# Prevent, Protect, Purify: The Benefits of Gas Filtration

Ryan Birney
Online Application Engineer
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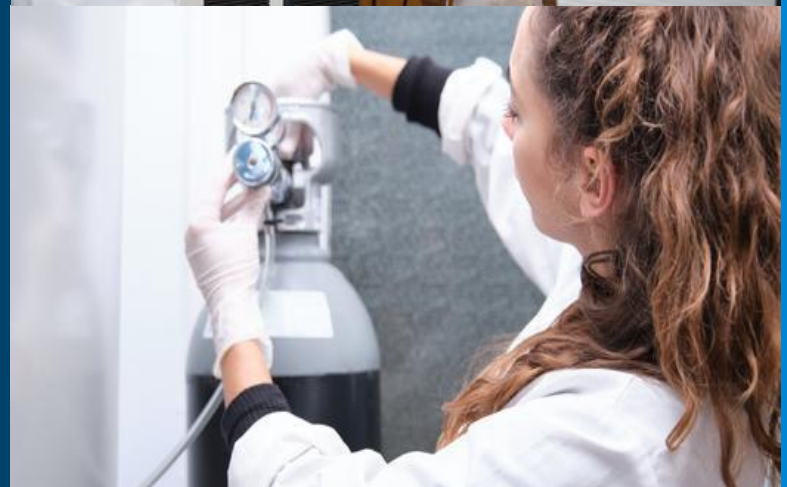


# Agenda

Gas setup – Regulators and plumbing

Prevent – Why filters are used

Protect – Types of filters and options

Purify - Using filters intentionally to purify lower quality gas

# Gas Setup

## Regulators

Agilent systems require two-stage regulators

- Should have a stainless steel diaphragm
- Able to provide 20 psi higher than the pressure required for the method
- Match the CGA number on the gas cylinder with the proper regulator
  - For air, CGA 590 is typically used in labs for chromatography instrumentation
- Always double check your site preparation guides - https://www.agilent.com/cs/library/usermanuals/public/usermanual-gc-siteprep-8890-g3540-90012-en-agilent.pdf

| Gas type | CGA number | Max pressure | Part number |
|---|---|---|---|
| Air (Medical Grade) | 346 | 125 psig (8.6 Bar) | 5183-4641 |
| Air (Zero Grade, for GC applications) | 590 | 125 psig (8.6 Bar) | 5183-4645 |
| Hydrogen, Argon/Methane | 350 | 125 psig (8.6 Bar) | 5183-4642 |
| Oxygen | 540 | 125 psig (8.6 Bar) | 5183-4643 |
| Helium, Argon, Nitrogen | 580 | 125 psig (8.6 Bar) | 5183-4644 |

# Gas Setup

## Tubing/plumbing

### Tubing

- Only use preconditioned copper tubing
- 1/8 in tubing for up to 15 ft (part number 5180-4196)
  - If >15 ft or in high demand, use 1/4 in

- Stainless steel tubing is recommended for hydrogen lines (CP4026)
  - Always use new lines when setting up a hydrogen line
    - Replace existing lines if switching to hydrogen from another carrier
  - Never use old copper tubing with hydrogen gas, it can create a safety hazard
  - If running hydrogen as a carrier for MS, be sure to review our user guide
    - We have a new Agilent HydroInert source specifically for hydrogen carriers
    - Follow the guide carefully
    - https://www.agilent.com/cs/library/usermanuals/public/user-guide-coverting-ei-gcms-instruments-5994-2312en-agilent.pdf

# Gas Setup

## Connections

- **Do not** use pipe dope, liquid sealant, PTFE tape, or chlorinated/halogenated solvents on tubing or fittings
  - An exception is PTFE tape - this is needed to seal the NPT connection at the regulator (0460-1266)

- Agilent uses Swagelok fittings for connections to the instrument
  - Our regulators ship with a 1/4 in NPT to 1/8 in Swagelok adapter

| Description | Part number |
|---|---|
| Swagelok 1/8-inch to female 1/4-inch NPT, brass | 0100-0118 |
| Swagelok 1/4-inch to female 1/4-inch NPT, brass | 0100-0119 |
| Reducing union, 1/4-inch to 1/8-inch, brass, 2/pk | 5180-4131 |

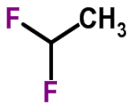
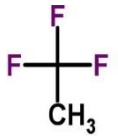
- We often recommend ordering an install kit that comes with connections and parts used in plumbing setup, such as:
  - 1/8 in brass nut and ferrule set, 20/pk, 5080-8750
  - 1/8 in tee, brass, 2/pk, 5180-4160
  - 1/8 in cap, brass, 6/pk, 5180-4121

# Use a Leak Detector or Electronics Duster to Find Your Leaks

## Why use a leak detector?

- High sensitivity for helium and hydrogen
- Recommended for leak detection in gas plumbing and fittings

**Typical Electronic Duster Components and Ions**

| | | |
|---|---|---|
|  | 1,1-difluoroethane | *m/z* 51,65 |
|  | 1,1,1-trifluoroethane | *m/z* 69 |
|  | 1,1,1,2-tetrafluoroethane | *m/z* 69,83 |

Use an electronics duster – MS only

Hold the can upright (don’t spray the liquid)

Spray short bursts around the possible leak points

“Live” tune profiling for ions to pinpoint the leak

# Agilent CrossLab CS (Cartridge System)

## No peaks from leaks

Features:

- Exchangeable cartridge with ADM Flow Meter
- Automatic notification of probe filter replacement
- Ergonomic and robust design
- Universal 3AA or USB power
- USB connects to web interface for added functionality and firmware updates
- Easy-to-view OLED screen
- Kickstand

Leak detector cartridge

Handheld


ADM Flow Meter cartridge

# Ordering Guide

G6693A – CrossLab CS Electronic Leak Detector

G6694A – Electronic Leak Detector cartridge

G6699A - CrossLab CS Bundle: ADM Flow Meter and Electronic Leak Detector

- The bundle will include one handheld, two cartridges, and a free carrying case.

G6694-60005 – Replacement probe filter

G6691-40500– Carrying case


Existing products:

G6691A – CrossLab CS ADM Flow Meter

G6692A – ADM Flow Meter cartridge*

- Note that the ADM Flow Meter cartridge is ordered annually for calibration.
  The Electronic Leak Detector does not need to be recalibrated.

# Prevent

## Why filters are used

# Gas Quality

GC instruments require 5.0 grade gas or above

- Verify your specific instrument needs using a site preparation guide
  - https://www.agilent.com/cs/library/usermanuals/public/usermanual-gc-siteprep-8890-g3540-90012-en-agilent.pdf
- What does this mean?
  - 99.9995% or greater
  - Typically called “ultra high purity”
    - Do not mistake “high purity” or “instrument grade”, which are typically 4.0 grade, with high concentrations of moisture and hydrocarbons

| Carrier, collision and reagent gas requirements | Purity | Notes |
|---|---|---|
| Hydrogen (carrier) (carrier and self-cleaning ion source) | 99.9995% | SFC grade |
| Nitrogen (carrier) | 99.9995% | |
| Nitrogen (drying gas, nebulizer pressure)* | 99.999% | Research grade |
| Methane reagent gas† | 99.999% | Research or SFC grade |
| Isobutane reagent gas‡ | 99.99% | Instrument grade |
| Ammonia reagent gas‡ | 99.9995% | Research or SFC grade |
| Carbon dioxide reagent gas‡ | 99.995% | SFC grade |
| Methanol** | 99.9% | Reagent grade. Purge and trap grade recommended. |

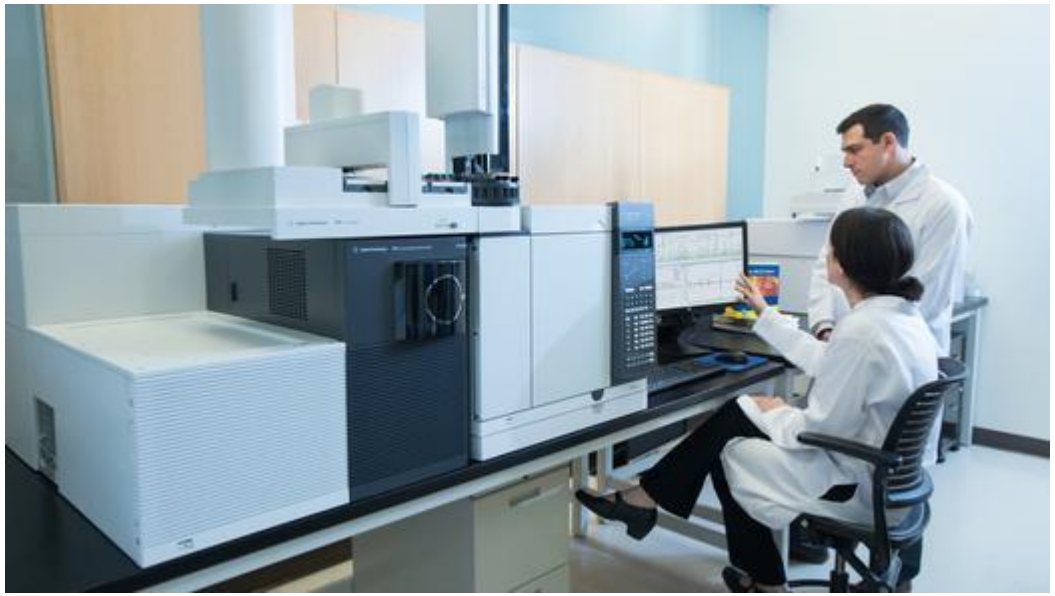
* Purity specification is the minimum acceptable purity. Major contaminants can be water, oxygen, or air. Drying gas and nebulizer pressure gas can be supplied by a nitrogen gas generator, house nitrogen system, or liquid nitrogen dewar.

† Required reagent gas for installation and performance verification, external CI MS only. The 5975 and 5977 operate in an external CI mode. The 5975, 5977, 7000 GC/MS, and 7200 Q-TOF MS operate in an external CI mode. The 5975 operates in an external CI mode.

‡ Optional reagent gases, CI mode only.

** Required reagent for performance verification in internal CI mode only. Evaporation residue <.0001%.

# Impact on the System

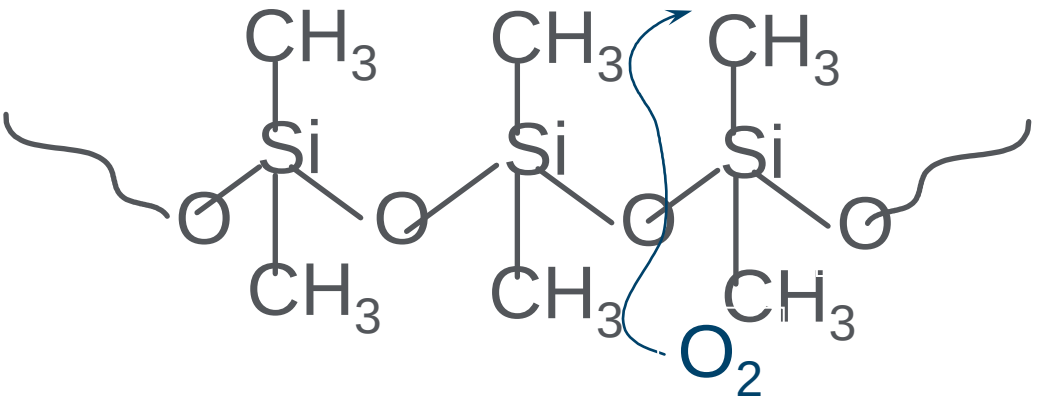


What could go wrong?

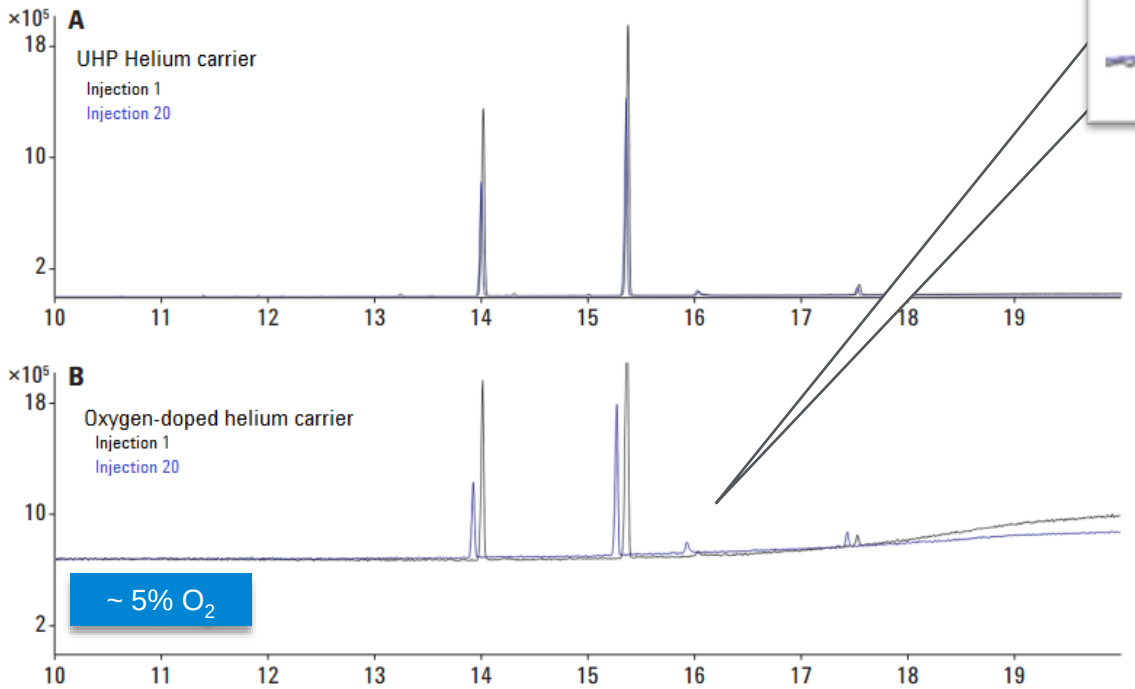
- Oxidative compounds
  - Column bleed and active sites
- Hydrocarbons and halocarbons
  - Contamination of inlet and detector
  - High or unstable baselines
  - Aberrant peaks
- Moisture
  - Wash out nonbonded stationary phases
  - Contamination/poor response, especially with some polar analytes
- Detector-specific issues
  - ECDs require low oxygen and moisture levels
  - SCD contamination leads to ceramic contaminations dropping sensitivity
  - MS will see increased source degradation, lower sensitivity, poor mid and high mass transmissions
  - Moisture can lead to FID flame outs

# Oxidation (O2 Damage)

Oxygen in the carrier gas rapidly degrades the stationary phase. The damage is accelerated at higher temperatures. Damage along the polymer backbone is irreversible. (Premature filament failure/excessive source maintenance.)



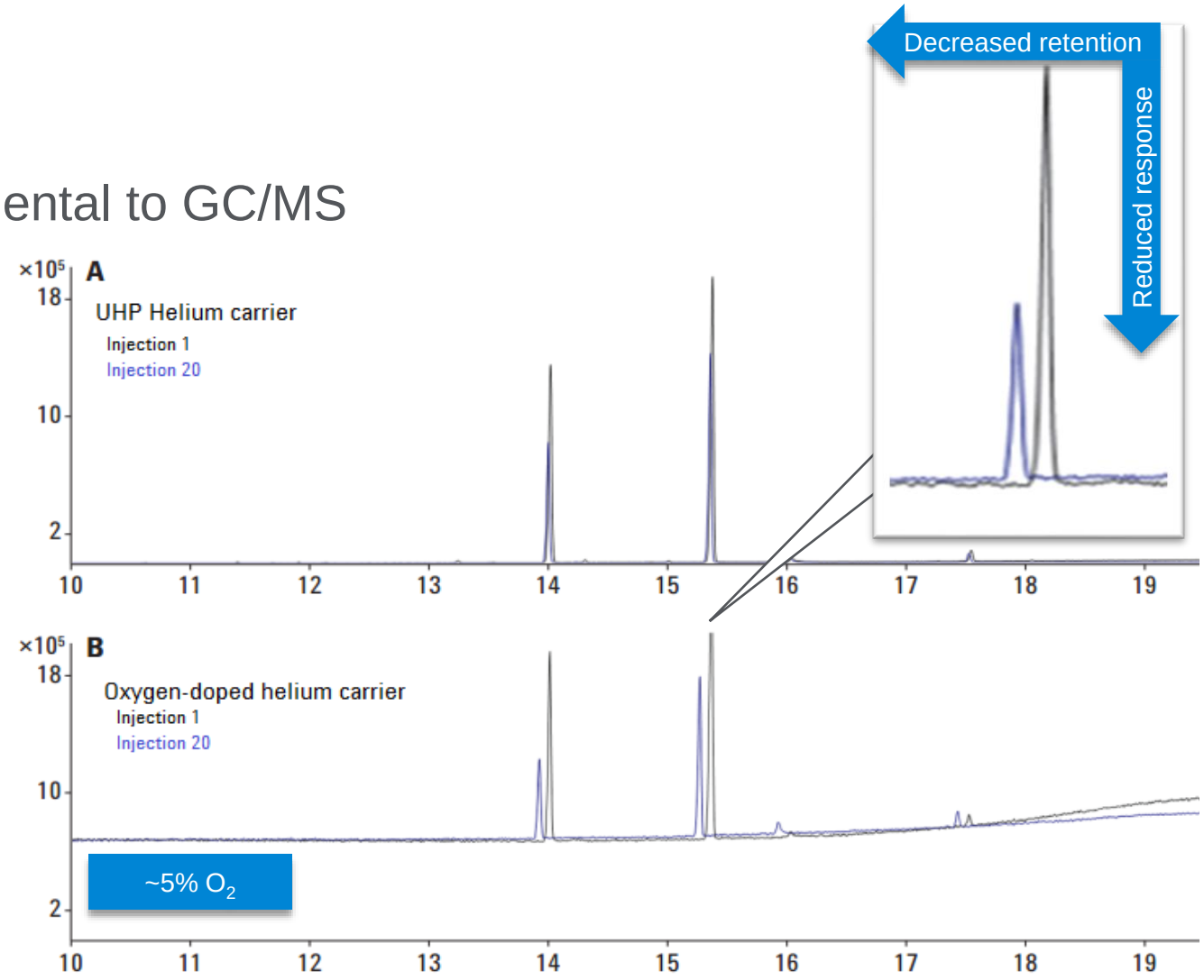

Dimethylpolysiloxane



# Oxygen Damage

- Oxygen in the carrier gas is detrimental to GC/MS
  - Reduced response
  - Elevated background
  - Irreversible column damage
  - Impaired electron multiplier function
  - Premature filament, liner lifetime

- Use UHP carrier gases
  - 99.9995% or greater
- Use Gas Clean carrier gas filters




GC/MS filter
Agilent p/n
CP17973

# Non-GC systems

## LC/MS systems

- Typically, you do not need the purity grades of GC and GC/MS systems
  - Be sure to verify with your specific system's site preparation guide

## ICP systems

- OES systems, like LC/MS systems, typically do not require purity levels of GC
- MS systems vary based on the gas and usage
  - MS systems may require different regulators. Full stainless steel, high purity regulators are needed for semicon work, as well as for cell gas.
  - Cell gas lines should only use stainless steel (Agilent p/n G3270-65035)

# Protect

## Types of filters and filter options

# Gas Management

Inline gas purifiers

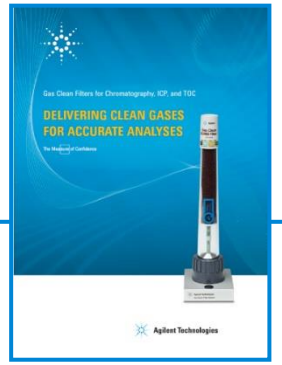
- Big traps 750 mL
- Combination traps
- Universal traps

Gas Clean purification system

- Carrier gas filter: $O_2$, $H_2O$, HC
**Shipped with every GC/MS SQ**

- $O_2$ specific
- $H_2O$ specific
- Hydrocarbons

Ordering guide
5990-8243EN




ReNEWable filter

Single GC/MS cartridge for
$O_2$, $H_2O$, hydrocarbons

# General Installation and Use of Filters

- Install all traps vertically – use the appropriate mounting bracket(s) for your trap
  - Flow should go from the top down
  - Do not place the filter horizontally

- For disposal, always check the safety data sheet (SDS) and dispose of the contents and container in accordance with all local, regional, national and international regulations

# Filter Types

## Inline gas purification

Connected directly to the gas lines

- To change or install a filter, you must stop the gas flow
- Typically, they have a large capacity compared to other options
  - Example of our Big Universal Traps (last ~13 “K” sized tanks):

| Capacity Data | | |
|---|---|---|
| **High Purity Helium-99.997%** | | **Removal Capacity** |
| $O_2$ | < 5 mg/L | 1.07 L |
| THC* | < 1 mg/L | 20 g |
| $H_2O$ | < 5 mg/L | 46 g |

*Total Hydrocarbons, analysis limited to three contaminant groups

| Effluent Concentration | | | |
|---|---|---|---|
| **Research Grade Helium-99.9999%** | | | |
| Impurities | < 1 mg/L | $H_2O$ | < 0.2 mg/L |
| $N_2$ | < 0.5 mg/L | $H_2$ | < 0.2 mg/L |
| $O_2$ | < 0.5 mg/L | Ar | < 0.1 mg/L |
| THC* | < 0.1 mg/L | Ne | < 0.5 mg/L |
| $CO+CO_2$ | < 0.1 mg/L | | |

*Total Hydrocarbons, analysis limited to three contaminant groups

Big moisture trap

Hydrocarbon Moisture trap

Refillable moisture trap MT120

# Filter Types

## GasClean purification system

Connect to a baseplate, which is plumbed inline with gas

- Does not require turning off the gas upstream
  - Internal valving system turns off the flow when the filter is not in place
  - Quick and easy to change
  - Less chance of leaks or atmosphere entering the line
  - Indicators for oxygen and moisture

GC/MS filter
Agilent p/n
CP17973

**Gas Clean Filters Technical Specifications**

| Description | Function | Indicator Color Change | Capacity | Outlet Concentration (at operating flow of 1-10 L/min) |
|---|---|---|---|---|
| **Oxygen Filter** | Removes oxygen as well as traces of sulfur and chlorine compounds from carrier gas | From green to gray | 150 mL oxygen | < 50 µg/L |
| **Moisture Filter/Process Moisture Filter** | Removes water, oil, and other foreign material from the carrier gas | From green to pale brown | 7.2 g water | < 0.1 mg/L |
| **Charcoal Filter** | Removes organic compounds from gas streams | No indicator | Approximately 7 g, depending on impurities | < 0.1 mg/L |
| **GC/MS Filter** | Single combination filter, removes water, oxygen, and organic compounds | Oxygen, from green to gray; Moisture, from green to pale brown | 100 mL oxygen, 1 g water, organics depending on impurities | Oxygen < 50 µg/L<br>Moisture < 0.1 mg/L<br>Organics < 0.1 mg/L |
| **$CO_2$ Filter** | Removes $CO_2$ from the gas stream; use with moisture filter | From white to violet | 9 g $CO_2$ | < 1 mg/L |

# Filter Types

## GasClean

GasClean uses a base plate and a filter, ordered separately.

- Base plates come with 1/4 or 1/8 in fittings.
  - Options of one, two, or four positions for the filters.
- Filters come as:
  - Carbon dioxide
  - Oxygen
  - Moisture
  - Charcoal
  - Triple filter of oxygen, moisture, charcoal
- P/ns found in our brochure - https://www.agilent.com/cs/library/brochures/5990-8243ENGasCleanFilters.pdf

# Gas Trap Indicators Help Tell You When It's Time to Change Them



**Agilent GasClean Sensor**
(Agilent 8890 and 8860 GCs)

If there are no indicators, then change them periodically or according to your SOP.

# Filter Types

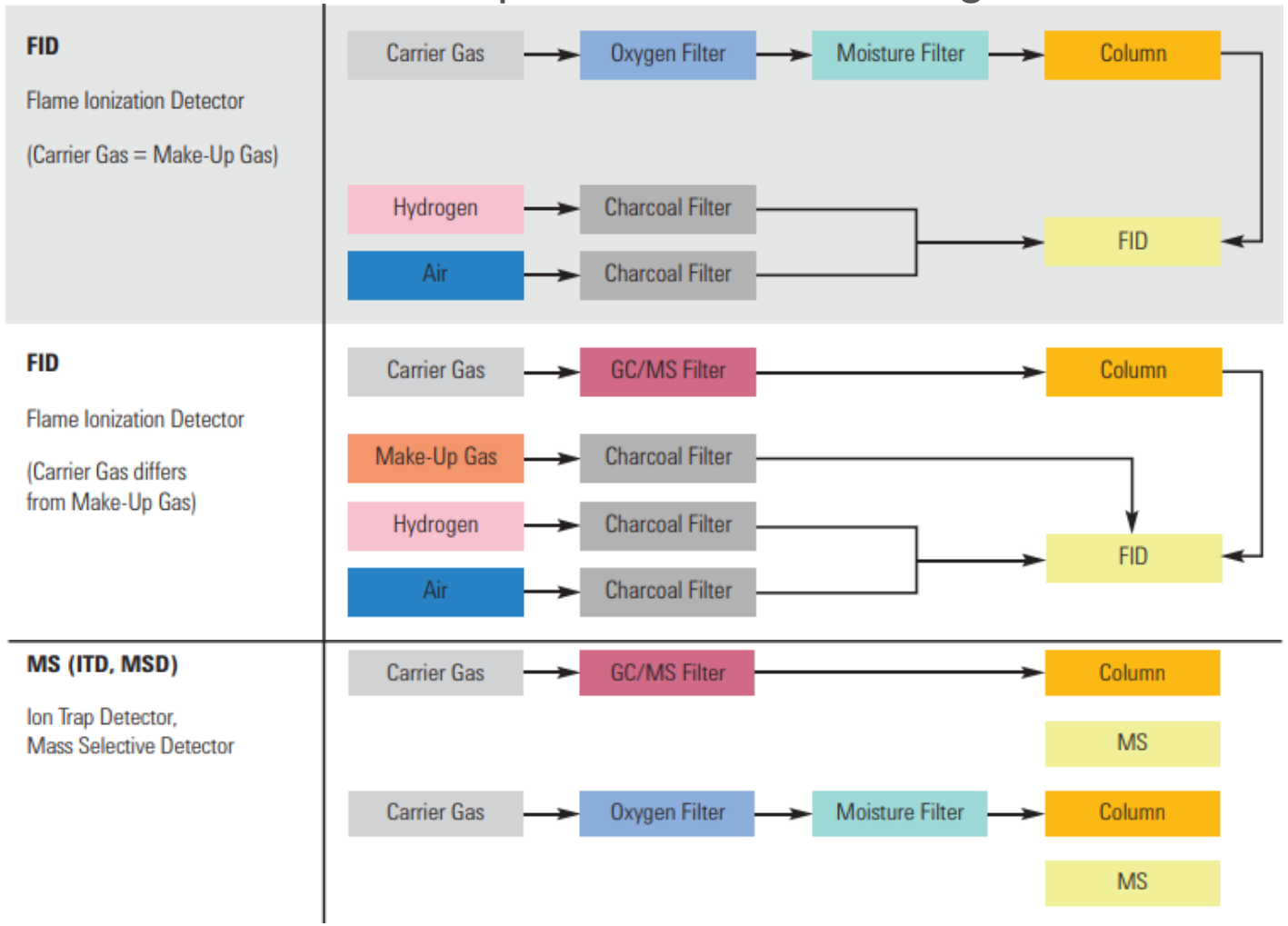
## ReNEWable gas purification system

Connects to a special mounting bracket

- Combination trap for oxygen, moisture, and hydrocarbons
  - Can be returned to Agilent and recycled
    - This process is supported by our orders team, please contact them for returns and reordering
  - Large capacity
    - 850 cc or more oxygen filtration, 12 g $H_2O$, and approximately 8 g hydrocarbon filtration per cartridge

# Examples of Different Setups for Systems

Different filters are required, based on the gasses used and how they are being used:




- Moisture traps are typically last in line
- Always mount traps vertically, plumbed top down

# Find Recommended Filters

We have a few resources to find filters for your specific system

- GasClean Manual - https://www.agilent.com/cs/library/usermanuals/public/GasCleanFilter_5973-1528.pdf
- GasClean Selection Tool - http://gascleanfiltertool.chem.agilent.com/
- Agilent catalog - https://www.agilent.com/cs/library/catalogs/public/5991-1056EN%20General%20Catalog.pdf

# Non-GC Systems

## LC/MS systems

- A universal inline trap is used for the nitrogen line on LC/MS systems
  - RMSN-4 for drying gas
    - Two run in parallel for Agilent Jet Stream sources due to increased flow
      - Uses T-unions (p/n 0100-0088) to split and rejoin flows
  - RMSN-2 for collision cells
  - Gas lines are run with 1/4 in PTFE tubing (p/n G1946-80078)

## ICP systems

- A universal trap is used to protect against possible supply contamination and leaks
  - GasClean universal filter is recommended for argon and each cell gas

# Purify

## Using filters intentionally to purify lower quality gas

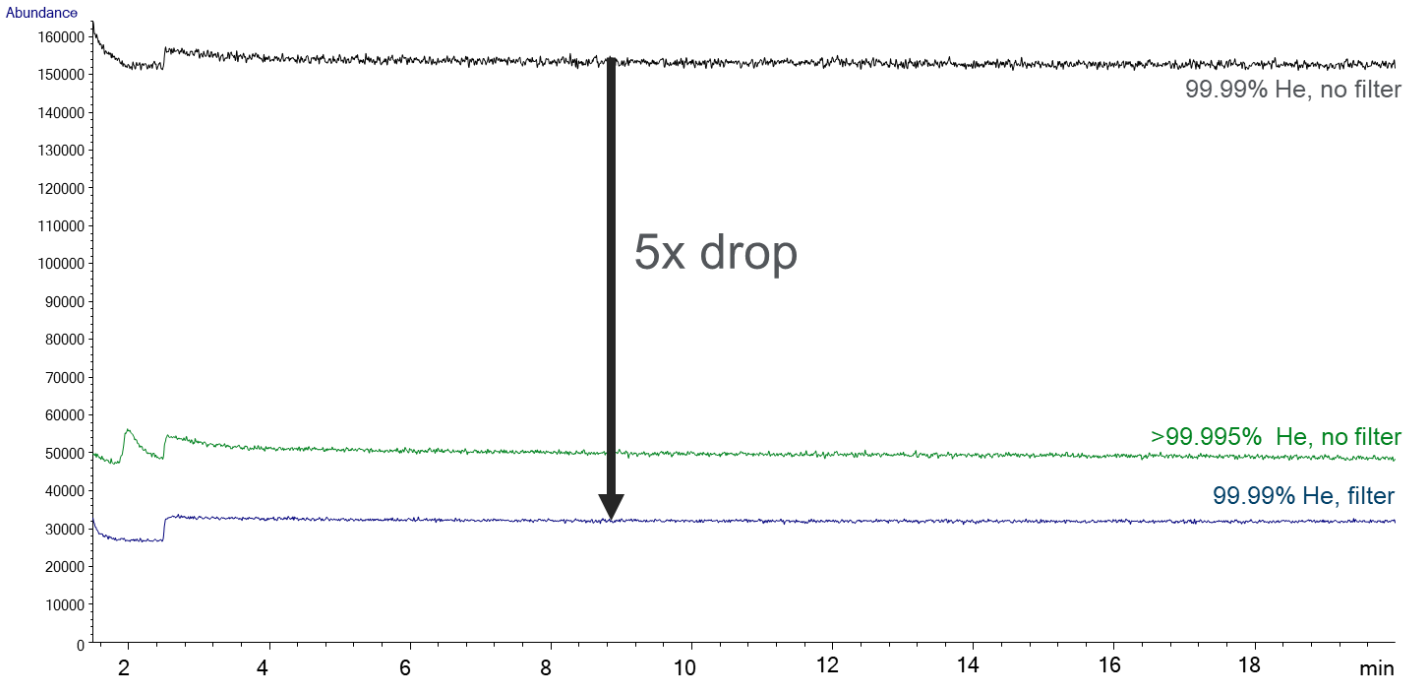
# Let’s Talk About Gas Quality and Filters

If lower quality gases were used, how much background could the filter clean up?

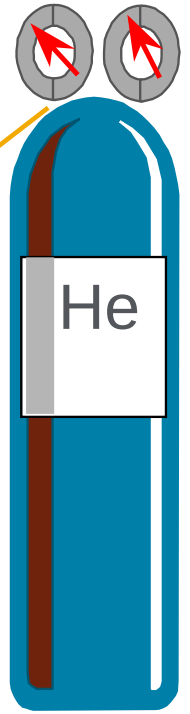

- Extend the lifetime of your Gas Clean (indicating) filter **and** your column

# Let's Talk About Gas Quality and Filters

## If you used lower quality gases, how much $O_2$ could the filter clean up?



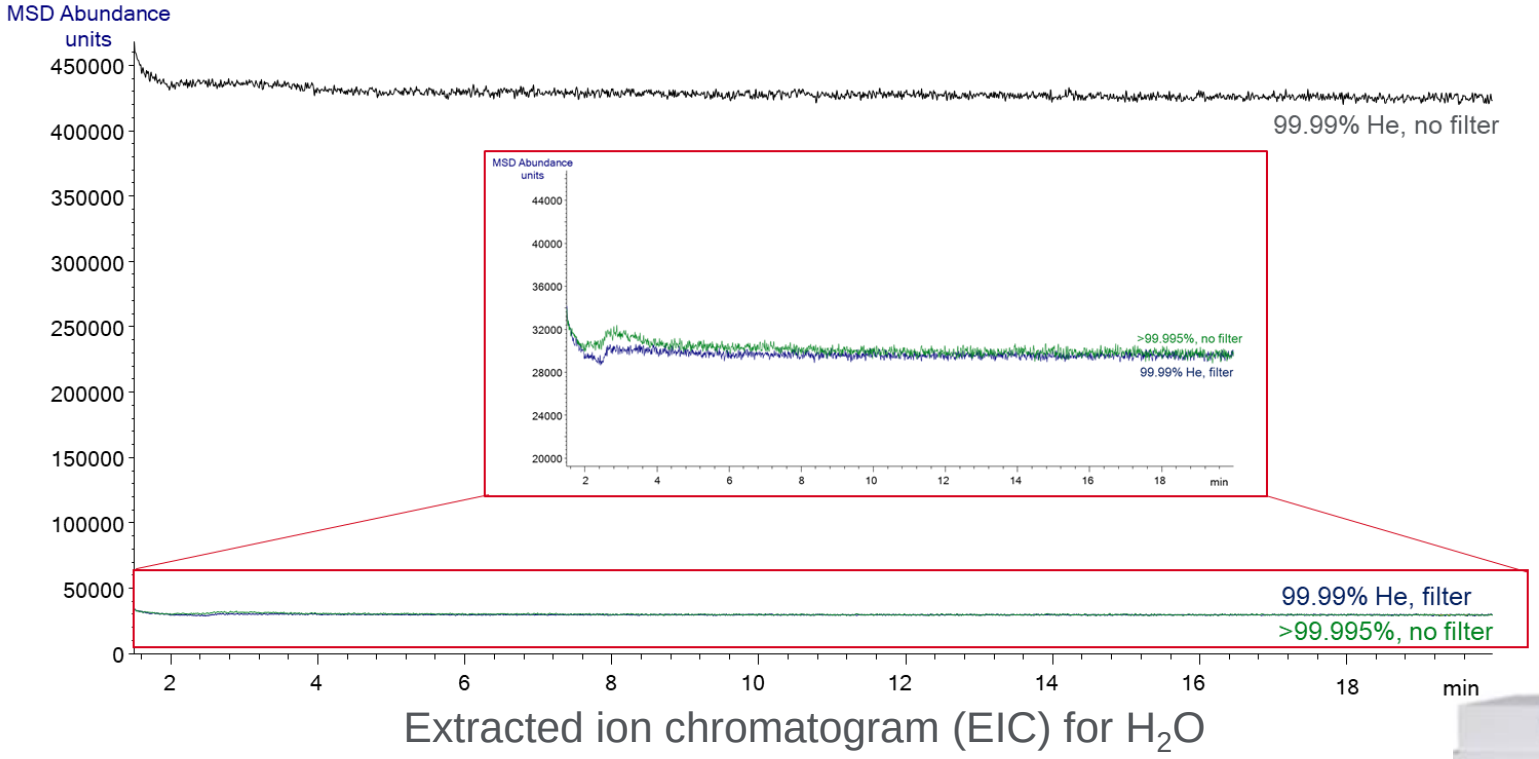

Extracted ion chromatogram (EIC) for $O_2$



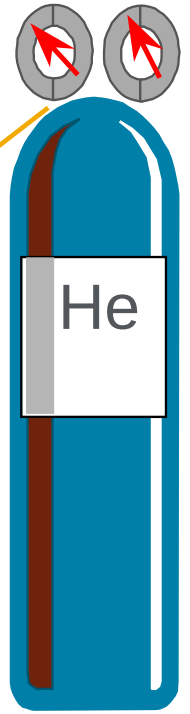

Installing (and properly purging) the Gas Clean carrier gas filter lowers the $O_2$ signal by a **factor of 5**.

# Let's Talk About Gas Quality and Filters

## If you used lower quality gases, how much $H_2O$ could the filter clean up?




Extracted ion chromatogram (EIC) for $H_2O$




Gas Clean filter lowered the $H_2O$ signal by a **factor >10**.

You can further increase the Gas Clean filter and column lifetime by installing the universal filter before the Gas Clean filter.

# Helium Purity Grades and Gas Clean Filter Impact

| Helium | Grade | Purity | Gas Clean | Water (ppb) | Oxygen (ppb) | HCs (ppb) |
|---|---|---|---|---|---|---|
| HP | 5.0 | 99.999% | No | **≤1000** | **≤2000** | **≤500** |
| UHP (MS) | 6.0 | 99.9999% | No | **≤1000** | **≤1000** | **≤500** |

**Impurities as per BOC UK specification**

Using Gas Clean filters

| Helium | Grade | Purity | Gas Clean | Water (ppb) | Oxygen (ppb) | HCs (ppb) |
|---|---|---|---|---|---|---|
| HP | 5.0 | 99.999% | **Yes** | **≤50** | **≤100** | **≤100** |
| UHP (MS) | 6.0 | 99.9999% | **Yes** | **≤50** | **≤100** | **≤100** |

- Gas purity assured even in presence of small leaks
- Lowering laboratory costs, upgrading lower purity gases
  - In general, we still recommend UHP, and never go below HP

# “The Secret to Dramatically Reducing GC/MS Running Costs” Programmable PDF

Calculator Download

Use this interactive worksheet to calculate how much you could save on GC maintenance by extending the life of your columns and supplies.

Clear fields

| | Parameter | Details | Enter values here. To enter the values, open this PDF in the Adobe Acrobat App. | |
|---|---|---|---|---|
| A | Labor cost per hour | What are the hourly wages for your GC analytical chemist? | » | $ per hr |
| B | Column change frequency | How often do you change the column per GC per year? | » | Instances per year |
| C | Column replacement time | How long does it take to replace a column and then condition the system, adjust the retention time windows, and run a system check standard? | » | minutes |
| D | Column cost | How much do you pay for a new GC column? | » | Avg price ($) per column |
| E | Total cost of column replacement per year (D x B +(A x B x C /60)) | | | $ |
| F | Supply component change frequency | How many times do you change your inlet liners, gold seals and septa per month? | » | changes per month |
| G | Supply component maintenance time | How long does it take to change an inlet liner, gold seal, septa (including time required for cooling oven)? | » | minutes |
| H | Supply component cost | How much do you pay for a new liner, seals, and septum? | » | $ |
| I | Total cost of liner/gold seal/septa replacement per year (H x (F x 12)) + (A x (F x 12)) x (G/60)) | | | $ |
| | Rows J-M are relevant only for GC-MS. Enter 0 in each field if you are not using a GC-MS | | | |
| J | Filament change frequency | How many MS filaments do you change per year? | » | MS filaments per year |
| K | Filament change maintenance time | How long does it take to change filaments (including MS pump down)? | » | minutes |
| L | Filament cost | How much do you pay for a new MS filament? | » | Avg price ($) per filament |
| M | Total cost of filament replacement per year (L x J + (A x K/60) x J ) | | | $ |
| N | Number of GCs | How many GCs do you have in your lab? | » | GCs |
| O | Impact of Gas Clean Filters | Gas Clean Filters can prolong the life of columns & supplies. Enter a value between 10-30% to see what impact increasing their life will have on your bottom line. | » 25 | % |
| P | Cost savings per year likely due to Gas Clean Filters (E + I + M) x N x O/100 | | | $ |

# Contact Agilent Chemistries and Supplies Technical Support

1-800-227-9770 option 3, option 3:

Option 1 for GC and GC/MS columns and supplies

Option 2 for LC and LC/MS columns and supplies

Option 3 for sample preparation, filtration, and QuEChERS

Option 4 for spectroscopy supplies

Option 5 for chemical standards

Available in the U.S. and Canada 8–5, all time zones

gc-column-support@agilent.com

lc-column-support@agilent.com

spp-support@agilent.com

spectro-supplies-support@agilent.com

chem-standards-support@agilent.com