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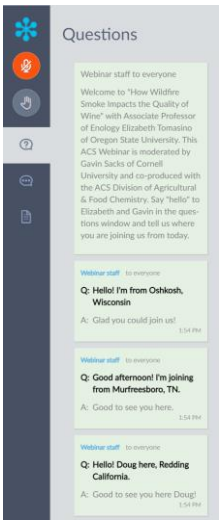

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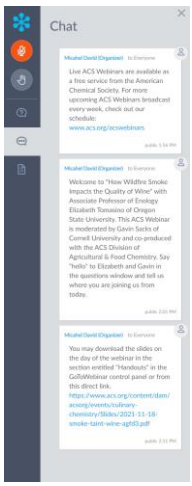

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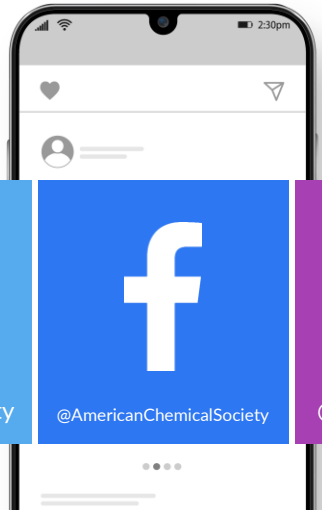

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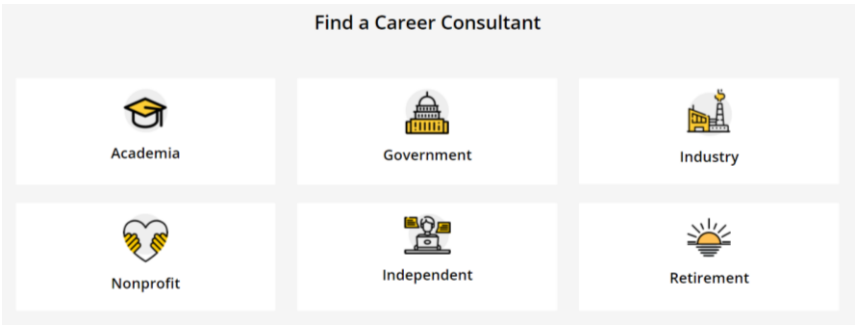

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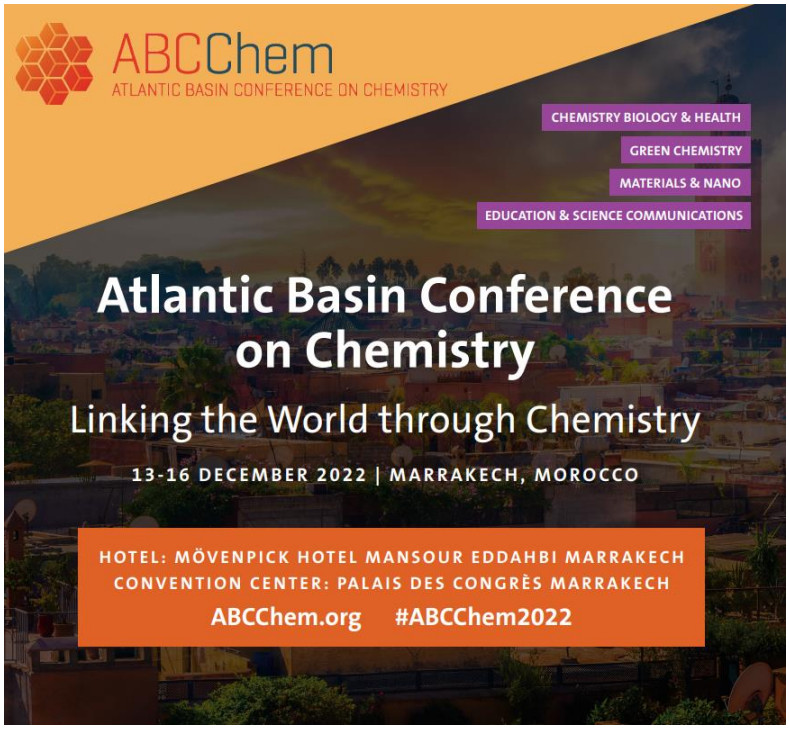

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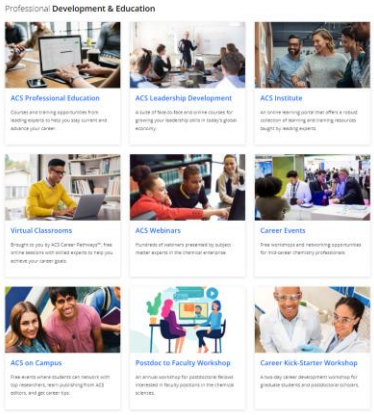

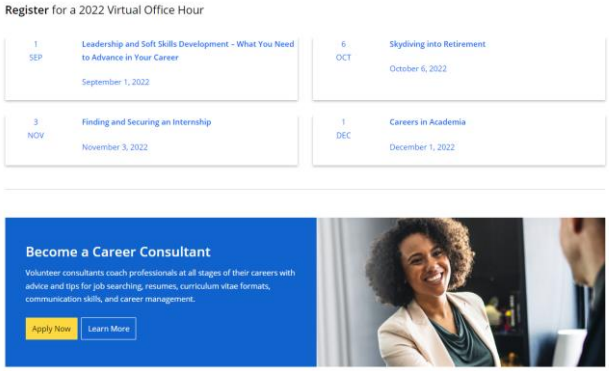

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Advancing ACS' Core Value of Diversity, Equity, Inclusion and Respect

Resources

Inclusivity Style Guide
Designed to help staff and members use language and images that respect diversity in all its forms.

ACS Webinars on Diversity
Covering diversity and inclusion at the workplace

ACS Publications DEIR Hub
See what ACS Publications is doing for fostering inclusivity in scholarly publishing

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Learn more about what Inclusion Moments are and see ideas to host them during your meetings.

Quick Guide: How to host inclusive in-person events
Recommendations and best practices to ensure that your events can accommodate everyone.

Diversity, Equity, Inclusion, and Respect
**Adapted from definitions from the Ford Foundation Center for Social Justice:

Equity**
Seeks to ensure fair treatment, equality of opportunity, and fairness in access to information and resources for all. We believe this is only possible in an environment built on respect and dignity. Equity requires the identification and elimination of barriers that have prevented the full participation of some groups.

Diversity**
The representation of varied identities and differences (race, ethnicity, gender, disability, sexual orientation, gender identity, national origin, tribe, caste, socio-economic status, thinking and communication styles, etc.), collectively and as individuals. ACS seeks to proactively engage, understand, and draw on a variety of perspectives.

Inclusion**
Builds a culture of belonging by actively inviting the contribution and participation of all people. Every person's voice adds value, and ACS strives to create balance in the face of power differences. In addition, no one person can or should be called upon to represent an entire community.

Respect
Ensures that each person is treated with professionalism, integrity, and ethics underpinning all interpersonal interactions.

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Switch your GC from Helium to Hydrogen: Save Time, Money, and the Planet!

LEE N. POLITE, PhD, MBA

President and Founder, Axion Analytical Labs, Inc. and Axion Training Institute, Inc.

BRYAN TWEEDY, BS

Assistant Director, ACS Education, Office of Career and Professional Education, American Chemical Society

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How to Switch Your GC Carrier Gas from Helium to Hydrogen:

Save Time…Save Money…Save the Planet!

Axion Analytical Laboratories, Inc.
Training Institute, Inc.

Dr. Lee N. Polite
Axion Analytical Labs, Inc.
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info@axionlabs.com

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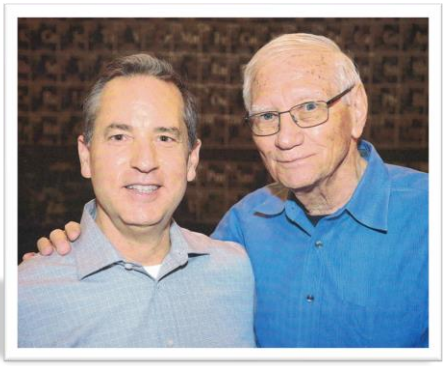
Professor Harold M. McNair (1933-2021)



- Built the first GC in the US…with the Nobel Prize winner AJP Martin
- Lived with the first and last men to walk on the moon (Neil and Gene)
- Expert witness for Howard Hughes “Mormon Will” Trial
- Chief science consultant to FBI and FDA
- Put 2 GC/MS’s on Mars in 1975
- Helped start the 2 biggest GC companies in the world before he turned 35

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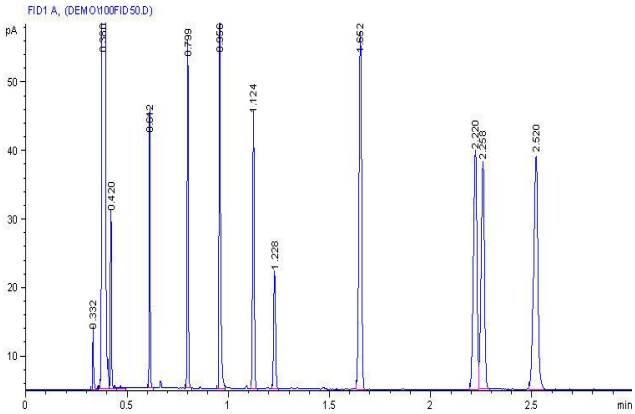
Gas Chromatography – The World's Most Popular Analytical Tool

GC can identify and quantify a wide variety of volatile organic compounds

Chromatograph

Chromatogram



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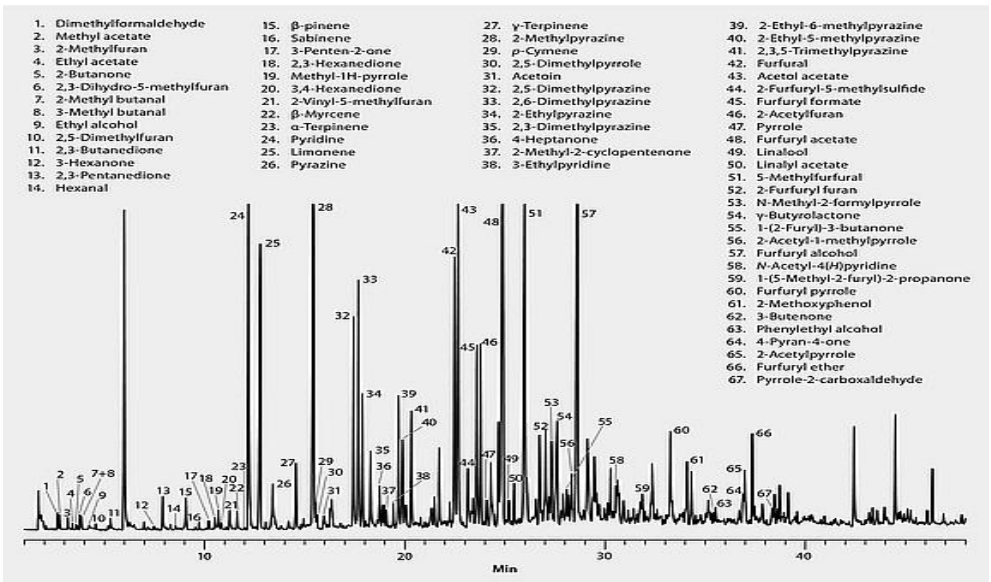
How Does GC Work?

by Separating Mixtures into Pure Compounds

Coffee Aroma Analysis by GC



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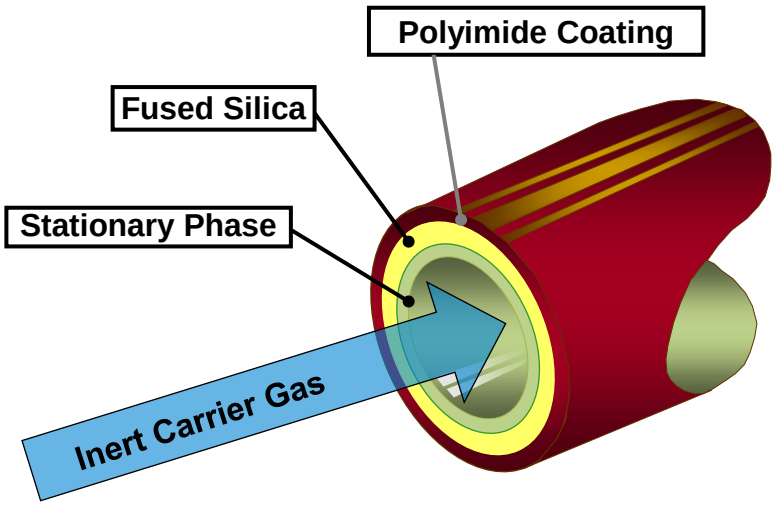
How Does GC Separate?

Analytes partition in and out of the stationary phase based on their relative affinity.



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How Do Separations Really Work?

- Most people expect GC separations to be really complicated, but there are only 3 parameters that affect the separation!
- The choice of carrier gas plays a minor roll in the separation.
- **And here's the best part**: YOU are in charge of all 3 parameters, so YOU are in charge of the separation.
- **So let's take a closer look** at these 3 parameters and how to set them properly.

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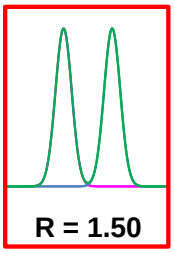
GC Master Resolution Equation



$$R_s = \left(\frac{k}{1+k}\right) x \left(\frac{\alpha - 1}{\alpha}\right) x \frac{\sqrt{N}}{4}$$

Resolution	Capacity Factor	Selectivity	Efficiency ("Peak Skinniness")
R>1.50	1 < k < 5	α > 1.05	Avg ~ 20,000 Max ~ 400,000
Equation	$k = (t_r - t_0)/t_0$	$\alpha = k_B/k_A$	$N = 5.545 \times \left(\frac{t_r}{W_h}\right)^2$
How do you improve it?	Lower Column Temperature: • Decrease by 25°C • Double the k!	Purely a function of the Stationary Phase	• Longer Column • Smaller Diameter • Thinner Film • Optimize Flow Rate • Column Installation

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What About the Choice of Carrier Gas?

- Has absolutely no effect on capacity factor (k')
- Has no effect on selectivity (α)!
- Has a minor effect on efficiency (Van Deemter Equation)

The Ideal Carrier Gas is:

- Inert
- Low Molecular Weight
- Low Viscosity
- Inexpensive
- Readily Available
- Hydrogen

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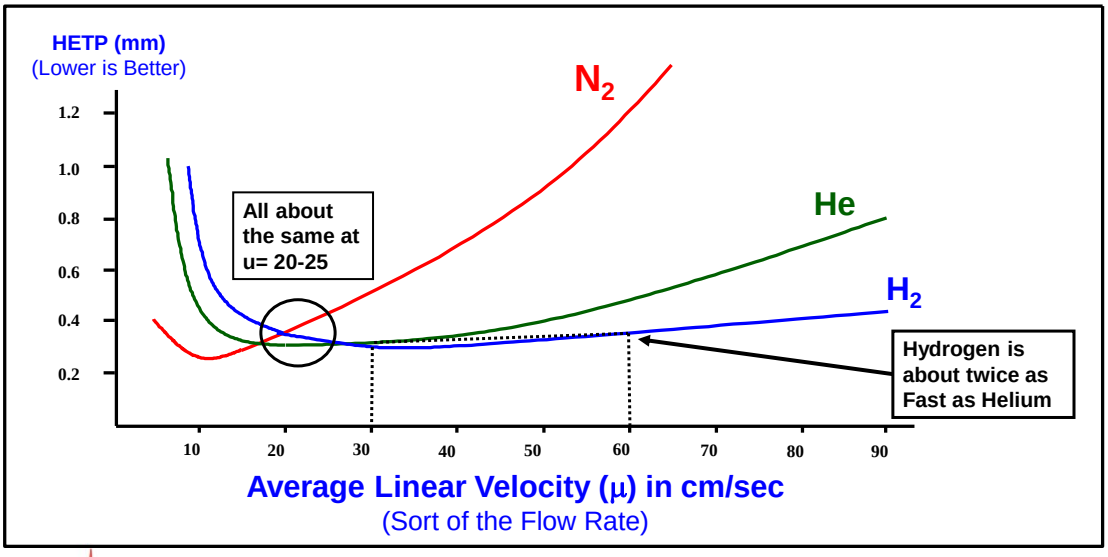
Type of Carrier Gas Effect on Efficiency – Van Deemter Plot



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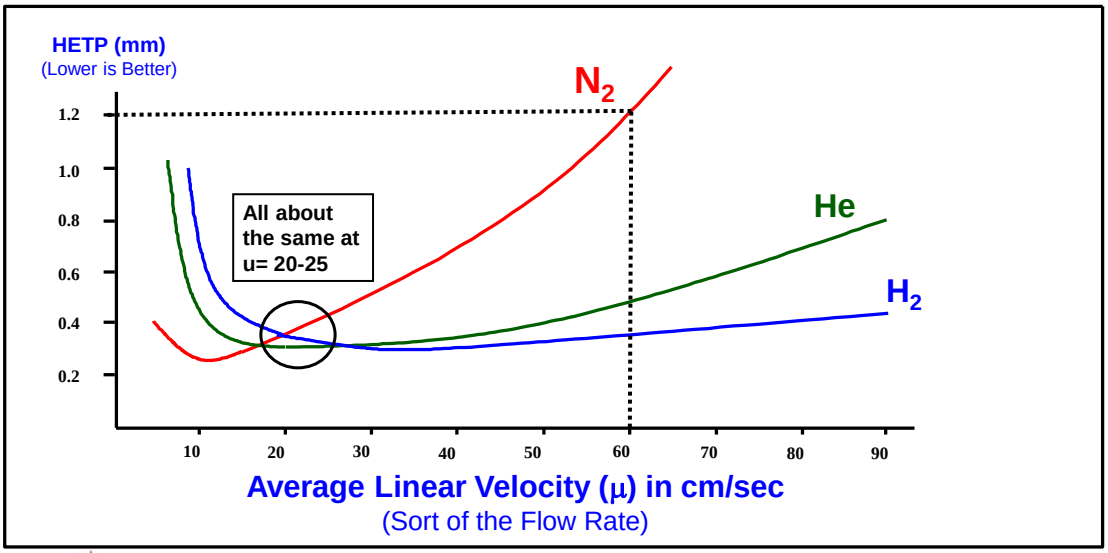
What About Nitrogen: Not Ideal, but It's Free!



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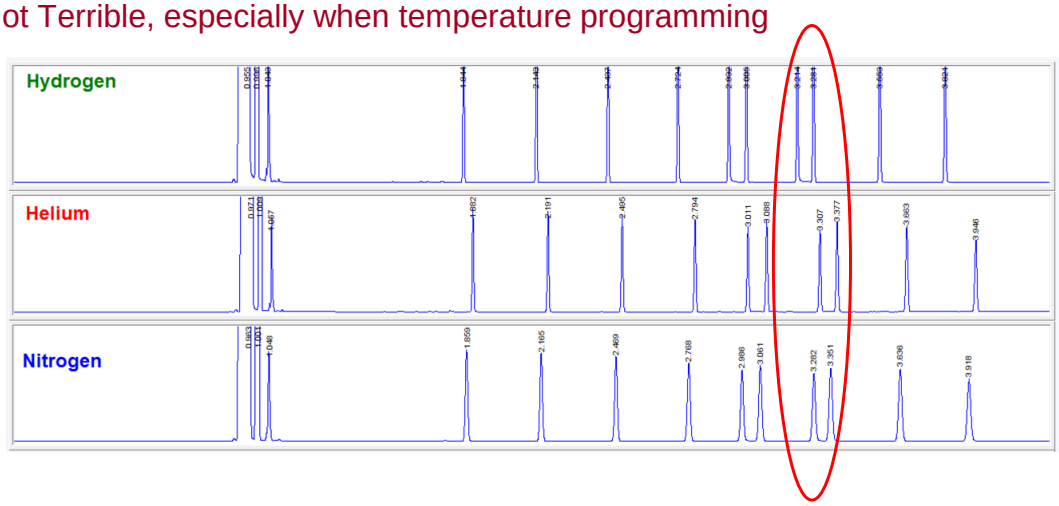
What About Nitrogen?

Not Terrible, especially when temperature programming



Linear Velocity = 60 cm/s

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How to Switch to Hydrogen Carrier Gas in 1 Easy Step!

1. Switch to Hydrogen…and tell the GC that you have switched to Hydrogen…That's It!

- Keep everything else the same (linear velocity, column, temperature, etc.), and you will get nearly the identical chromatogram.
- IF you want to reap the benefits of using hydrogen, double the linear velocity and you will get the same separation in about half the time!
- If you Really want to maximize the befits of hydrogen, use method translator to get you the fastest conditions, while maintaining good resolution.

When to Proceed With Caution

- Headspace GC (make sure you can pressurize with something other than hydrogen)
- GC/MS – Can be done but results may be different, plus it may require hardware tweaks. I would not rush into this one, unless you really need to change.

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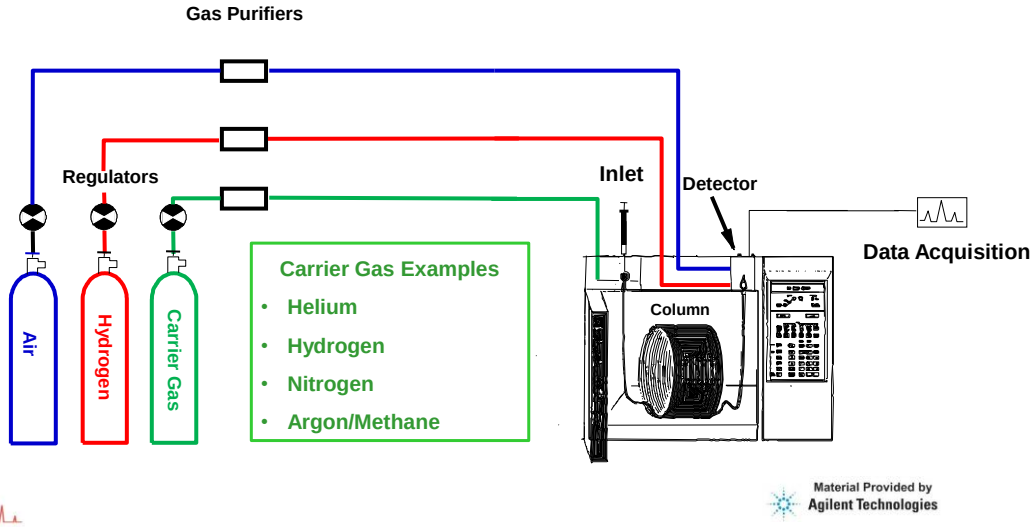
GC Gases and Plumbing with Cylinders



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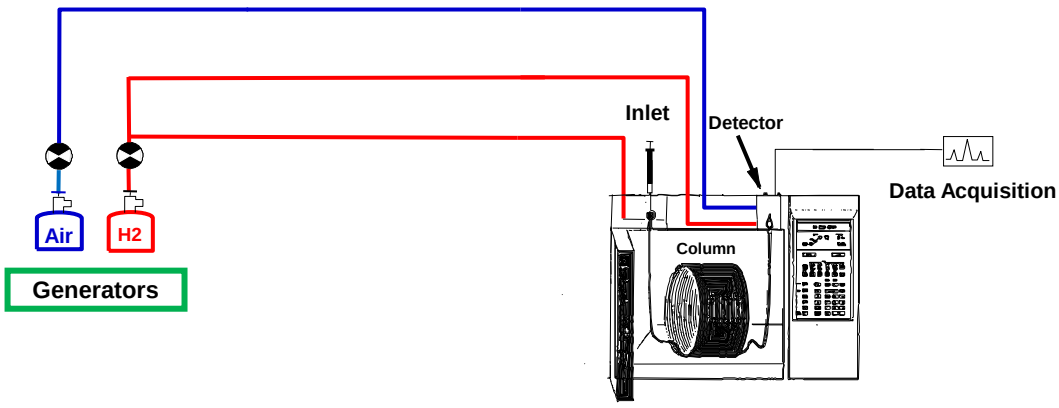
GC Gases and Plumbing with Generators



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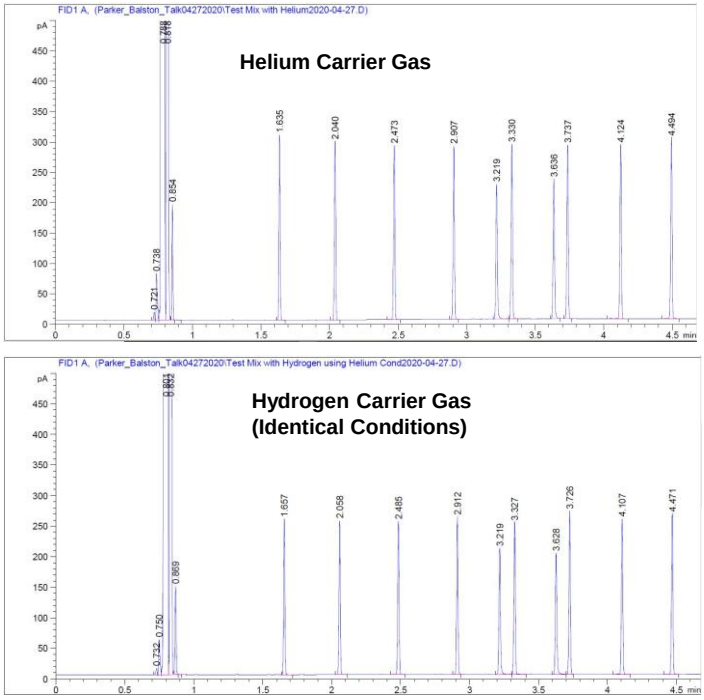
Switch from Helium to Hydrogen

Same Conditions = Same Chromatogram



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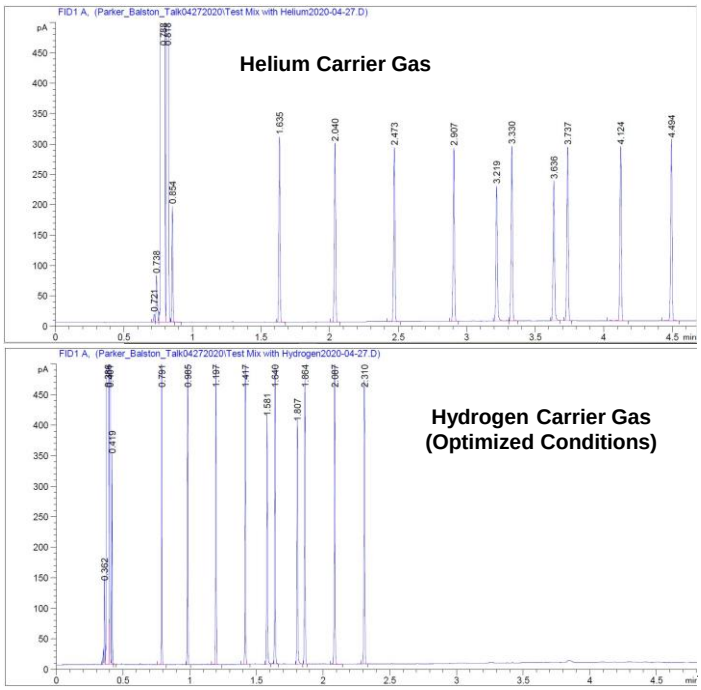
Switch from Helium to Hydrogen

Optimize Conditions = Faster Results



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Hydrogen Safety

Hydrogen gas may be used as carrier gas, and/or as fuel for the FID, FPD, and NPD. When mixed with air, hydrogen can form explosive mixtures.

WARNING

When using hydrogen (H_2) as the carrier gas or fuel gas, be aware that hydrogen gas can flow into the GC oven and create an explosion hazard. Therefore, be sure that the supply is turned off until all connections are made and ensure that the inlet and detector column fittings are either connected to a column or capped at all times when hydrogen gas is supplied to the instrument.

Hydrogen is flammable. Leaks, when confined in an enclosed space, may create a fire or explosion hazard. In any application using hydrogen, leak test all connections, lines, and valves before operating the instrument. Always turn off the hydrogen supply at its source before working on the instrument.

Safety: What Happens During a Hydrogen Shutdown?

The GC monitors inlet and auxiliary gas streams. If a stream shuts down because it is unable to reach its flow or pressure setpoint *and* if that stream is configured to use hydrogen, the GC assumes that a leak has occurred and declares a *hydrogen safety shutdown*. The effects are:

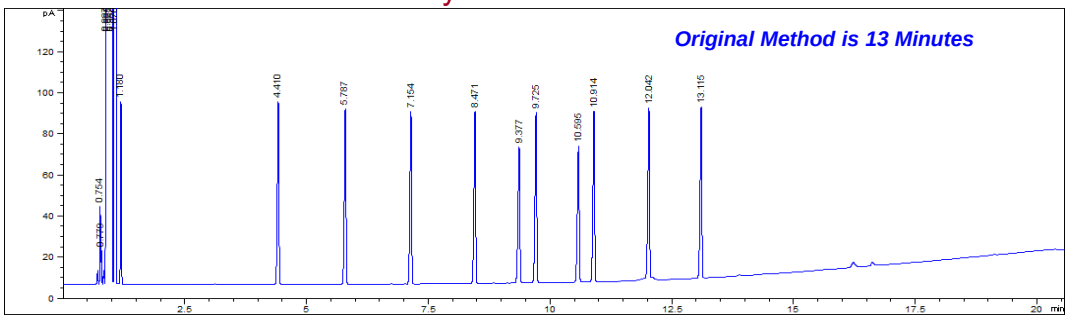
- The offending channel and any associated channels (such as septum purge) are set off.
- The split valves in the split/splitless and PTV inlets open.
- The oven (heater and fan) turns off.
- The small heated zones are turned off.
- An alarm tone sounds.

To recover from this state, fix the cause of the shutdown (tank valve closed, serious leak, others). Turn the instrument off, then back on.

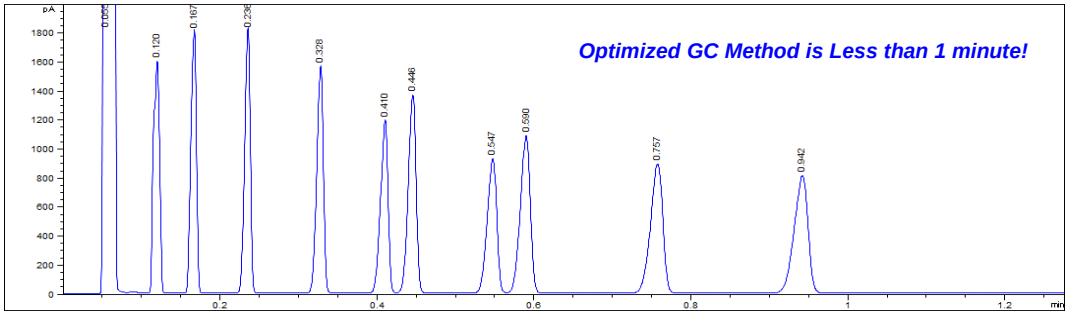
Making it Faster with Hydrogen:

Save Time…Save Money...and Save the Planet!

20°C/min
32 cm/sec



120°C/min
300 cm/sec



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