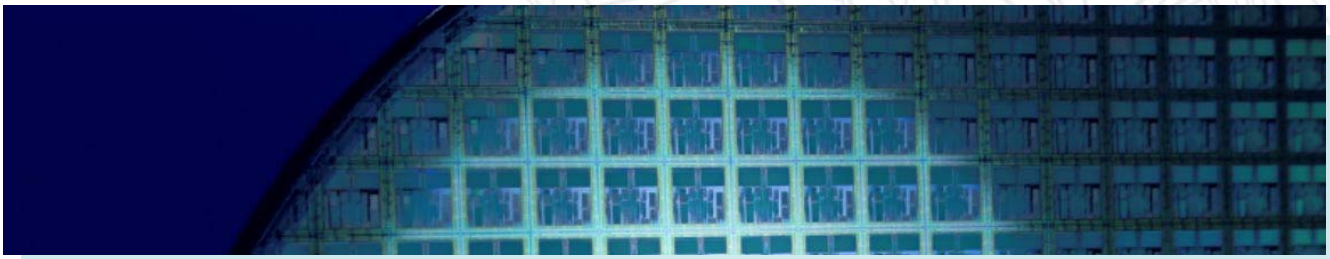
AsH_3 (Arsine) ION-X® Dopant Gas Storage and Delivery System

Next-Generation Adsorbent Technology of Sub-Atmospheric Dopant Gases



Versum Materials and NuMat Technologies announce a global alliance to bring ION-X® sub-atmospheric gas storage and delivery system solutions to our worldwide customers.

BENEFITS

New line of products for the safe storage and delivery of toxic dopant gases, using state-of-the-art MOF (Metal Organic Framework) technology as adsorbent
Delivers ultrahigh purity dopant gases at sub-atmospheric pressures
Best true sub-atmospheric solution
100% Plug and Play with existing implant machines
Delivers capacity premium to SDS3 with AsH_3 and BF_3
Reduced change-outs and cost-of-ownership
Favorable desorption and flow characteristics supporting ease of gas extraction
Superior cylinder construction with the least failure modes

SPECIFICATIONS

(Shelf life: 5 years)

Arsine (AsH_3)	≥ 99.9995%
Carbon Dioxide (CO_2)	≤ 0.5 ppmv
Carbon Monoxide (CO)	≤ 0.1 ppmv
Methane (CH_4)	≤ 0.5 ppmv
Nitrogen (N_2)	≤ 2.0 ppmv
Oxygen (O_2)	≤ 1.0 ppmv
Water (H_20)	≤ 2.0 ppmv

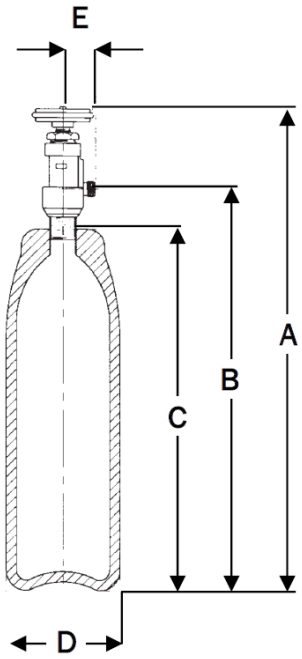
SAFETY INFORMATION

Formula	AsH_3
Physical Description	Colorless gas with a mild, garlic-like odor
CAS Number	7784-42-1
OSHA PEL	TWA 0.05 ppm
NIOSH PEL	0.002 mg/m^3 (15 min. ceiling)
ACGIH-TLV	0.05 ppm
NIOSH-IDLH	Ca (3 ppm)

CYLINDER AND VALVE SPECIFICATIONS

Cylinder pressure (full)	650 +/- 50 Torr at 21°C
Regulatory Approvals	
US Dot	DOT 3AA2015
European Union	ADR and PED Compliant (“π” marked)
Maximum working pressure	2015 psig
Minimal burst pressure	5375 psig
Cylinder material	Carbon steel
Valve	Stainless steel diaphragm type
Valve connection	1/2” VCR male
Adsorbent material	NuMat Metal-Organic Framework

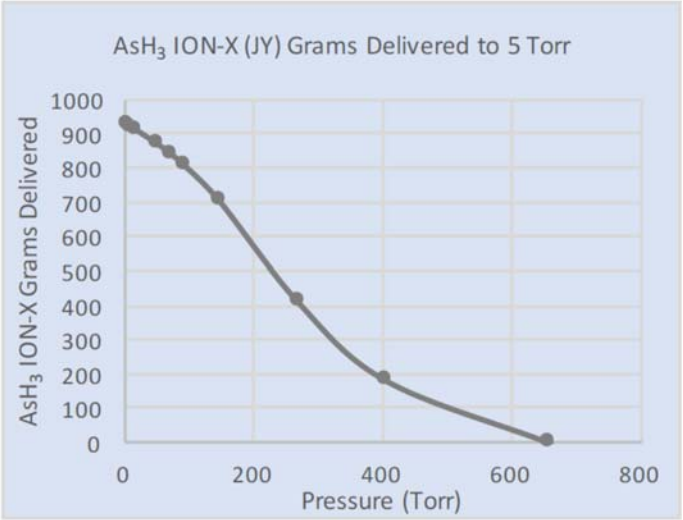
*VCR® is a registered trademark of Swagelok Marketing Co. Solon, Oh



CYLINDER DIMENSIONS AND VOLUME

Size	Units	A	B	C	D	E	Volume
JY	(in)	17.4	14.8	13.5	4.4	1.3	146 in^3
	(mm)	442	377	343	112	33	2.4 liter
UY	(in)	23.6	21.1	19.8	6.3	1.3	450 in^3
	(mm)	601	536	502	159	33	7.37 liter

FINAL CYLINDER PRESSURE (TORR)	JY DELIVERABLE CAPACITY	UY DELIVERABLE CAPACITY
100	790g	2400g
50	865g	2600g
20	910g	2710g
10	920g	2750g
5	925g	2760g



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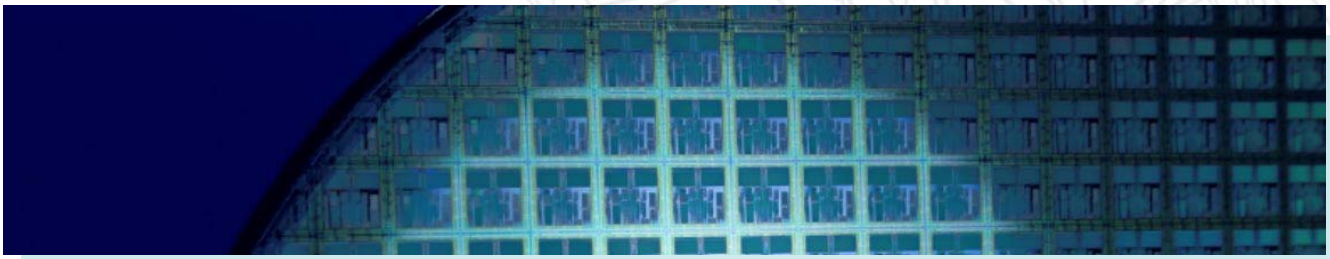
Isotopically-Enriched BF_3 (Boron Trifluoride) ION-X® Dopant Gas Storage and Delivery System

Next-Generation Adsorbent Technology of Sub-Atmospheric Dopant Gases



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BENEFITS

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Delivers ultrahigh purity dopant gases at sub-atmospheric pressures
Best true sub-atmospheric solution
Delivers capacity premium to SDS3 with AsH_3 and BF_3
100% Plug and Play with existing implant machines
Reduced change-outs and cost-of-ownership
Favorable desorption and flow characteristics supporting ease of gas extraction
Superior cylinder construction with the least failure modes

SPECIFICATIONS

(Shelf life: 5 years)

Boron Trifluoride (BF_3)	≥ 99.9%
$^{11}BF_3$	≥ 99.7%
Argon (Ar)	≤ 25 ppmv
Carbon Dioxide (CO_2)	≤ 25 ppmv
Hydrogen Fluoride (HF)	≤ 25 ppmv
Nitrogen (N_2)	≤ 25 ppmv
Oxygen (O_2)	≤ 25 ppmv
Sulfur Dioxide (SO_2)	≤ 25 ppmv

SAFETY INFORMATION

Formula	BF_3
Physical Description	Colorless with a pungent, suffocating odor. Forms dense white fumes in moist air.
CAS Number	20654-88-0
OSHA PEL	Ceiling 1 ppm (3 mg/m^3)
NIOSH PEL	Ceiling 1 ppm
ACGIH-TLV	1 ppm
NIOSH-IDLH	25 ppm

CYLINDER AND VALVE SPECIFICATIONS

Cylinder pressure (full)	650 +/- 50 Torr at 21°C
Regulatory Approvals	
US Dot	DOT 3AA2015
European Union	ADR and PED Compliant (“π” marked)
Maximum working pressure	2015 psig
Minimal burst pressure	5375 psig
Cylinder material	Carbon steel
Valve	Stainless steel diaphragm type
Valve connection	1/4” VCR male
Adsorbent material	NuMat Metal-Organic Framework

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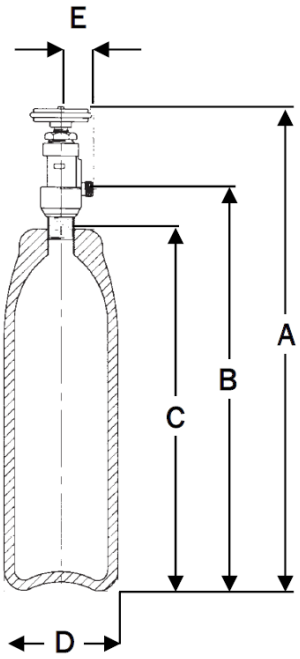

CYLINDER DIMENSIONS AND VOLUME

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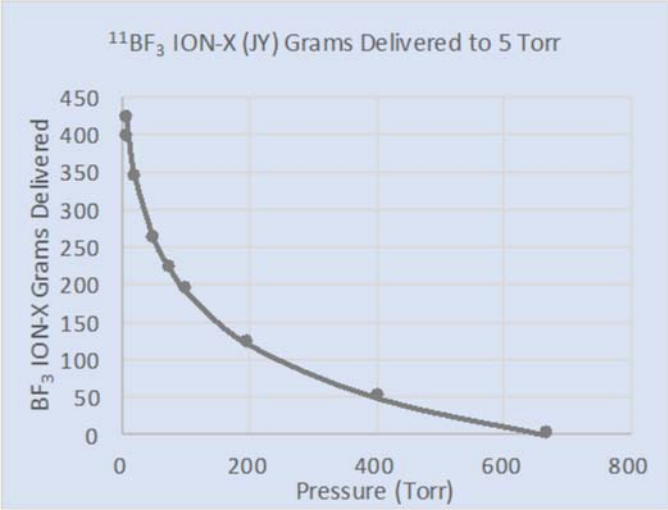
	(mm)	442	377	343	112	33	2.4 liter
UY	(in)	23.6	21.1	19.8	6.3	1.3	450 in^3
	(mm)	601	536	502	159	33	7.37 liter

FINAL CYLINDER PRESSURE (TORR)	JY DELIVERABLE CAPACITY	UY DELIVERABLE CAPACITY
100	190g	570g
50	260g	775g
20	340g	1025g
10	395g	1185g
5	420g	1255g



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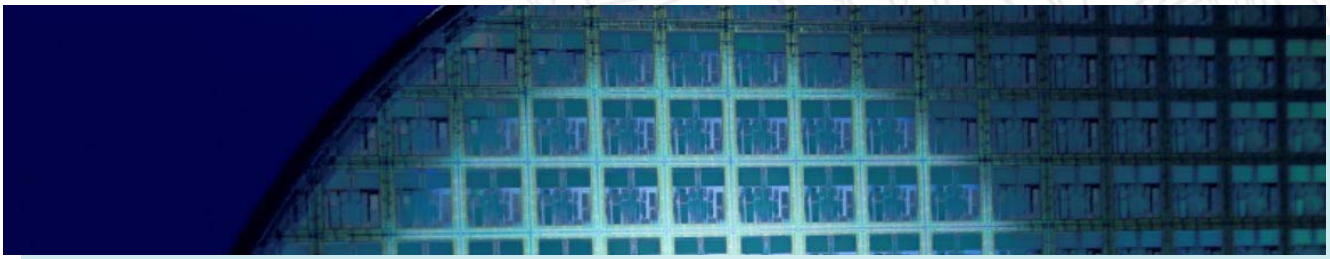
PH_3 (Phosphine) ION-X® Dopant Gas Storage and Delivery System

Next-Generation Adsorbent Technology of Sub-Atmospheric Dopant Gases



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BENEFITS

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Best true sub-atmospheric solution
100% Plug and Play with existing implant machines
Reduced change-outs and cost-of-ownership
Favorable desorption and flow characteristics supporting ease of gas extraction
Superior cylinder construction with the least failure modes

SPECIFICATIONS

(Shelf life: 5 years)

Purity	≥ 99.9997%
Carbon Dioxide (CO_2)	≤ 0.1 ppmv
Carbon Monoxide (CO)	≤ 0.1 ppmv
Methane (CH_4)	≤ 0.5 ppmv
Nitrogen (N_2)	≤ 2.0 ppmv
Oxygen (O_2)	≤ 1.0 ppmv
Water (H_2O)	≤ 2.0 ppmv

SAFETY INFORMATION

Formula	PH_3
Physical Description	Colorless gas with a fish or garlic-like odor
CAS Number	7803-51-2
OSHA PEL	TWA 0.03 ppm (0.42 mg/m^3)
NIOSH PEL	TWA 0.03 ppm
ACGIH-TLV	0.3 ppm
NIOSH-IDLH	50 ppm

CYLINDER AND VALVE SPECIFICATIONS

Cylinder pressure (full)	650 +/- 50 Torr at 21°C
Regulatory Approvals	
US Dot	DOT 3AA2015
European Union	ADR and PED Compliant (“π” marked)
Maximum working pressure	2015 psig
Minimal burst pressure	5375 psig
Cylinder material	Carbon steel
Valve	Stainless steel diaphragm type
Valve connection	1/2” VCR male
Adsorbent material	NuMat Metal-Organic Framework

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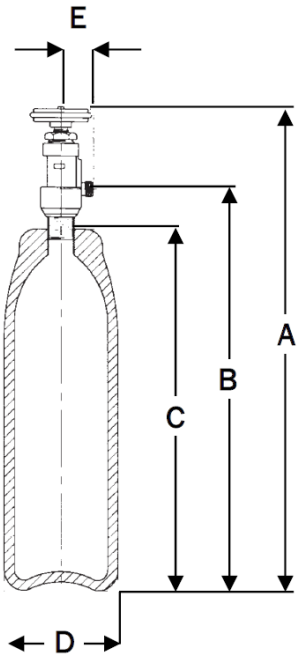

CYLINDER DIMENSIONS AND VOLUME

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JY	(in)	17.4	14.8	13.5	4.4	1.3	146 in^3
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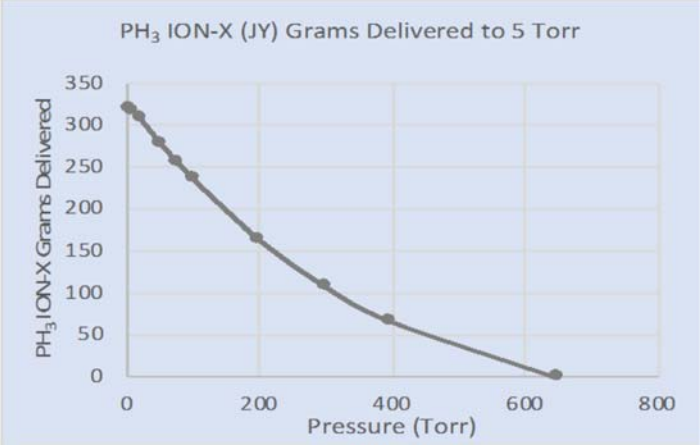
UY	(in)	23.6	21.1	19.8	6.3	1.3	450 in^3
	(mm)	601	536	502	159	33	7.37 liter

FINAL CYLINDER PRESSURE (TORR)	JY DELIVERABLE CAPACITY	UY DELIVERABLE CAPACITY
100	235g	700g
50	280g	830g
20	307g	915g
10	317g	945g
5	320g	955g



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