HYDROGEN VS. HELIUM

FOR GAS CHROMATOGRAPHY

HYDROGEN

The first element of the periodic table, hydrogen is a colorless, and insipid gas. It is the most flammable of the known substances and a powerful reductive agent, reacting with the oxides and chlorides of many metals.

REACTIVE
Hydrogen reacts with a number of metals and non-metals and is a powerful reducer. It is highly combustible.

NON-TOXIC
Although non-toxic, hydrogen can be absorbed through inhalation and cause oxygen deficiency in high concentrations.

ATOMIC MASS
Low atomic mass: 1.007825 g·mol^{-1}
Low boiling point (l/c) – 252.8°C.

SMALL MOLECULAR SIZE
Vanderwaals radius: 0.12 nm.

HELIUM

Helium has many unique properties: low boiling point, low density, low solubility, high thermal conductivity and inertness, so it is used for any application which can exploit these properties.

INERT
Doesn't react with other elements and is non-combustible.

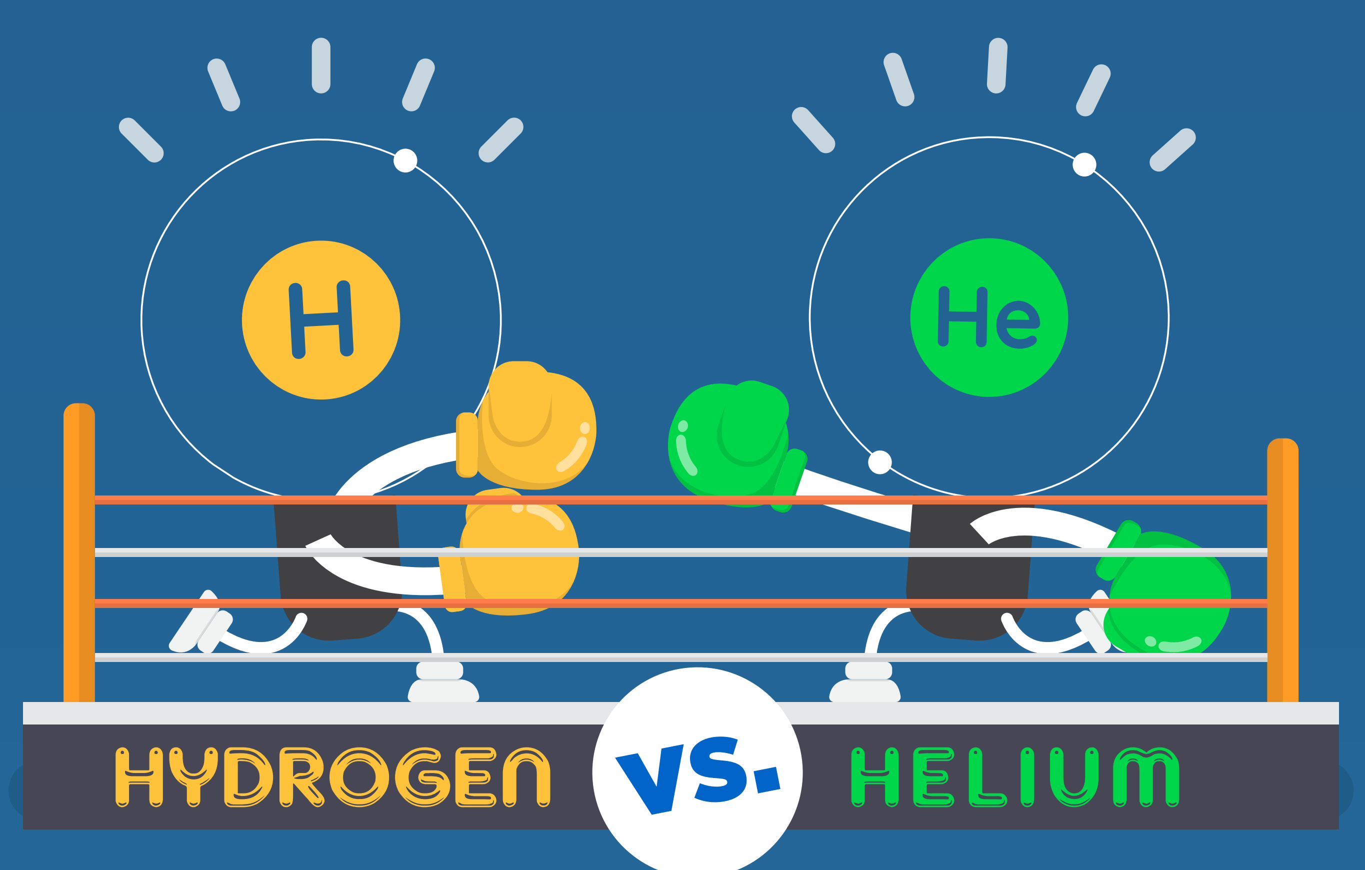
NON-TOXIC
Safe to use in a variety of applications.

LOWEST BOILING POINT – 268.9°C
Liquid at ultra-cool temp.

SMALL MOLECULAR SIZE
Vanderwaals radius: 0.118.nm.

SELECTING A GC CARRIER GAS

Historically, most gas chromatography labs have used helium as a carrier gas. Helium offers the benefits of being non-combustible, inert, and provides moderate speed of analysis. In contrast, Hydrogen, is flammable, and may be reactive under specific conditions. However, it produces high-speed analysis and generates sharper peak shapes. For those researchers who value time and increased sensitivity, hydrogen is a smart alternative. Further, given that helium is a limited resource and much more expensive than hydrogen, many labs are switching to hydrogen carrier gas.



HYDROGEN

ADVANTAGES

- Affordable
- Provides most time efficient separation
- Sharper peak shapes
- Efficient at high gas velocities (i.e., 60 cm/sec)
- Easily produced

DISADVANTAGES

- Can form explosive mixture with air
- Reactive under some circumstances

HELIUM

ADVANTAGES

- Very inert, will not react with analytes
- Non-flammable
- Provides time efficient separations

DISADVANTAGES

- Expensive
- Non-replenishable resource

3 MYTHS OF HYDROGEN GAS USAGE

HYDROGEN IS TOO DANGEROUS

☒ In spite of the fact that hydrogen has a history of unpleasant events in many labs being both flammable and explosive in air, a hazardous mixture can be easily avoided under standard lab conditions.

FACTS

- ☑ Being the lightest of the gasses, hydrogen rises quickly (45 miles/hr) and quickly dissipated in the lab environment.
- ☑ Hydrogen generators produce gas in an on demand and store less than 100 ml of hydrogen at low pressure—far less than a typical cylinder which holds 50 L at 200 atm.
- ☑ Flow rates from a hydrogen generator are controlled and far below the lower explosive limit for hydrogen in air when released in the oven of an average GC.
- ☑ Hydrogen generators are equipped with built-in leak detection sensors that shut down the system if a leak is detected.
- ☑ Most labs are already using hydrogen for a number of purposes, it is the fuel gas for FID detectors and is therefore already used in most GC labs.

HYDROGEN IS TOO REACTIVE FOR MANY GC APPLICATIONS

☒ Some gas chromatographers are deterred from using hydrogen as it is a reducing agent that can promote hydrogenation.

FACTS

- ☑ Hydrogenation is favored only at high temperatures and high pressures, and in the presence of a metallic catalyst such as nickel. platinum, or palladium
- ☑ Conditions for hydrogenation do not exist within regularly used open tubular fuses silica columns
- ☑ Some precautions should be taken when using nickel or alumina (Al_2O_3) columns

METHODS WON'T BE EASILY TRANSLATED FROM HELIUM TO HYDROGEN

☒ Changing carrier gas may involve some method redevelopment–however, this doesn't necessarily have to be difficult.

FACTS

- ☑ Not all methods have to be redeveloped. The likelihood that a method will need redevelopment depends on the complexity of the chromatogram.
- ☑ Method development software is available that can assist chromatographers when changing carrier gasses.
- ☑ For labs using regulated methods, consult the regulating agency—many new methods are available that utilize hydrogen as a carrier gas.

BENEFITS OF HYDROGEN GENERATORS

1 SAFETY

Eliminates the risks associated with high pressure cylinders, which can cause significant injury if dropped, or physical injuries while moving or lifting heavy cannisters.

2 CONSISTENCY

Gas purity may vary slightly from canister to canister impacting testing results. Further contamination can occur from piping joints, sealants, and leaks.

3 CONVENIENCE

Hydrogen generators eliminate inconvenient cannister switches that interrupt work and cost time. Additional time spent ordering, transferring, inventorying, and monitoring cannister stock can also be recovered.

4 COST-SAVINGS

As helium prices increase due to limited supply, switching to affordable hydrogen offers immediate savings. Further by producing hydrogen with a gas generator, indirect costs associated with purchasing, shipping and storing gas cannisters can also be achieved.

5 IMPROVED RESULTS

Hydrogen offers faster separations with better peak resolution. Significantly decreasing analysis time greatly improved both through put and productivity—in many cases results can be obtained in half the time.