Product Manual

saes getters

SAES Pure Gas, Inc.

A member of the SAES Getters Group

MICRO TORR®

Point-of-Use
Ambient Temperature Purifiers

Introduction

MicroTorr® purifiers are designed to remove gaseous contaminants down to part-per-trillion levels. Product dimensional and purity performance specifications had been provided along with the present Product Manual.

MicroTorr® use a variety of specifically developed getter-stabilized zeolites (GSZ) and other media for ambient temperature purification (no power to function). Purification Media are specific to each gas and impurities removal is generally based on chemisorption, physisorption or catalytic oxidation and physisorption.

Most GSZ media can be fully regenerated providing the lowest cost of ownership purification solution available as well as eliminating hazardous waste disposal problems.

Safety Precautions and Handling

DANGER!	COMPLETELY READ THIS MANUAL PRIOR INSTALLATION AND ANY OPERATION. For more specific information on Gas Handling and Safety Refer to gas supplier's Material Safety Data Sheet.
DANGER!	PRESSURIZED GASES ARE DANGEROUS. Do not operate this product unless you are familiar with all necessary safety precautions taken to prevent hazardous conditions (pressure unexpected release). Ensure ventilation to the installation area to prevent operator's asphyxiation.
DANGER!	USE THE PURIFIER ONLY FOR APPROVED GAS ONLY. If the product is exposed to gases different from what specified strong exothermic reactions or other adverse reactions may occur. It is user responsibility to install all safety equipment to prevent hazardous conditions.
DANGER!	NEVER USE THE PURIFIER WITH MULTIPLE GASES UNLESS APPROVED BY SAES PURE GAS CUSTOMER SERVICE
DANGER!	FAILURE TO CORRECTLY DEFACILITIZE THE PURIFIER BY NOT EXACTLY FOLLOWING THE REMOVAL PROCEDURE COULD CAUSE ATMOSPHERIC EXPOSURE OF PROCESS GAS RESIDUALS AND MAY RESULTS IN EQUIPMENT DAMAGE OR INJURY OF PERSONNEL.
Warning	TO AVOID IRREVERSIBLE PURIFICATION UNIT DAMAGE OR PURIFICATION PERFORMANCE DEPLETION DO NOT EXCEED MAX OPERATING PRESSURE, FLOW RATE AND TEMPERATURE. For further information see the unit mechanical specification chart attached with this manual
CAUTION!	Initial operation with process specialty gases may product heat. Strictly follow the Operation Manual Installation instructions
CAUTION!	If the process gas is different than the purge gas used during installation, care must be taken to eliminate the risk of exposing the purification media to ambient air when switching gases
CAUTION!	High contaminant concentrations (> 10 ppmV) or the use of low grade tubing and components upstream or downstream the unit may result in incomplete gas purification

Unpacking and Mounting Orientation

- Each purifier is filled with nitrogen or an inert gas and is shipped in a vacuum sealed bag. The inlet and outlet fittings are capped.
- The purifier must be installed vertically with process gas flow running from top to bottom (inlet to outlet) according the flow arrow label indication. .
- For other mounting orientations please contact SAES Pure Gas Customer Service (Page 4)

Installation

Connection of purifier with factory-supplied isolation valves:

1. Purge the process line with inert gas or nitrogen (99.999% pure minimum). Maintain the purge gas pressure of approximately 5 psig during the whole installation to prevent air from entering the purifier. The gas flow rate for purge should be minimum 50-100 sccm.

2. Orient the purifier in the gas line with the flow arrow pointing in the direction of the gas flow

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The following steps should be performed quickly and should take less than 30 seconds for each connection.

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3. Install a new VCR® gasket (included) into the inlet fitting of the purifier inlet isolation valve and connect to the upstream piping. Cycle Purge and then purge the VCR® connection while keeping the isolation valve closed. Tighten to VCR® fitting manufacturer specification, typically 1/8 of a turn past finger tight to complete each face seal fitting. Some slight additional tightening may be necessary to meet the desired leak rates. PLEASE USE CAUTION, excessive over-tightening can damage sealing bead (toroid) and possibly cause system leakage.

4. Open the inlet valve of the purifier.

5. Allow at least 10 seconds for the purifier to pressurize with purge gas.

6. Open the outlet isolation valve. Install a new VCR® gasket (included) into the outlet fitting of the isolation valve installed. Connect the purifier to the downstream piping. Tighten to VCR® fitting manufacturer specification, typically 1/8 of a turn past finger tight to complete each face seal fitting. Some slight additional tightening may be necessary to meet the desired leak rates. PLEASE USE CAUTION, excessive over-tightening can damage sealing bead (toroid) and possibly cause system leakage.

7 Flow inert gas for 15-30 minutes at 10% of the maximum purifier flow (see the Purification Unit Specs Provided). The Purifier installation is complete.

8 Leak check with Helium all piping and connections according SEMI Standard F1-96 (Specification for Leak Integrity of High-Purity Gas Piping Systems and Components).

Connection of purifier without factory-supplied isolation valves:

1. Purge the process line with inert gas or nitrogen (99.999% pure minimum). Maintain the purge gas pressure of approximately 5 psig during the whole installation to prevent air from entering the purifier. The gas flow rate for purge should be minimum 50-100 sccm

2. Orient the purifier in the gas line with the flow arrow pointing in the direction of the gas flow

The following steps should be performed quickly and should take less than 30 seconds for each connection.

3. Remove the inlet cap. Install a new VCR® gasket (provided), into the inlet fitting and connect the purifier to the upstream piping. Tighten to VCR® fitting manufacturer specification, typically 1/8 of a turn past finger tight to complete each face seal fitting. Some slight additional tightening may be necessary to meet the desired leak rates. PLEASE USE CAUTION, excessive over-tightening can damage sealing bead (toroid) and possibly cause system leakage.

4. Allow at least 10 seconds for the purifier to pressurize with purge gas.5. Remove the outlet cap. Install a new VCR® gasket (provided), into the outlet fitting and connect the purifier to the downstream piping. Tighten to VCR® fitting manufacturer specification, typically 1/8 of a turn past finger tight to complete each face seal fitting. Some slight additional tightening may be necessary to meet the desired leak rates. PLEASE USE CAUTION, excessive over-tightening can damage sealing bead (toroid) and possibly cause system leakage.

   A temperature label has been affixed to the purifier to assist in monitoring the temperature during conditioning.

5. Flow inert gas for 15-30 minutes at 10% of the maximum purifier flow (see the Purification Unit Specs Provided). The Purifier installation is complete.

6. Leak check with Helium all piping and connections according SEMI Standard F1-96 (Specification for Leak Integrity of High-Purity Gas Piping Systems and Components).

Conditioning

Conditioning is required to ensure that the unit specified purity levels are met prior putting the purifier into service. After conditioning the purity specification will be met at the purifier outlet connection. Additional piping conditioning could be required if the purity specifications will be measured downstream the purifier through other gas pipelines and components.

If for any reason your set up does not allow to follow the below conditioning instructions please contact SAES Pure Gas Customer Service (Page 4) for alternative and customized conditioning recipes.

Below are the instructions for two types of conditioning: Type A and Type B.

Refer to the table below to determine the correct conditioning type for your purifier and process gas.

If the purification unit code is not included in the table above refer to the conditioning guidelines present with the unit Specification or contact SAES Pure Gas Customer Service (Page 4).

A temperature label has been affixed to the purifier to assist in monitoring the temperature during conditioning (the green number indicates the unit current temperature)

	Media Type			
	404,502,602, 702, 703, 802, 905		202, 203, 302, 403, 406, 902, 904, 906	
	Type A Conditioning		Type B Conditioning	
Model	Flow	Flow Period	Flow	Flow Period
MC1/NT12	0.1 slpm	4 hours	0.1 slpm	1 hour
MC50/SP150	0.1 slpm	4 hours	0.2 slpm	2 hours
MC190/HP190/PG1	0.4 slpm	5 hours	0.5 slpm	2 hours
MC200	0.4 slpm	5 hours	0.5 slpm	2 hours
MC400/HP400	0.7 slpm	5 hours	0.7 slpm	2 hours
MC450	0.7 slpm	5 hours	0.7 slpm	2 hours
MC500	0.7 slpm	5 hours	1.0 slpm	4 hours
MC700/HP700	0.7 slpm	5 hours	1.0 slpm	4 hours
MC1500	2.2 slpm	5 hours	2.0 slpm	4 hours
MC3000/HP3000	3.0 slpm	5 hours	5.0 slpm	4 hours
MC4500	7.0 slpm	5 hours	7.5 slpm	4 hours
MC9000	10.0 slpm	5 hours	10 slpm	4 hours
SP70	0.3 slpm	5 hours	1.0 slpm	2 hours
SP300	0.4 slpm	5 hours	1.0 slpm	2 hours
SP600	0.7 slpm	5 hours	1.0 slpm	2 hours
Model numbering explanation: MC1-202FV (MC1=Purifier size 202=Media F=0.003 µm filter V=Valves)				

<u>Type A Conditioning</u>

It is recommended that the purifier is properly vented to a scrubber during conditioning.

For MC1, NT12, MC50 unit conditioning, only perform Steps 1 & 3.

Switch to process gas for conditioning.

1. Begin flowing process gas at rate indicated on chart below. Carefully monitor temperature on temperature label (the green number indicates the current temperature).
2. Monitor to ensure temperature stays below 60°C for 30 minutes. (If temperature rises over limit, isolate the purifier and let cool to less than 45°C. When cooled, go back to Step 1).
3. Purge with process gas for at least 5 hours at rate indicated.

NOTE for media 502: extend the conditioning to total 6 hours and do not stop and isolate the purifier until the end of the conditioning process.

<u>Type B Conditioning</u>

Switch to process gas for conditioning.

1. Begin flowing process gas at rate indicated on chart below. Carefully monitor temperature on temperature label (the green number indicates the current temperature).
2. Monitor to ensure temperature stays below 60°C. If temperature rises over limit, isolate the purifier and contact SAES Pure Gas Customer Service (Page 4)
3. The period of flow on chart is required to confirm that the purifier is not heating

Decommissioning

- Cycle purge with inert gas or nitrogen: decrease line pressure to minimum pressure achievable – must be less than .3 bar (5 psig) but higher than atmospheric pressure – then increase to maximum achievable without exceeding operating pressure of unit (100 psig is recommended) – this must be at least 5 bar (75 psig). Repeat through 10 cycles for nitrogen and rare gases and 50 cycles for specialty gases.
- For specialty gases, after cycle purging, continue purging with nitrogen or inert gas for 48 hours at 30% the maximum purifier flow rate.
- After the above purging is complete, regulate the gas pressure to max 20 psig and then close the outlet valve. Disconnect the purifier outlet VCR® connection and cap using a new VCR® gasket (not included). Tighten to VCR® fitting manufacturer's specifications.
- While purging the gas at 20 psig, close inlet valve. Disconnect the inlet VCR® connection and cap using a new VCR® gasket (not included). Tighten to VCR® fitting manufacturer's specification.

Purifier Lifetime

The purification unit will operate for a specific lifetime based on the following parameters:

- Application average flow rate (slpm, scfm, nm3/hour, scfh...)
- Application duty cycle (hours/week/years the purifier will be in service)
- Application inlet gas purity levels (ppmV-w-mole, ppbV-w-mole, ng/l...)
- Application purity outlet requirements (ppbV-w-mole, pptV-w-mole, ng/l...)

To determine the precise lifetime, after having collected the above info, contact your local SAES Getters office or send an email to *spg@saes-group.com*

Disposal of purifier

Follow proper disposal procedures for the purifier. The disposal of the material, as with any other industrial waste, should be performed in accordance with the specific local and national laws and regulations.
Dispose the purifier referring to the appropriate Material Safety Data Sheet (MSDS) sent by SAES Pure Gas along with the purification unit.
If there are any questions concerning correct disposal methods, contact your local SAES Getters office.

Purifier Regeneration

Purifier factory regeneration is an environment friendly service SAES Pure Gas is offering to minimize product's cost of ownership. Instead of expensive hazardous materials waste disposal, MicroTorr units could be factory regenerated. Regenerated units will have the same purity performance, lifetime expectation and warranty as a fresh unit.

Please consult the following chart to see if your purifier is regenerable as well if the purification material requires special care for shipment.

The media refers to the three digit number located in the part number of the purifier. For example, the purifier MC1-902F contains 902 media which is regenerable.

Media	Is it Regenerable (Yes/No)	Is the media classified as Dangerous Goods (Yes/No)
202	Yes	No
203	Yes	No
302	No	No
403	No	No
404	Yes	No
406	No	No
502	No	No
602	Yes	Yes
702	Yes	Yes
703	Yes	Yes
802	No	Yes
902	Yes	Yes
904	Yes	Yes
905	Yes	Yes
906	Yes	No

Additional Information, Regeneration and Reorder

For additional information or any kind of assistance visit please contact your SAES Pure Gas representative or call SAES Pure Gas:

- **Lifetime evaluation**: + 1 (805) 541-9299; *spg@saes-group.com*
- **Reorder**: + 1 (805) 541-9299; *spg@saes-group..com*
- **Regeneration service** : +1 (805) 781-2392 ; *spg.fse@saes-group.com*
- **Customer Service**: USA (800) 934-3628; International +1 (805) 781-2392 ; *spg.fse@saes-group.com*

Additional and updated information is also available at SAES Pure Gas Website *www.saespuregas.com*

SAES Pure Gas

The Technology of Pure Gas

SAES Getters Group, Pure Gas Technologies

Customer Service
24 Hours, 7 days/week

(1-805) 781-2392 International
(1-800) 934-3628 US Domestic

www.saespuregas.com

Email: spg@saes-group.com

SAES Pure Gas, Inc.
The Technology of Pure Gas
4175 Santa Fe Road, San Luis Obispo, CA 93401
Tel: 1 (805) 541-9299 | Fax: 1 (805) 541-9399

MICRO TORR® Specifications

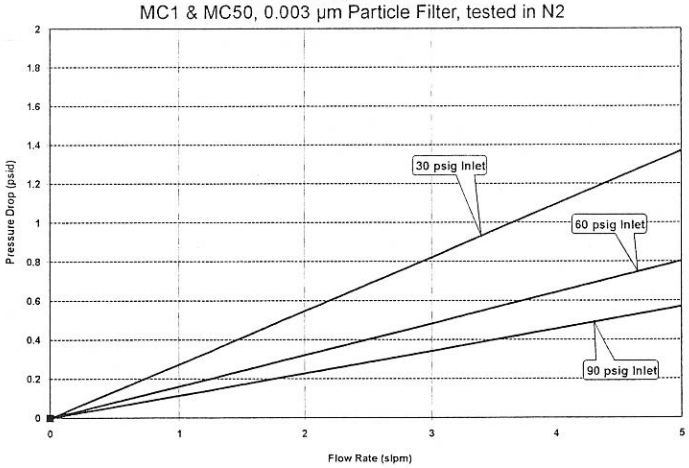
MC1

MicroTorr purifiers are the most complete and reliable solution for Point-of-Use (POU) gas purification. Combining model size with a selection of gas-specific purification materials, MicroTorr purifiers can be tailored to many different customer applications, while maintaining impurity removal to Part-Per-Billion (ppbV) levels or better. Optional valves and a 0.003 micron particle filter are available as well as custom subsystem configurations.

Competitive Advantages and Benefits:

- **Reliability.** Uncompromised process consistency and yield improvement.
- **Performance.** State-of-the-art purification technology, low pressure drop, and long lifetimes.
- **Regenerability**. Most MicroTorr media are factory regenerable, minimizing potentially hazardous waste.
- **Quality.** 316L stainless steel, Helium leak checked, pressure tested, and analytical testing to Part-per-Trillion (pptv) levels.
- **Support.** Lifetime estimation and regeneration service available through SAES Pure Gas Sales Network.

Pressure Drop vs. Flow Rate
MC1 & MC50, 0.003 µm Particle Filter, tested in N2



Ordering Information

MC1 - XXX XX

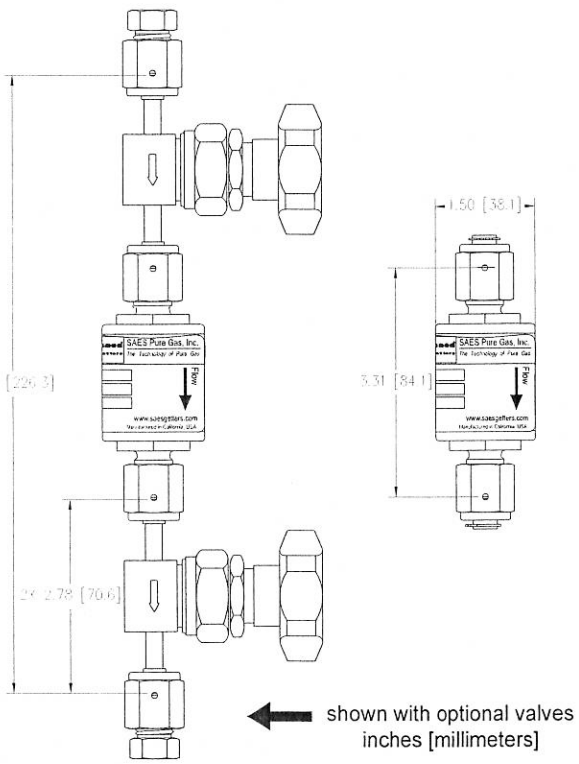
Model	Media	Options	
MC1	202, 203, 302, 403, 404, 502, 602, 702, 703, 802, 902, 904, 905, 906		No options
		F	0.003µm Particle Filter
		V	Inlet/Outlet Valves
		FV	Filter and Valves

Example: MC1-902F
Model: MC1 Media: 902 Options: 0.003µm Particle Filter

MC1

- **Lifetime**
  Consult factory for specific lifetimes
- **Maximum Flow:** 5 slpm†
- **Nominal Flow:** 0.5 slpm†
- **Maximum Pressure:** 1,000 psig

† See reverse for Arsine & Phosphine flowrates



shown with optional valves
inches [millimeters]

Install Vertically with flow downward in direction of arrow. Consult factory for other mounting options.

SAES Pure Gas, Inc.
The Technology of Pure Gas
4175 Santa Fe Road, San Luis Obispo, CA 93401
Tel: 1 (805) 541-9299 | Fax: 1 (805) 541-9399

MICRO TORR® Specifications

MC1

Mechanical Specefications

Model	MC1-*F	MC1-*FV
Maximum Flow	5 slpm	5 slpm
Nominal Flow	0.5 slpm	0.5 slpm
Valves	N/A	1/4" manual
Max Operating Pressure	1000 psig (69 barg) @ 40°C	
Max Temperature Rating	40°C (104°F) **	
Inlet	1/4" MVCR	1/4" FVCR
Outlet	1/4" MVCR	1/4" FVCR
Length (Face to Face)	3.31"±.03 [84.1mm±0.8]	8.91"±.05 [226.3mm±1.3]
Weight	0.7 lbs (0.3 kg)	2.6 lbs (1.2 kg)
Outside Diameter	1.50" [38.1mm]	
Electropolish	Yes	
Leak Rating	$1x10^{-9}$ atm cc/sec of He	
Material	Body-316L Stainless Steel	
Filter (Outlet)	Integrated 0.003 micron, metal	

*The 3 digit number found in the model number equates to the "Media" row in the table below.
†Flowrates with 502 media: Arsine/Phosphine max= 1.0 slpm, nominal= 0.5 slpm.

Purification and Removal Capabilities

Media	Gases Purified	Impurities Removed	Outlet Performance	Regenerable	Dangerous Goods (DG) Classification
202	Ar, CDA, H_2, He, Kr, N_2, Ne, O_2, Xe, CO_2, N_2O, D_2	H_2O	< 1 ppbV	YES	Non-DG
203	Ar, CDA, H_2, He, Kr, N_2, Ne, O_2, Xe, N_2O, D_2	H_2O, CO_2,	< 100 pptV	YES	Non-DG
		Acids, Organics, Refractory Compounds*	< 1 pptV		
		Bases*	< 5 pptV		
302	B_2H_6, BCl_3, BF_3, $CClH_3$, Cl_2, CO_2, $GeCl_4$, GeH_4, H_2S, H_2Se, HBr, HCl, N_2O, NF_3, NO, $SiCl_4$, SiF_4, SiH_2Cl_2, $SiHCl_3$, SO_2, $CHClF_2$	H_2O	< 1 ppbV	NO	Non-DG
		Metals Removal	< 1 ppbW		
403	Ar, CDA, H_2, He, Kr, N_2, Ne, O_2, Xe, CO_2	Acids, Organics, Refractory Compounds*	< 1 pptV	NO	Non-DG
		Bases*	< 5 pptV		
404	Ar, CDA, H_2, He, Kr, N_2, Ne, O_2, Xe, CO_2, C_2H_2, C_3H_6, C_2H_4, NH_3	Organics*	< 1 ppbV	YES	Non-DG
502	PH_3, AsH_3	H_2O, O_2	< 1 ppbV	NO	Non-DG
602	CO	H_2O, O_2, CO_2, Acids, Bases, Organics, Refractories*	< 1 ppbV	NO	DG - UN3089 Class 4.1
702	NH_3, C_2H_7N, $C_2H_8N_2$, C_2H_4, C_3H_6, CH_3SiH_3, GeH_4, H_2-SiH_4 mix, SF_6	H_2O, O_2, CO_2	< 1 ppbV	YES	DG - UN3089 Class 4.1
703	NH_3	H_2O, O_2, CO_2, NMHCs	< 1 ppbV	YES	DG - UN3089 Class 4.1
802	SiH_4	H_2O, O_2, CO, CO_2, NMHCs, Sulphur Compounds	< 1 ppbV	NO	DG - UN2881 Class 4.2
902	Ar, He, Kr, N_2, Ne, Xe	H_2O, O_2, CO, CO_2, H_2	< 100 pptV	YES	DG - UN2881 Class 4.2
		Acids, Organics, Refractory compounds*	< 1 pptV		
		Bases*	< 5 pptV		
904	H_2, H_2 -Inerts Mix, D_2	H_2O, O_2, CO, CO_2	< 100 pptV	YES	DG - UN2881 Class 4.2
		Acids, Organics, Refractory compounds*	< 1 pptV		
		Bases*	< 5 ppbV		
905	C_2F_6, C_2H_6, C_3F_8, C_3H_8, $C_2F_4H_2$, C_4F_8, C_4H_{10}, CCl_4, CF_4, CH_4, CHF_3, SF_6	H_2O, O_2, CO, CO_2, H_2 NMHCs	< 1 ppbV	YES	DG - UN2881 Class 4.2
906	CDA, O_2, N_2O	H_2O, CO, CO_2, NMHCs	< 1 ppbV	YES	Non-DG

*Organic compounds (C>5) measured as Toluene. Acid compounds (SO2, NOx, H2S..) measured as SO2. Base compounds (NH3, amines..) measured as NH3. Silicon/Refractory compounds (HMDSA, HMDSO, TMS) measured as HMDSO

Other Sizes Available

Model Number	MC1	MC50	MC190	MC200	MC400	MC450	MC500	MC700	MC1500	MC2525	MC2550	MC3000	MC4500	MC9000
Maximum Flow (slpm)	5	10	50	50	60	75	100	120	250	300	500	500	1000	1000
Average Flow (slpm)	0.5	1.5	5	5	9	10	12	25	40	80	80	80	200	300

Product Warranty

Limited Warranty and Disclaimer of Warranties

SAES warrants that its products and parts will perform in accordance with SAES's published specifications or the specifications agreed to by Buyer and SAES in writing and referring to this order. This warranty shall have a term of TWELVE (12) MONTHS from the date of installation at Buyer's facility or EIGHTEEN (18) MONTHS from the date of shipment, whichever term is shorter. In the case of after-sale field upgrades or non-warranty repairs, SAES shall warrant all materials and workmanship for a period of NINETY (90) DAYS from the date of installation or upgrade. Subject to the remainder of this Paragraph, any action by Buyer for any alleged breach of this warranty shall be brought by Buyer within thirty (30) days of Buyer's discovery of the breach. This warranty shall only apply to the Buyer and may not be assigned.

During the term of the warranty set forth above, SAES will promptly repair goods which do not conform to the specifications and which Buyer returns to SAES at the address provided below. Buyer shall be responsible for all transportation charges incurred in returning goods to SAES for repair, provided that SAES shall be responsible for such charges if Buyer obtains a Returned Material Authorization ("RMA") number and specific shipping instructions from the SAES PURE GAS Field Support Group prior to its shipping of the goods to SAES. SAES shall not unreasonably deny Buyer authorization to ship goods to SAES and an RMA number upon Buyer's request under this Paragraph. SAES shall return repaired goods to buyer, with surface transportation charges prepaid by SAES.

If SAES, in its sole discretion, determines that it is not commercially practicable to repair goods returned by Buyer, SAES will either (i) replace those goods or (ii) refund the purchase price to Buyer, less the reasonable pro-rated rental value of the goods for the period during which Buyer used them prior to its discovery of their failure to comply with the warranty set forth above. Buyer expressly agrees that should SAES replace returned goods, the replacement goods may consist of or contain refurbished goods and/or parts. Any refurbished goods or parts SAES ships to Buyer under this Paragraph shall be equivalent to new in performance, shall meet SAES's published specifications or the specifications agreed to by Buyer and SAES in writing and referring to this order, and shall be subject to the limited warranties set forth in this Paragraph. SAES shall be responsible for any surface transportation charges incurred in shipping replacement goods to Buyer.

The warranty set forth above shall not apply to damage resulting from (i) loss or damage in transit; (ii) unreasonable use (including without limitation the failure to provide reasonable and necessary maintenance); (iii) accident; (iv) Buyer's attempt to make or cause to be made any repairs or alterations on the goods and parts covered during the warranty period without the prior written permission of SAES; (v) Buyer's acts or omissions which subject the goods to more rigorous environments than are set forth in the applicable specifications, including without limitation Buyer's use of toxic, corrosive or caustic liquids and/or gases with the goods; (vi) Buyer's negligence, mishandling, misuse, abuse or use which is not in accordance with SAES's specifications and instructions; or (vii) any defects in those purchased goods which Buyer has detected after the end of the term of the warranty herein. SAES reserves the right to examine the goods returned to determine if the warranty is applicable. SAES MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, AND SAES DISCLAIMS ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. SAES MAKES NO WARRANTY THAT THE GOODS DO NOT INFRINGE ANY PATENT, TRADEMARK, COPYRIGHT, OR SIMILAR RIGHTS OF THIRD PARTIES AND SAES DISCLAIMS ANY IMPLIED WARRANTY OF NONINFRINGEMENT.

The warranty set forth above is the only warranty made by SAES with respect to the goods delivered hereunder, and no employee, representative or other person or entity is authorized to assume for SAES any obligations or liability beyond or at variance with that warranty in connection with the sale of SAES's goods.

Limitation of Liabilities. BUYER AND SAES AGREE THAT (I) THE SOLE AND EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONCERNING THE GOODS SHALL BE REPAIR OR REPLACEMENT OF THOSE GOODS OR THEIR COMPONENT PARTS OR REFUND OF THE PURCHASE PRICE AS STATED IN THIS PRODUCT WARRANTY ABOVE; AND (II) SAES SHALL HAVE THE EXCLUSIVE RIGHT TO SELECT ANY SUCH REMEDY IN ITS SOLE DISCRETION.

IF SAES BREACHES THIS AGREEMENT, BUYER'S SOLE DAMAGES SHALL BE THE DIFFERENCE BETWEEN THE MARKET PRICE AND THE CONTRACT PRICE. SAES SHALL NOT BE LIABLE FOR CONTINGENT, INCIDENTAL OR CONSEQUENTIAL DAMAGES TO PERSONS OR PROPERTY AND SAES'S SOLE LIABILITIES AND BUYER'S EXCLUSIVE REMEDIES HEREUNDER ARE AS PROVIDED IN THESE STANDARD TERMS AND CONDITIONS OF SALES. SAES SHALL NOT BE LIABLE FOR ANY EXCESS REPROCUREMENT COSTS OR SPECIFIC PERFORMANCE.

Notwithstanding any implication to the contrary, SAES shall have no liability whatsoever unless and until Buyer shall have paid the full purchase price of all goods delivered.

Proprietary Rights. Buyer agrees that any of SAES's Software and Firmware products ordered or included in the Goods ordered are proprietary to Seller. No change, modification, defacement, alteration, reverse engineering decompilations or reproduction of such Software or Firmware products or disclosure of programming content to other parties is allowed without the express prior written consent of SAES. TO THE EXTENT NECESSARY TO MAINTAIN SELLER'S TRADE SECRET, COPYRIGHT, AND OTHER PROPRIETARY PROTECTION OF SUCH SOFTWARE AND FIRMWARE, SUCH ITEMS ARE NOT SOLD HEREUNDER BUT ARE LICENSED TO BUYER.

Trademarks, service marks and other product identifications are SAES's property at all times and shall only be used in connection with SAES's products. Buyer shall not remove or deface any such marks.

Material Safety Data Sheet

1: Identification of substance

Trade Names covered under this MSDS: *MicroTorr* Series, 902 Media

Document number: MSDS-902 *Date o f preparation:* 10/18/11 *Revision: B* *Preparer:* TEB

Manufacturer / supplier: *SAES Pure Gas, Inc.*
4175 Santa Fe Road
San Luis Obispo, CA. 93401
USA
Phone: 1-805-541-9299
Fax: 1-805-541-9399

Emergency information:
In USA: 1-800-424-9300 CHEMTREC®
Outside of USA: +1-703-527-3887 CHEMTREC®

2: Hazard Identification

Hazard Classification:

toxic (T) substance

harmful (Xn) substances

Risk Phrases

R40 Limited evidence of a carcinogenic effect.
R43 May cause sensitization by skin contact.
R49 May cause cancer by inhalation.
R53 May cause long-term adverse effects in the aquatic environment.

Safety Phrases

S02 Keep out of the reach of children.
S22 Do not breathe dust.
S36 Wear suitable protective clothing.
S45 In case of accident or if you feel unwell, seek medical advice immediately (show the label whenever possible.)
S53 Avoid exposure - obtain special instructions before use.
S61 Avoid release to the environment. Refer to special instructions / safety data sheets.

3: Composition/information on ingredients

Chemical characterization description: Metal Alloy Compounds and Formed Zeolites

Ingredients	*CAS No.*	*RTECS*	*Percent by volume*	*Safety Label*
Nickel	7440-02-0	QR5950000	<31	Xn Symbol
Nickel Oxide	1313-99-1	QR8400000	<32	T Symbol
Silica, Amorphous	7631-86-9	VV7565000	<24	*N/A*
Magnesium Oxide	1309-48-4	OM3850000	<13	*N/A*

Emergency Overview: This material is contained within stainless steel sealed purifier vessel(s) and under normal operating conditions, presents no hazards to the user. However, in the event of a vessel breach, material may be exposed and should be handled according to this MSDS sheet. Mis-handling and/or misuse of this material such as cutting, grinding etc. will produce dust or particles. Some of these particles are considered to be spontaneously combustible metals and or flammable solids, therefore, all sources of ignition should be eliminated. This includes; open flames, electric sparks or static electric discharges. Exposure to the dust or particles may present health hazards which are referable to the elemental constituents. See section 8 for specific information regarding Permissible Exposure Levels.

Statement of Hazards: Fire hazard, in the form of dust, when exposed to heat or flame, sparks. Prolonged, chronic, or repeated skin contact may cause irritation, sensitization, dermatitis, and possible destruction and/or ulceration. May cause respiratory irritation, coughing, bronchitis, respiratory tract cancer or lung damage.

Precautionary Statements: Do not breathe dust. Do not get in eyes, on skin, or on clothing. Avoid repeated or prolonged contact. Keep container tightly closed. Wash thoroughly after handling.

4: First aid measures

In the unlikely event of an exposure, follow the appropriate recommendations and obtain medical assistance as needed. *Please provide this MSDS to the health care provider.*

Inhalation	Move victim to fresh air. Apply artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Get medical aid immediately.
Skin Contact	Immediately flush skin with plenty of soap and water for at least 15-20 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists. Wash clothing before reuse.
Eye Contact	Flush eyes with plenty of water for at least 15-20 minutes, occasionally lifting the upper and lower eyelids. Get medical aid if irritation develops or persists.
Ingestion	Never give anything by mouth to an unconscious person. Get medical aid immediately.

5: Fire fighting measures

Extinguishing agents: DO NOT USE WATER, FOAM, OR CO_2. Dousing a metal fire with water may generate hydrogen gas, which is extremely explosive. Burning powders may be controlled by covering with plenty of dry sand, dry soda ash, dry graphite powder, dry sodium chloride, or special dry extinguishing powder for metal fires, class D. It is preferable to smother the fire, if argon is available and it is safe to do so, create an argon blanket that covers the fire to smother it. *Please keep in mind that Argon is a simple asphyxiant and will displace the oxygen in the atmosphere. If the oxygen concentration falls below 19.5%, a self contained breathing apparatus (SCBA) or other atmosphere supplying respirator (ASR) will be required.*

Special instructions: Dusts at sufficient concentrations can form explosive mixtures with air. Open flames, electric sparks, or static electric discharges may cause of ignition. When exposed to excess air and moisture, the oxidation process may generate temperatures high enough to cause combustion. Exposure to atmospheres containing hydrogen and temperatures above 150°C (300°F) will render this product pyrophoric. Exposure of the pyrophoric product to air at room temperature will cause ignition.

Protective equipment: It is recommended that a self-contained breathing apparatus (which is MSHA / NIOSH approved or equivalent) in the pressure-demand mode be utilized along with full protective gear.

Hazardous decomposition: During a fire, irritating and highly toxic gases may be generated from either thermal decomposition or combustion. *See section 10*

6: Accidental release measures

In the unlikely event that material should spill from the vessel, ELIMINATE all sources of ignition. Do not touch or walk through spilled material without utilizing the proper PPE (see section 8).

Personnel Non-emergency personnel should be stay upwind and at a distance. Emergency personnel with the appropriate PPE should only attempt a clean-up if the material is not on fire or generating heat. (if the material is on fire or generating heat, refer to section 5). When conducting clean-up operations, avoid creating dust, breathing dust or coming in contact with the dust in either the eyes or skin.

Environmental precautions Do not allow to enter drainage systems, surface or ground water.

Methods for clean-up Avoid generating dust, while sweeping up the spilled material and place it in a United Nations approved container along with any contaminated clean-up supplies. Once the material is placed in the proper drum, close the container and label it for disposal in accordance with Federal, State, and Local laws. Consideration should be given to creating an inert atmosphere with Argon or other compatible inert gas. Ensure the room has adequate ventilation and sufficient oxygen (>19.5% - <23.5%).

7: Handling and storage

Handling When connecting the vessel to the processing station, ensure good ventilation to minimize the possibility of overexposure to gas being processed by this vessel. Avoid overheating, keep away from sources of ignition, keep away corrosive materials, handle gently, do not shake, do not pulverize, avoid skin contact. Protect against electrostatic charges, keep away from sources of ignition and no smoking while the vessel end caps are open.

Storage Keep closed and store sealed metal containers under inert gas. Store in cool dry area away from incompatible materials (see section 10).

8: Exposure controls and personal protection

These materials are contained within a stainless steel sealed vessel (s) and under normal operating conditions, present no hazard to the user. However, in the event of a vessel breach, the material may be released and should be handled according to this MSDS sheet. Mis-handling and/or misuse of this material such as cutting, grinding etc. will produce dust or particles. Some of these particles are considered to be spontaneously combustible metals and or flammable solids, therefore, all sources of ignition should be eliminated. This includes; open flames, electric sparks or static electric discharges. Exposure to the dust or particles may present health hazards which are referable to the elemental constituents.

Ingredients	*CAS No.*	*RTECS*	*Exposure limits*	*IDLH*
Nickel	7440-02-0	QR5950000	1 mg/m^3	10 mg/m^3
Nickel Oxide	1313-99-1	QR8400000	1 mg/m^3	10 mg/m^3
Silica, Amorphous	7631-86-9	VV7565000	80 $mg/m^3/\%SiO_2$	3000 mg/m3
Magnesium Oxide	1309-48-4	OM3850000	5 mg/m^3 ceiling	500 mg/m^3

Unless otherwise noted, all values are reported as 8-hour Time-Weighted Averages (TWAs) and total dust (particulates only). OSHA PELs refer to 29 CFR section 1910.1000 tables Z-1 through Z-3. Final Rule, NIOSH Publication 2000-130 from July 2000.

Ventilation & engineering controls: Under normal operating conditions, none is required.

Respiratory protection: Where the potential exists for exposures over the exposure limits listed above, use a MSHA / NIOSH approved respirator equipped with a HEPA filter or an Atmosphere Supplying Respirator.

Eye protection: Avoid contact with eyes, wear dust proof goggles when working with powders or dust, unless full face piece respiratory protection is worn.

Hand protection: Avoid skin contact, wear impervious protective gloves.

Body protection: Avoid skin contact, wear impervious protective clothing.

9: Physical and chemical properties

Appearance and odor: Black odorless extrusions ***Physical state:*** Solid

Melting point No specific data available. ***Freezing point*** N/A ***Initial Boiling point/range*** N/A

Flash point N/A ***Evaporation rate*** N/A ***Auto-ignition temperature*** N/A

LEL Not determined ***UEL*** Not determined ***Vapor pressure*** N/A ***Vapor density*** N/A

Relative density 0.9g/cc ***pH*** 10.3 ***Solubility in water*** Insoluble.

Partition coefficient N/A ***Viscosity*** N/A ***Decomposition temperature*** N/A

NFPA 704 M If the specific ingredient has been evaluated by NFPA, it is listed below:

Nickel	Health	4	Fire	2	Reactivity	1	Special None
Nickel Oxide	Health	2	Fire	0	Reactivity	0	Special None
Silica, Amorphous	Health	1	Fire	0	Reactivity	0	Special None
Magnesium Oxide	Health	1	Fire	0	Reactivity	0	Special None

10: Stability and reactivity

Stability: This product is stable under normal shipping and handling conditions. Material is stable when used as specified. However, some of the ingredients when exposed to a non-specified gas, including normal air, will oxidize and may create a fire. *Please review the list below:*

Nickel Potential for a dust explosion if the dust is mixed with air.
Nickel Oxide Stable under normal shipping and handling conditions.
Silica, Amorphous Stable under normal shipping and handling conditions.
Magnesium Oxide Stable under normal shipping and handling conditions.

Conditions to avoid: Overheating and do not allow the vessel to be breached in an uncontrolled fashion.

Incompatibility: Listed below are incompatible materials for each specific ingredient:

Nickel Acids, aluminum, ammonia, ammonium nitrate, bromine pentafluoride, ethylene + aluminum, dioxane, fluorine, hydrazine, hydrazoic acid, methanol, nitric acid, nitryl fluoride, organic solvents, oxidants, phosphorus, potassium per chlorate, selenium, sulfur and compounds.
Nickel Oxide Fluorine, hydrogen sulfide, barium oxide and air.
Silica, Amorphous Magnesium.
Magnesium Oxide Strong oxidizing agents; reacts violently with phosphorous pentachloride, chlorine trichloride, or bromine pentafluoride. Will absorb CO2 from air.

Hazardous decomposition products: Oxides from metallic fires are a severe health hazard. Fire may produce irritating, corrosive and/or toxic gases.

Hazardous polymerization: Under normal conditions, the material is stable.

11: Toxilogical information

Health hazards: Although no specific data exist for this vessel, the components contained with-in it have been evaluated. The following information is based on those individual evaluations and may not be exact:

Effects of Acute and Chronic Exposures

Nickel	Prolonged or repeated skin contact may cause sensitization dermatitis and possible destruction
Exposure effects	and/or ulceration. May cause respiratory tract cancer.
Inhalation	Inhalation of fumes may cause metal fume fever, which is characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increased white blood cell count. Inhalation of a mist of this material may cause respiratory tract irritation.
Skin Contact	May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. May cause severe irritation and possible burns. May cause dermatitis.
Eye Contact	May cause eye irritation and possible burns.
Ingestion	Causes gastrointestinal irritation with nausea, vomiting and diarrhea.
Nickel Oxide	Repeated inhalation is associated with nasal and nasopharyngeal cancer.
Exposure effects	
Inhalation	Causes respiratory tract irritation. May cause allergic respiratory reaction.
Skin Contact	May cause severe irritation and possible burns. May cause dermatitis.
Eye Contact	Causes eye irritation.
Ingestion	Causes gastrointestinal irritation with nausea, vomiting and diarrhea.
Silica, Amorphous	Prolonged exposure to respirable crystalline quartz may cause delayed lung injury/fibrosis (silicosis).
Exposure effects	
Inhalation	May cause respiratory tract irritation. May cause lung damage. Contains crystalline silica which may lead to respiratory abnormalities and silicosis.
Skin Contact	May cause skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	May cause digestive tract disturbances.
Magnesium Oxide	Lethargy, hyporeflexia, weakness, and subjective feeling of thirst and heat may occur. Excessive absorption of magnesium from cathartics may result in CNS depression and
Exposure effects	seizures, most notably in renal failure patients.
Inhalation	May cause respiratory tract irritation. Inhalation of fumes may cause metal fume fever, which is characterized by flu-like symptoms with metallic taste, fever, chills, cough, weakness, chest pain, muscle pain and increased white blood cell count.
Skin Contact	May cause skin irritation.
Eye Contact	May cause eye irritation.
Ingestion	May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause central nervous system depression.

Carcinogenicity Nickel compounds are listed in the IARC group 1 (Carcinogenic to humans)

Reproductive Toxicity None of the ingredients are listed as reproductive toxins to males or females

Teratogenicity the ingredients are not on this list

Embryotoxicity the ingredients are not on this list

Mutagenicity the ingredients are not on this list

Synergistic Products or Effects None known to exist

12: Ecological information

Ecotoxicity No specific data available

Persistence and Degradability No specific data available

Bio accumulative Potential	No specific data available	*Mobility in Soil*	No specific data available
Other Adverse Effects	No specific data available		

13: Disposal

All waste materials should be reviewed to determine the applicable hazards (testing may be necessary). Disposal requirements will vary by location and the type of disposal selected. **NOTE** Chemical additions, processing or otherwise altering this material may make the information provided on this MSDS, incomplete, inaccurate or otherwise inappropriate. As local regulations may vary, all waste must be either disposed, recycled, or reclaimed in accordance with federal, state and local environmental control regulations.

14: Transportation

UN ID Number	UN 2881	*Transportation Class*	4.2 Spontaneously combustable
UN Proper Shipping Name	Metal catalyst, dry, (contains nickel mixture)		
Packing Group	II	*Marine Pollutant*	Not listed as a marine pollutant
Special shipping information	None		

Additional information for Air Transportation IATA
≤ 50 kg is only acceptable cargo aircraft by following package instruction # 473

Additional information for Sea Transportation IMDG
Follow packing instruction: P410
EmS: F-G, S-M
Storage and Segregation: Category C.

15: Regulatory information

US FEDERAL REGULATIONS:
All ingredients are on the TSCA list

16: Other information

Purifiers are determined to be an "article" according to the OSHA Hazard Communication Standard and is thereby excluded from any requirement of the standard. The material safety data sheet is therefore supplied for information purposes only. The information and recommendations contained herein have been compiled from sources believed to be reliable and represent current opinion on the subject. No warranty, guarantee, or representation is made by SAES Pure Gas, Inc. as to the absolute correctness or sufficiency of any representation contained herein and SAES Pure Gas, Inc. assumes no responsibility in connection therewith, nor can it be assumed that all applicable safety measures are contained herein or that other or additional measures may not be required under particular or exceptional conditions or circumstances.

SHIPPER'S DECLARATION FOR DANGEROUS GOODS

(Provide at least three copies to the airline.)

Shipper
NOAH CARTER
SABS PURE GAS
4175 SANTA FE ROAD

SAN LUIS OBISPO CA 93401 US

Air Waybill No. 692139773152

Page 1 of 1 Pages

Shipper's Reference Number
(optional)

Consignee
NORA BOYD
UNIVERSITY OF WASHINGTON
108 N. PHYSICS LAB. BLDG. 354290

SEATTLE WA 98195 US

Two completed and signed copies of this Declaration must be handed to the operator

WARNING

Failure to comply with all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties.

TRANSPORT DETAILS

This shipment is within the limitations prescribed for: *(delete non applicable)*

PASSENGER AND CARGO AIRCRAFT | CARGO AIRCRAFT ONLY

Airport of Departure
SAN LUIS OBISPO

Airport of Destination: SEATTLE 85BFIA

Shipment type: *(delete non-applicable)*

NON-RADIOACTIVE | RADIOACTIVE

NATURE AND QUANTITY OF DANGEROUS GOODS

UN Number or Identification Number, proper shipping name, Class or Division (subsidiary risk), packing group (if required), and all other required information.

UN 2881, Metal catalyst, dry(Contains Nickel Mixture),4.2,II// 1 Fiberboard Box X 0.02 kg//473

Additional Handling Information

CHEMTREC# 19415
I declare that all of the applicable air transport requirements have been met.

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labelled/placarded, and are in all respects in proper condition for transport according to applicable International and National Governmental Regulations. I declare that all of the applicable air transport requirements have been met.

Emergency Telephone Number
8009249300

Name/Title of Signatory
AARON ZAGALA/SHIPPING AGENT

Place and Date
San Luis Obispo, CA USA 08/03/2012

Signature (see warning above)
AARON ZAGALA

FOR RADIOACTIVE MATERIAL SHIPMENT ACCEPTABLE FOR PASSENGER AIRCRAFT, THE SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN OR INCIDENT TO RESEARCH, MED ICA L DIAG NOSIS , OR TREATMENT. ADR EUROPEAN TRANSPORT STATEMENT: CARRIAGE IN ACCORDANCE WITH 1.1.4.2.1

SAES Pure Gas, Inc.
A member of SAES Getters Group
4175 Santa Fe Road
San Luis Obispo, CA 93401

Manufacturer's Certificate of Conformance

SAES Pure Gas, Inc. certifies this product and its construction materials, have been manufactured, inspected, and tested, in accordance with the product and customer specifications.

Purifier Model: MC1-902F SN: V35953

Declaration of Conformity

The Gas Purifier described as:

Model: PS10 Series
PS11-MC/MCD/HP/PG/FT (1-1500)
PS11-MC/MCD3000 (Inert Gases Only)
MC (1-1500)
HP (190 & 400)
SP70

Complies with the essential health and safety requirements of the following directives:

Directive:
Pressure Equipment Directive 97/23/EC, Category SEP

Standards considered:

ASME Sec VIII	Construction of Pressure Vessels
ASME Sec IX	Welding and Brazing

The Authorized Signatory to this declaration, on behalf of the manufacturer, is identified below.
Title: Quality Assurance Representative

Signature: MSW