



Stainless steel plumbing for high purity applications. (Optional on 230 HP, 450 HP, 1000 HP & 2000 HP models)



Relief valve and burst disc vent-out safety piping accessory for indoor installations.



Fill Isolation Valve Kit option with ball valve and in-line relief valve on fill circuit.



Horizontal Shipping Kit can be used to safely lay the 2000 and 3000 liter Perma-Cyl® tanks on their side for ease of shipment or access through doorways. (Shown with forklift.)



Dual Safeties & Rupture Discs— Diverter valve allows to safely change relief valves or rupture discs without depressurizing the tank. (Optional on all models / standard on Perma-Cyl horizontal, 5500, 2000 CO₂ HP & FlexFill)



Phase Line tee connections allow for a convenient connection point of high and low phase lines for an owner supplied telemetry system or remote level gauge.



Bulk CO₂ Fill Fittings are available for 1500 HP, 2000 HP and 3000 HP Perma-Cyl tanks to accept CO₂ deliveries from large transport trucks.



Wika Liquid Level Gauge option replaces the standard Cyl-Tel® Liquid Level Gauge.



Vacuum jacketed valve and bayonet for efficient liquid withdrawal. ½" female bayonet. (Optional on 1000 HP, 1500 HP, 2000 HP & 3000 HP – specify tank side – built-to-order.)

Perma-Cyl® VIP Ready C-Flex Vacuum Insulated Transfer Hoses

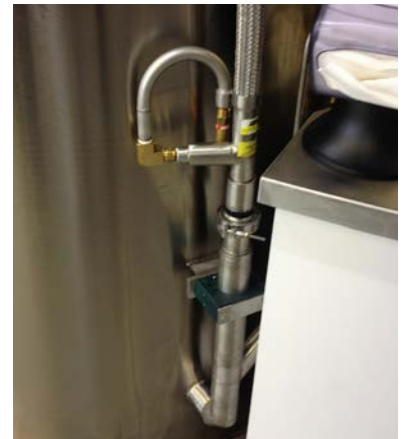
Cryo-Flexible vacuum insulated liquid nitrogen transfer hoses are used in a wide variety of applications, such as Cryosaunas and CryoBio freezers to reduce liquid loss. The coaxial bellows construction allows for optimal flexibility, while the use of lightweight stainless steel reduces cool-down loss to an absolute minimum. C-Flex hoses are protected by a stainless steel spiral wrap or a braided outer cover.

Product Advantages

- Minimize Safety Issues – eliminate many of the hazards associated with non-insulated hoses
- Minimal Cool Down & Steady State Losses – compared to standard non-insulated hoses
- MVE Bayonet with Shrink-Fit™ technology – plugs into Perma-Cyl® tank for a robust easy cryogenic seal
- Easy Installation & Modifications – bendable, lightweight, and its plug-n-play approach facilitates easy installation and allows for on-site layout changes
- Integrated Pump Out & DV-6R Vacuum Gauge – confirms peak operation and long serviceable life
- Hose protection between isolation valves – integrated 150 psig safety relief valve
- Approved for liquid argon service – consult factory for liquid oxygen service

Applications (Recommended size: 3/8")

- Biological Storage Freezers
- Controlled-Rate Freezers
- Cryosaunas
- Cryo Ice Cream
- Test Chambers



Vertical VIP Run w/ RV - MVE2 End1



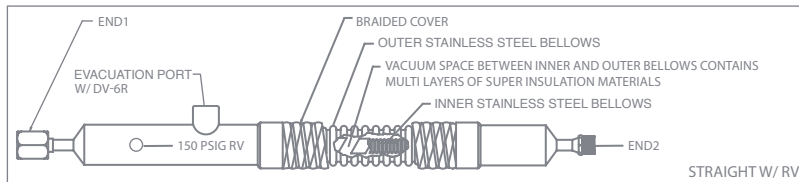
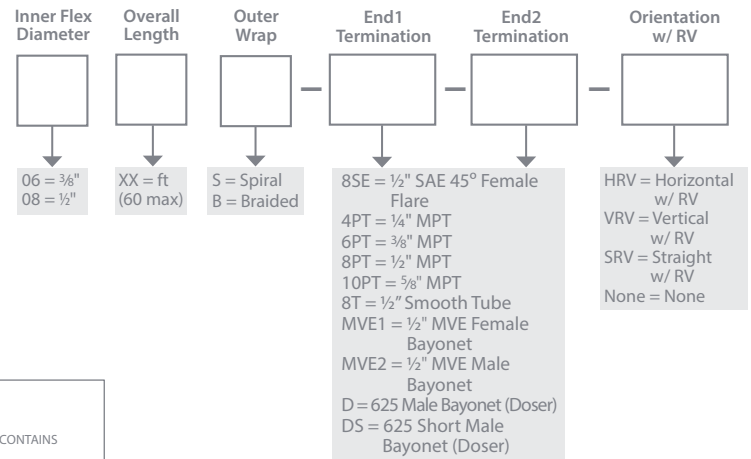
Horizontal VIP Run w/ RV - MVE2 End1

C-Flex Technical Information

Model	06S/B	08S/B
Inner Diameter (ID)	3/8" (9.5 mm)	1/2" (12.7 mm)
Outer Diameter (OD)	1.65" (41.91 mm)	1.80" (45.72 mm)
Minimum Flexible Bend Radius	8" (203 mm)	10" (254 mm)
Minimum Static Bend Radius	6" (152 mm)	7" (177 mm)
Maximum Operating Pressure	150 psi (10.3 bar)	150 psi (10.3 bar)

S: Spiral wrap outer covering **B:** Braided outer covering

Smart Numbering System



C-Flex Flow data 22 psi LN₂ Source; 4 psi Pressure Drop (max)

Length (in / ft)	48" / 4'	72" / 6'	96" / 8'	120" / 10'	144" / 12'	192" / 16'	240" / 20'
3/8" Inner Diameter (ID)	6.0 gpm	4.8 gpm	4.1 gpm	3.6 gpm	3 gpm	2.8 gpm	2.6 gpm
1/2" Inner Diameter (ID)	11.4 gpm	9.0 gpm	7.6 gpm	6.8 gpm	6 gpm	5.2 gpm	4.4 gpm

The Orca™ Delivery System Standard and Custom Delivery Units

All Orca™ MicroBulk Delivery System models feature an exclusive “Smart” flow metering system that contains no moving parts for an accurate, trouble-free service life. The Orca system controls automatically sense the Perma-Cyl® MicroBulk Storage System float shut-off for a safe and reliable fill.



XT Models

Designed for smaller markets or as a starter system, the XT Series delivers product efficiently from an innovative Pulse Technology process. This pumpless design uses a high-pressure pulse tank that integrates with the low-pressure main tank for a low-loss and low cost delivery solution. The XT Series' pulse pressure design benefits larger deliveries from the main tank.



Chart Exclusive -
Submerged pump for inert service. Eliminates cool down losses and reduces delivery time.

Pat. Nos.: 5,616,838 · 5,682,750

ST & HL Models

The ST & HL models incorporate an external pump for oxygen service or an innovative submerged pump for inert service. The submerged pump eliminates cool down time and completes a Perma-Cyl system fill in 3 to 15 minutes without product loss under normal conditions.

Pressure Transfer							Pump Transfer		
MODEL	XT-2000			XT-2500			HL-1650		
Gas Services	LIN, LAR & LOX			LIN, LAR & LOX			LIN, LAR & LOX		
Pressure Builder Type	HP ² & ZX technologies			HP ² & ZX technologies			Pump force-feed/Auto Subcool		
Design Codes	ASME and CGA-341			ASME and CGA-341			ASME, MC-338, CGA-341		
SPECIFICATIONS	Overall Unit	Main Tank	Pulse Tank	Overall Unit	Main Tank	Pulse Tank	Overall Unit		
Gross Capacity (gal/ltrs)	2026 / 7671	1947 / 7372	79 / 299	2489 / 9422	2410 / 9123	79 / 299	1726 / 6534		
Capacity* ** - CGA-341 (gal/ltrs)	1929 / 7302	1850 / 7003	79 / 299	2369 / 8966	2290 / 8667	79 / 299	1640 / 6207		
Capacity** - MC338 (gal/ltrs)							1534 / 5807		
MAWP (psig/bar)		217 / 15.0	350 / 24.1		217 / 15.0	350 / 24.1	50 / 3.4		
Overall Length (in/cm)	234 / 594			270 / 686			192 / 488		
Overall Height (in/cm)	78 / 198			78 / 198			87 / 221		
Overall Width (in/cm)	96 / 244			96 / 244			102 / 259		
Tank Diameter (in/cm)	72 / 183			72 / 183			80 / 203		
Tare Weight (lbs/kg)	10,900 / 4944			11,600 / 5262			7700 / 3493		
PERFORMANCE									
Dispense Method/Technology	Pulse Transfer / Pressure			Pulse Transfer / Pressure			External	Submerged Pump	
Pump	None			None			Ext 60	Sub 60	Sub 100 KA
Min. Dispensing Rate (gpm/lpm)		10 / 38	10 / 38		10 / 38	10 / 38	10 / 38	10 / 38	10 / 38
Max. Dispensing Rate (gpm/lpm)		75 / 284	30 / 114		75 / 284	30 / 114	60 / 227	60 / 227	100 / 379
Max. Dispensing Pressure (psig/barg)		217 / 15.0	350 / 24.1		217 / 15.0	350 / 24.1	260 / 17.9	275 / 19.0	425 / 29.3
Max. Receiving Tank Pressure (psig/barg)		167 / 11.5	250 / 17.2		167 / 11.5	250 / 17.2	210 / 14.5	225 / 15.5	375 / 25.9

* With road relief valve at 25.3 psig

** Maximum fill levels depend on vehicle weight, local road weight limits, etc.

The Orca™ Advantage

- Fast on-site filling of the Perma-Cyl® storage system with auto shut-off
- Exclusive low maintenance submerged pump for instant starts and continuous delivery (ST/HL Series - Inert Service)
- Pumpless pulse transfer plus pulse pressure technology reduces equipment costs and associated maintenance costs (XT Series)
- Single Hose Delivery system minimizes contamination, cool down losses and pressure drop
- Push-button Flowcom® 3000 Flow Meter System with manual override to simplify operator training (ST/HL Series)
- Electronic pump speed control allows driver to safely optimize delivery rate (ST/HL Series)
- National Institute of Standards & Technology (NIST) and California Weights & Measures approved metering system
- Stainless steel and bronze plumbing for long service life
- Robust inner vessel support system for rugged road conditions



HL Series updated controls and plumbing



Chart Exclusive -
“Smart” flow metering system monitors flow electronically with no moving parts in meter section. (Standard on all models.)

HL Series Updated Features

- Auto Subcool – standard on all pump models, simplifies operator training and reduces product loss
- Updated electronics for operations to -40°F / -40°C
- Single hose dispense circuit for low flow Perma-Cyl tank and high flow bulk tank deliveries
- Larger cabinet with removable access panels for ease of maintenance and servicing
- Calibrated meter column system that can be easily removed for recalibration or service

Pump Transfer						
HL-2000	HL-2800		HL-3300	HL-4400	ST-4100***	
LIN, LAR & LOX	LIN, LAR & LOX		LIN, LAR & LOX	LIN Only	LIN, LAR & LOX	
Pump force-feed/Auto Subcool	Pump force-feed/Auto Subcool		Pump force-feed/Auto Subcool	Pump force-feed/Auto Subcool	Pump force-feed/Auto Subcool	
ASME, MC-338, CGA-341	ASME, MC-338, CGA-341		ASME, MC-338, CGA-341	ASME, MC-338, CGA-341	ASME, MC-338, CGA-341	
Overall Unit	Overall Unit		Overall Unit	Overall Unit	Overall Unit	
2144 / 8116	2880 / 10,902		3399 / 12,867	4654 / 17,617	4250 / 16,088	
2037 / 7710	2736 / 10,357		3229 / 12,223	4421 / 16,736	4038 / 15,285	
1907 / 7219	2560 / 9691		3023 / 11,443	4068 / 15,398	3950 / 14,952	
50 / 3.4	50 / 3.4		50 / 3.4	50 / 3.4	38 / 2.6	
200 / 508	244 / 620		273 / 693	344 / 874	338 / 859	
87 / 221	87 / 221		87 / 221	87 / 221	133 / 338	
102 / 259	102 / 259		102 / 259	102 / 259	102 / 259	
80 / 203	80 / 203		80 / 203	80 / 203	80 / 203	
8500 / 3856	9400 / 4264		10,500 / 4763	12,200 / 5534	17,100 / 7756	
	External	Submerged Pump		Submerged Pump	External	Submerged Pump
	Ext 60	Sub 60	Sub 100 KA	Sub 100 KA	Ext 60	Sub 60 Sub 100 KA
	10 / 38	10 / 38	10 / 38	10 / 38	10 / 38	10 / 38 10 / 38
	60 / 227	60 / 227	100 / 379	100 / 379	60 / 227	60 / 227 100 / 379
	260 / 17.9	275 / 19.0	425 / 29.3	425 / 29.3	235 / 16.2	250 / 17.2 400 / 27.6
	210 / 14.5	225 / 15.5	375 / 25.9	375 / 25.9	185 / 12.8	200 / 13.8 350 / 24.1

MAWP = Maximum Allowable Working Pressure, NIST = National Institute of Standards and Technology, FET = Federal Excise Tax, DP = Differential Pressure Specifications subject to change without notice. ***ST model also available in 6800 gallons upon request.



Chart Online Marketing Services

As Chart Inc. continues to provide distributors and customers with the best products and services in the industry, we would like to introduce you to an innovative marketing support tool designed to assist you in growing your business faster! Chart Online Marketing Services is like having your very own 24/7 marketing department providing you the marketing materials needed to drive customers to you. But this is much more than just a site to download product photos, you now have the ability to truly customize brochures, spec sheets and posters with your local contact information and company logo.

3 Easy Steps To Getting Onto Our Website To Order Marketing Materials!



1. Go to <http://literature.chart-ind.com>.
2. Enter your User ID and Password. Click Log In, or click on Sign Up to create an account.
3. Choose a category that you are interested in.



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- Personalized account information
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- Shopping cart stores your parts before you buy
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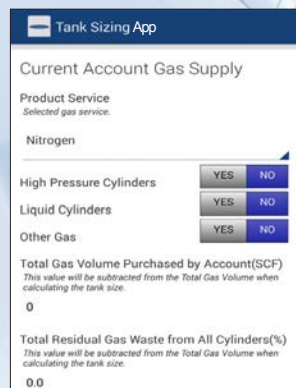


Chart Tank Sizing App

Correctly sizing your cryogenic equipment supply is easy when you know how – or know who to ask. For decades, Chart has helped gas distributors select the optimal cryogenic storage products for their customers. But now, Chart has developed a new **Tank Sizing App** that can advance your mode-change sales process faster and more accurately. No matter the challenge, Chart will provide the tools you need to succeed.

Download the app today for free at your app store and start learning from our experience.

SCF of GAS / Liter of LIQUID

Pressure psig	Argon	Nitrogen	Oxygen	CO ₂	Pressure psig	Argon	Nitrogen	Oxygen	CO ₂
0	29.69	24.60	30.36		225	23.58	18.35	24.24	20.34
25	28.24	23.17	28.89		250	23.17	17.89	23.83	20.07
50	27.32	22.26	27.97		275	22.77	17.43	23.43	19.82
75	26.60	21.53	27.25	22.40	300	22.37	16.96	23.03	19.58
100	25.98	20.89	26.63	21.96	325	21.98	16.47	22.64	19.34
125	25.43	20.33	26.09	21.57	350	21.43	15.96	22.25	19.11
150	24.93	19.80	25.59	21.23	375	21.19	15.42	21.86	18.88
175	24.46	19.30	25.12	20.91	400	20.79	14.80	21.47	18.66
200	24.01	18.82	24.67	20.61	425	20.39	14.07	21.08	18.44

Gas Densities at Liquid Pressures

Argon

	Weight		Gas		Liquid	
	Pounds (Lb)	Kilograms (Kg)	Cubic Feet (SCF)	Cubic Meters (Nm ³)	Gallons (Gal)	Liters (L)
1 Pound	1.0	0.4536	9.671	0.2543	0.08600	0.3255
1 Kilogram	2.205	1.0	21.32	0.5605	0.18957	0.7176
1 SCF Gas	0.1034	0.04690	1.0	0.02628	0.008893	0.03366
1 Nm ³ Gas	3.933	1.7840	38.04	1.0	0.3382	1.2802
1 Gal Liquid	11.630	5.276	112.5	2.957	1.0	3.785
1 L Liquid	3.072	1.3936	29.71	0.7812	0.2642	1.0

Conversion Data

Nitrogen

1 Pound	1.0	0.4536	13.803	0.3627	0.1481	0.5606
1 Kilogram	2.205	1.0	30.42	0.7996	0.3262	1.2349
1 SCF Gas	0.07245	0.03286	1.0	0.02628	0.01074	0.04065
1 Nm ³ Gas	2.757	1.2506	38.04	1.0	0.4080	1.5443
1 Gal Liquid	6.745	3.060	93.11	2.447	1.0	3.785
1 L Liquid	1.782	0.8083	24.60	0.6464	0.2642	1.0

Oxygen

	Weight		Gas		Liquid	
	Pounds (Lb)	Kilograms (Kg)	Cubic Feet (SCF)	Cubic Meters (Nm ³)	Gallons (Gal)	Liters (L)
1 Pound	1.0	0.4536	12.076	0.3174	0.1050	0.3977
1 Kilogram	2.205	1.0	26.62	0.6998	0.2316	0.8767
1 SCF Gas	0.08281	0.03756	1.0	0.02628	0.008691	0.0329
1 Nm ³ Gas	3.151	1.4291	38.04	1.0	0.3310	1.2528
1 Gal Liquid	9.527	4.322	115.1	3.025	1.0	3.785
1 L Liquid	2.517	1.1417	30.38	0.7983	0.2642	1.0

SCF (Standard Cubic Foot) gas measured at 1 atmosphere and 70°F.
Liquid measured at 1 atmosphere and boiling temperature.

Nm³ (normal cubic meter) measured at 1 atmosphere and 0°C.
All values rounded to nearest 4/5 significant numbers.

Carbon Dioxide

	Weight			Gas		Liquid		Solid
	Pounds (Lb)	Tons (T)	Kilograms (Kg)	Cubic Feet (SCF)	Cubic Meters (Nm ³)	Gallons (Gal)	Liters (L)	Cubic Feet (Cu Ft)
1 Pound	1.0	0.0005	0.4536	8.741	0.2294	0.11806	0.4469	0.010246
1 Ton	2000.0	1.0	907.2	17,483.0	458.8	236.1	893.9	20.49
1 Kilogram	2.205	0.0011023	1.0	19.253	0.5058	0.2603	0.9860	0.2260
1 SCF Gas	0.1144	—	0.05189	1.0	0.02628	0.013506	0.05113	0.0011723
1 Nm ³ Gas	4.359	0.002180	1.9772	38.04	1.0	0.5146	1.9480	0.04468
1 Gal Liquid	8.470	0.004235	3.842	74.04	1.9431	1.0	3.785	0.08678
1 L Liquid	2.238	0.0011185	1.0151	19.562	0.5134	0.2642	1.0	0.02293
1 Cu Ft Solid	97.56	0.04880	44.25	852.8	22.38	11.518	43.60	1.0

SCF (Standard Cubic Foot) gas measured at 1 atmosphere and 70°F.
Liquid measured at 21.42 atmospheres and 1.7°F.
Solid measured at -109.25°F.

Nm³ (normal cubic meter) gas measured at 1 atmosphere and 0°C.
All values rounded to nearest 4/5 significant numbers.



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