

# The Flame Ionization Detector

## Introduction

The flame ionization detector (FID) is *the* most sensitive gas chromatographic detector for hydrocarbons such as butane or hexane. With a linear range for 6 or 7 orders of magnitude ( $10^6$  to  $10^7$ ) and limits of detection in the low picogram or femtogram range, the FID is the gas chromatographic detector for volatile hydrocarbons and many carbon containing compounds.

## Limitations

Molecules that contained only carbon and hydrogen respond best in this detector but the presence of "heteroatoms" in a molecule, such as oxygen, decreases the detector's response. For instance, the FID's methane response ( $\text{CH}_4$ ) is fabulous but formaldehyde's ( $\text{CH}_2\text{O}$ ) is quite poor. Therefore, highly oxygenated molecules or sulfides might best be detected using another detector instead of the FID. Sulfides determination by the flame photometric detector and aldehydes and ketones analyzed with the photoionization detector are alternatives to the use of the FID for those molecules.

## Detector Construction

As the animations available here show ([www.shsu.edu/~chm\\_tgc/sounds/sound.html](http://www.shsu.edu/~chm_tgc/sounds/sound.html)) the FID is constructed of a small volume chamber into which the gas chromatograph's capillary column is directly plumbed.

Usually the small diameter capillary is fitted directly into the bottom of the detector's flame jet. The gaseous eluents from the column are mixed with separately plumbed in hydrogen and air and all are burned on the jet's tip. After the fuel ( $\text{H}_2$ ) and oxidant ( $\text{O}_2$  in air) are begun, the flame is lit using an electronic igniter, actually an electrically heated filament that is turned on only to light the flame.

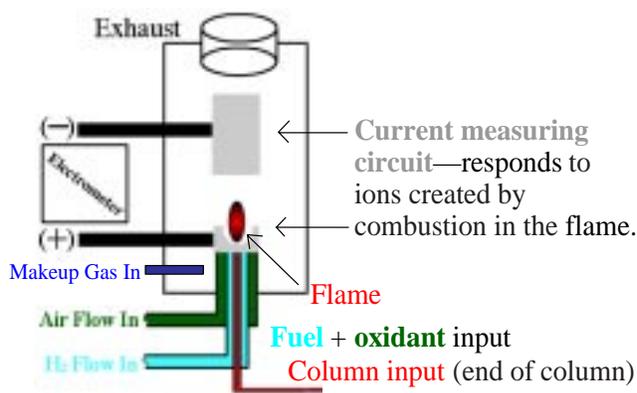
The charged particles created in that combustion process create a current between the detector's electrodes. One electrode is actually the metallic jet itself, another is close by and above the jet. The gaseous products leave the detector chamber via the exhaust. The detector

housing is heated so that gases produced by the combustion (mainly water) do not condense in the detector before leaving the detector chimney.

## Makeup Gases

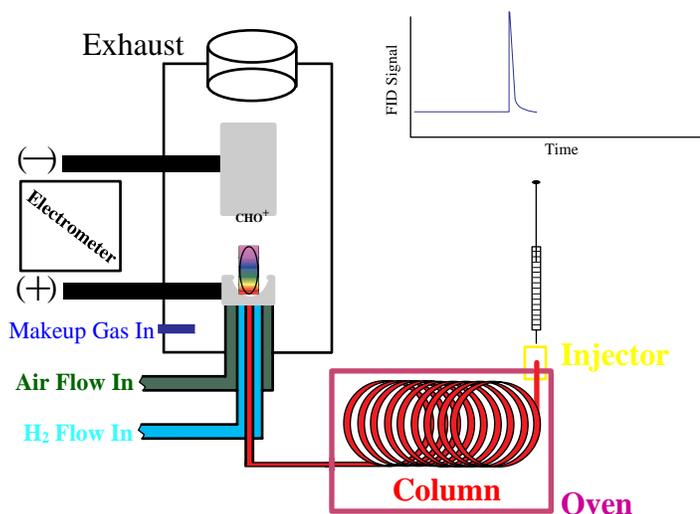
The total volume of gas in the FID that yields the most sensitive and widest linear response is **not** the same volume of gas when the column effluent flow ( $\sim 1$  mL/min) and hydrogen and air flows are flowing; these gases' total flow into the detector is too small. Another way to say this is that the optimum column flow to maintain the best chromatography and the best fuel and oxidant flows for the best flame conditions--all added together--don't create the best gas flow for the FID detector's design. This means that to maintain the best analytical conditions, additional gas must be constantly

## Flame Ionization Detector (FID)



flowed into the detector. This gas *makes up* the additional needed gas flow and so is termed **makeup gas**.

Since the gas needs to be inert so that its addition doesn't upset the fuel and oxidant balance and since it needs to be added in relatively large amounts (~30+ ml/min in some detector designs) nitrogen is usually the gas of choice. Helium would work also but is a nonrenewable resource and more expensive. All gas flows are controlled by adjustable gas regulators.



### Ignition and Shut Down

The process of lighting the FID goes like this: fuel is turned on at a predetermined flow rate (controlled by the H<sub>2</sub> tank's pressure regulator); air on; ignitor is lit and the flame ignited. After the flame is confirmed burning, makeup gas flow is turned on. The flame stabilizes within an hour or less and then is routinely left on continuously to maintain the lowest signal background and therefore produce the lowest detection limits. Some labs with high sample throughputs keep FID flames burning continuously, only shutting the flame off when gas tanks need be replaced. GC column carrier is also obviously keep constantly flowing.

Turning off the flame involves first shutting off the fuel flow which extinguishing the flame, then the oxidant and makeup gas flows are closed.

**These notes were written by Dr. Thomas G. Chasteen; Department of Chemistry, Sam Houston State University, Huntsville, Texas 77341. Copyright 2000.**