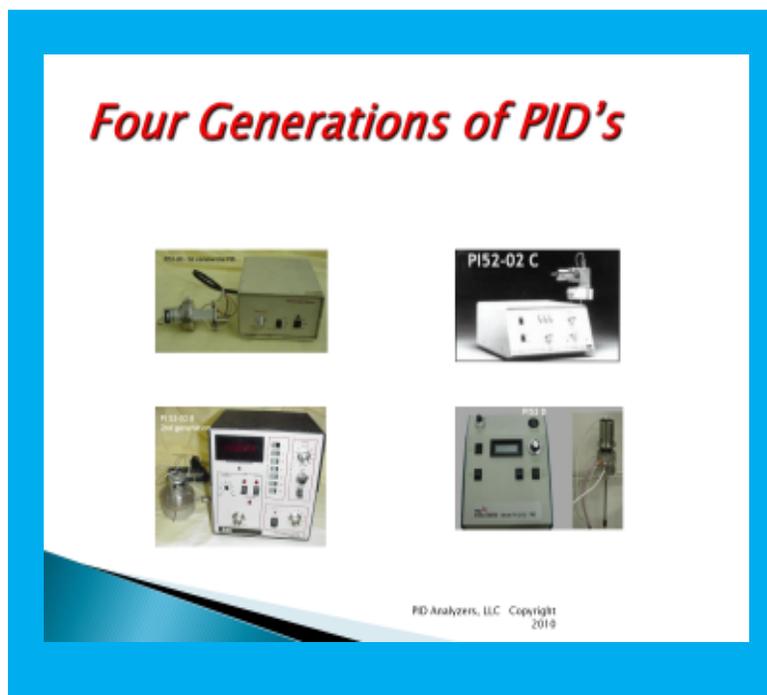


PID Detector (4th generation)

Add-on to any GC

*For R&D, QC, Industrial Hygiene, and
Environmental & Routine ppb Analysis*



PID Model-52-02-D/
PID Model-51-02-D

*VOC's, aromatic HC, Chemical Agents, Halogenated HC,
Sulfur Compounds*

Benzene detection limit - 0.5 ppb

Copyright 1994-2005 PID Analyzers



Model 51/52-02D Photoionization Detector

**Benzene, VC, H₂S, 1,3 BD, Methane, LNG, Nitro cpds, explosives,
Sulfur & Phosphorus Cpds., Nerve gases, Hydrocarbons, SF₆, PH₃,
AsH₃, NH₃, Air, Water, IH, Process, Stacks, & Building security**

Introduction

HNU developed the first commercial PID in 1974 and introduced the first GC detector in 1976. Now, nearly 30 years later, we introduce the Model 52-02C that has improved detection limits by nearly five fold.

Should you upgrade your GC?

More than 70% of the GC's sold in the last decade have only single detector capability (FID or TCD). This configuration is ideal for the measurement of hydrocarbons or inorganic gases at high levels but if your requirements extend to the measurement of other species, environmental or trace levels, why buy another GC? Simply add a selective or general purpose detector that will enhance the capabilities of your present GC. This can expand the capabilities of your laboratory without wiping out your budget. It can also extend the lifetime of your present GC.

Why Upgrade?

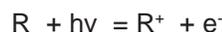
- Have you had to add a derivitization step to your method to make up for poor sensitivity to a target compound? Why waste precious time? Analyze directly by upgrading your detector capability instead
- Eliminate H₂ and air (for an FID) by adding a PID or FUV detector · Add years to the lifetime of your capital equipment with a detector upgrade
- Reduction of capital costs- Why buy a new GC with autosampler, data system and other expensive items when you can just add capabilities with a new detector at a fraction of the cost?
- Extend your lab budget- spend approximately \$5K for a detector instead of \$25K for a new GC detector
- Save \$. Are you sending out analyses which could be more profitably done in your own lab?
- Save time on fast turnaround analyses needed for manufacturing processes or effluent analyses by using a more specific . Easily

Adaptable to Any GC- These detectors are easy to use with any gas chromatograph.

- Save \$. Are you sending out analyses which could be more profitably done in your own lab?
- Save time on fast turnaround analyses needed for manufacturing processes or effluent analyses by using a more specific **detector**.

PID- Principle of Operation

PID The PID provides a response to a wide range of organic and some inorganic compounds at part per billion (ppb) levels. The HNU PID consists of an ultraviolet lamp and an ion chamber. The detector measures the concentration of gases present in a sample using the method of photoionization. Photoionization occurs when a molecule absorbs a photon (light energy) of sufficient energy, creating a positive ion and an electron as shown below:



The sample exits the column, goes into the ion chamber and is exposed to photons generated by the ultraviolet lamp. Molecules in the sample with ionization potentials less than or equal to the energy level of the lamp are ionized. The ionization potential is that energy in electron volts (eV) needed to free an electron from a molecule. A positively biased accelerator electrode repels these ions, causing them to travel to the collecting electrode, where an analog signal proportional to the concentration of the sample is generated. The signal is amplified to provide an analog output for graphic recording or electronic integration. Ultraviolet lamps are available in four energies; 8.3, 9.5, 10.6, and 11.7 electron volts (eV). Detector selectivity (and sensitivity) varies with each lamp. The PID becomes more selective as the lamp energy decreases since it is capable of ionizing fewer compounds. The detector becomes less selective as the lamp energy increases. It is capable of ionizing a larger number of compounds. The 10.6 eV lamp provides the maximum sensitivities for those compounds it detects. The PID has a linear range of better than seven decades (>10⁷), is nondestructive, and can be used in series with other detectors.

Responds to wide range of organic and inorganic compounds

The photoionization detector can be used to analyze a wide variety of compounds. Any compound with an ionization potential (IP) < 12 eV will respond. This allows the detection of aliphatics (except CH₄), aromatics, ketones, aldehydes, esters, heterocyclics, amines, organic sulfur compounds, and some organometallics. The detector also responds to inorganics such as O₂, arsine, ammonia, hydrogen sulfide, HI, chlorine, iodine, and phosphine. When used with a 10.2 eV lamp, it does not respond to several commonly used solvents such as methanol, or to extraction solvents such as chloroform, dichloroethane, carbon tetrachloride, and acetonitrile. These can be used as extraction solvents and produce a minimal response.

Sensitivity and detection limits

One of the most significant characteristics of the HNU photoionization detector is its sensitivity. The lower limits of detection for organics are 10-200 times better than those of a flame ionization detector (FID). Lower limits of detection for inorganics are often 10-20 picograms, which makes the PID 2- 10 times more sensitive than the flame photometric or Hall detectors. Wide dynamic range The PID has the widest dynamic range of any GC detector, extending from 2 picograms through 30 micrograms. This covers virtually the entire dynamic range of many of the other GC detectors. The range and detection limits for the most common GC detectors are shown below.

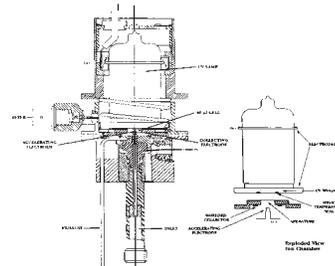
Selectivity

Four ultraviolet light sources (8.3 eV, 9.5 eV, 10.6 eV, and 11.7 eV) are offered by PID analyzers. The 10.6 eV is the most common, but the other sources either increase the number of compounds detected (11.7 eV), or allow additional selectivity in detection (9.5 or 8.3 eV).

Non destructive detector

Photoionization itself is virtually a non destructive technique The PID can be connected in series with other detectors

PID & Its characteristics

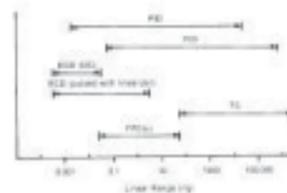


Detector Selection Guide

Application	Detector				
	PID	FUV	ECD	FPD (P)	FPD (S)
Alkanes	>C4 G	G			
Aromatics	G	G			
Sulfur Cpds	G	G			S
PCB's	G		S		
Pesticides	G		S	S	S
Inorganics- O2, CO	0	G	0	0	0
Freons	M	G	S	0	0
Nitro cpds.	G		S	0	0
Phosphorus Cpds.	G	G		S	0
Chlorinated HC	G	G	S	0	0

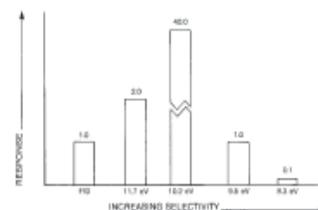
S= specific; G= general; 0 = No response

Comparison of Linear Dynamic Ranges of Various GC Detectors



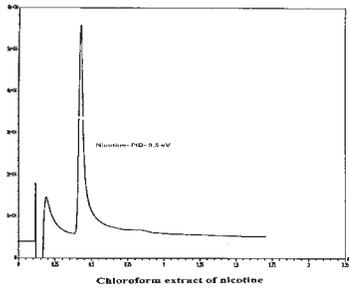
Response for the Various Ultraviolet Lamps

RELATIVE SENSITIVITY vs. FID (benzene or biphenyl)



PID Applications

PID 9.5/11.7 Applications



Sample Trimethylamine Peak #1
Dimethylamine Peak #2
Triethylamine Peak #3

Concentration 5 ppm, 29 ppm, 30 ppm

Inject Size 1.0 cc

Detector PID

Lamp 9.5 eV

Column 8' Triton 100
Sodium Hydroxide
on Chromasorb P/W

Flow 20 cc/min

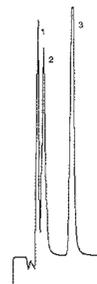
Attenuation x10

Injector Temp 200°C

Ovens Temp 100°C

Matrix Air

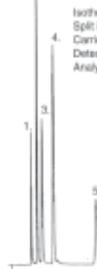
Analysis Time 3:00



NBW-311
25 m x 0.53 mm, 4.5 µm

Chlorinated Hydrocarbons

Isothermal: 70°
Split injection
Carrier gas: He 10 ml/min
Detector: PID 11.7 eV
Analysis time: 6 min



Compounds:
1. trans-1,2-Dichloroethylene
2. cis-1,2-Dichloroethylene
3. 1,1,1-Trichloroethane
4. Trichloroethylene
5. Tetrachloroethylene

Sample Epichlorohydrin Peak #1
2-Chloroethanol Peak #2
Ethylene Dichloride Peak #3

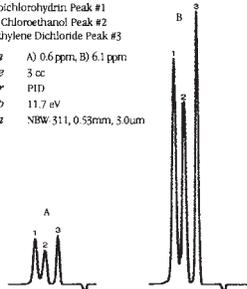
Concentration A) 0.6 ppm, B) 6.1 ppm

Inject Size 3 cc

Detector PID

Lamp 11.7 eV

Column NBW 311, 0.53mm, 3.0µm



PID Applications

Sample Formaldehyde Peak #1
Acrylonitrile Peak #2
Vinyl Acetate Peak #3
Methyl Acrylate Peak #4
Ethyl Acrylate Peak #5
Methyl Methacrylate Peak #6
Butyl Acrylate Peak #7

Concentrations 20 ppm

Inject Size 125 µl

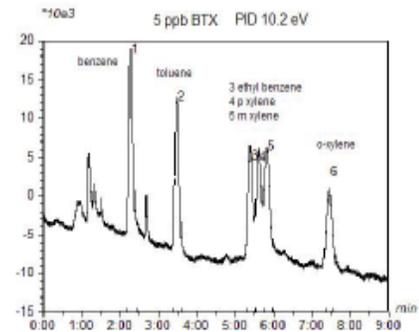
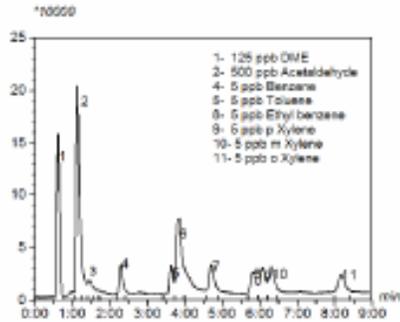
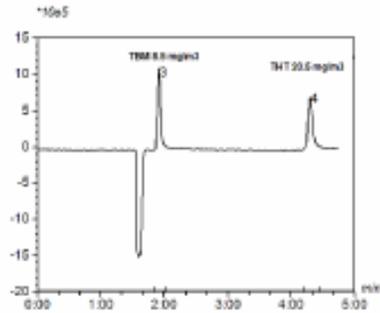
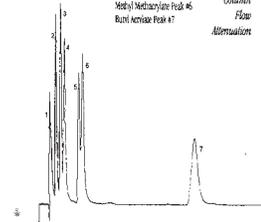
Detector PID

Lamp 11.7 eV

Column 15m DB-1, 5m DB-50

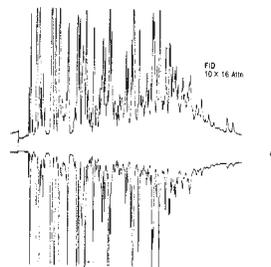
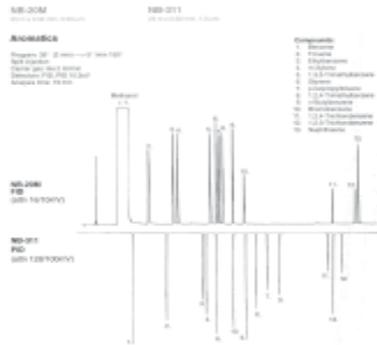
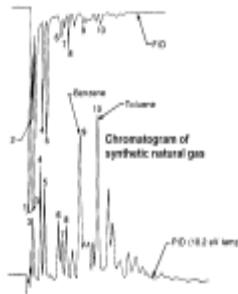
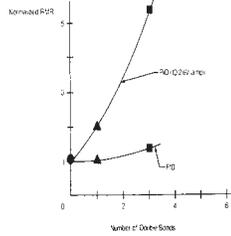
Flow 10 cc/min

Attenuation x1



PID Applications

PID/FID/FUV Applications

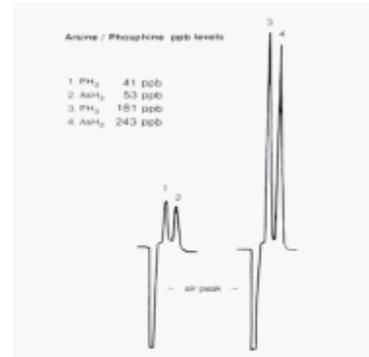


PID Inorganic Applications

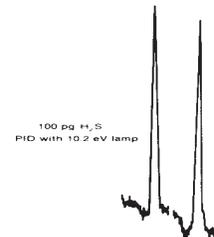
Detection Limits for Selected Inorganics

Compound	LLD (pg)
H ₂ S	15
PH ₃	20
I ₂	25
NO	52
Pb(C ₂ H ₅) ₂ (TEL)	150
NH ₃	200
AsH ₃	25

Many other inorganics may be detected - contact factory.



Detection of Picogram Quantities of Hydrogen Sulfide with PID



PID Configurations

Model PI51 & PI52

The PID Analyzers **Model PI51** consists of a PID and a constant current power supply that powers the PID lamp and supplies the accelerating voltage. It also comes with an adapter for the various GC's below. With this Model, the FID power supply already in the GC is used to amplify the PID signal.

There are a number of adaptors available for the for the PID- Model 51. These are described below-choose one adaptor:

Note that the Model PI51 does not come with an electrometer. That Model is the PI52 that is described below:

The PID Analyzers **Model PI52** consists of a low dead volume PID and a constant current power supply for the PID lamp. The supply also generates the accelerating voltage for the ionization chamber. It also comes with your choice of an adapter for the various GC's above. This Model, also has the PID power supply to amplify the PID signal.

Adaptors for the PID Models 51/52

With adapter for the HP

GC 5890 -H5890
GC 6890 -H6890

With adapter for the Agilent

GC 6890 -A6890

With adapter for Varian GC's

GC 3400 -V3400
GC 3600 -V3600

With adapter for Perkin Elmer GC's

Clarus 500 -P500
Earlier Models

With adapter for Shimadzu GC's

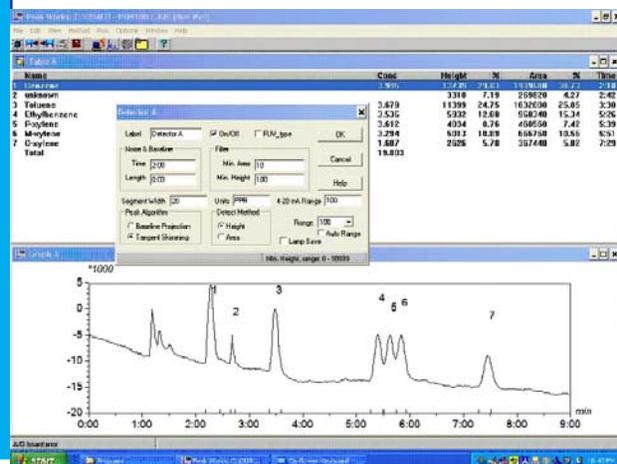
GC14 -S14
GC17A -S17A

A typical part # for a Model PI for an HP 5890 would be # PI51-01-C-H5890.

PeakWorks Data Acquisition Systems

The output from the PID electrometer can be fed into the ADC system for the GC, typically with a special card or an external data acquisition system can be used. These will require a PC for operation of the software and data acquisition card.

PeakWorks™ is PID's Windows based chromatography software that can be used to control the GC parameters, integrate & display the chromatograms and store the data for the GC 301-B. The software is written in C++ as an overlay/interface for the Windows operating system. Low and high alarm levels and concentration range can be set in the PC. A 24 hour graph of each point can be displayed on the VGA color screen. Each day at midnight, a new file is created and named (by date). These files can be directly imported into EXCEL and plotted. A copy of the screen for 3 ppb of benzene is shown in the Figure below. PeakWorks has multipoint calibration capabilities and response factors that can be calculated automatically or entered manually. Windows are adjustable for each compound. A typical chromatogram of 3 ppb of btx is shown in the figure below:



PID Features & Other Add-On Detectors

Features-

- *Selectivity- improves separations and analysis of trace species*
- Wide linear dynamic range- $> 10^7$.
- 50-200 times more sensitive than the FID
- High sensitivity- pg or sub pg detection limits-most sensitive PID available
- Adaptability- Is readily adaptable to any chromatograph
- Non destructive; detectors can be run in-series
- Used by environmental agencies worldwide

Specifications

- **Detection limit:** 0.5 ppb of benzene
- **Range:** $> 5 \times 10^7$
- **Detector:** 2.5 " D x 5.5" L
- **Electronics enclosure:**
 - Weight: 4.5 lbs.
 - Size: 6" W x 7" L x 3" H
- **Controls:** Attenuation, T (degrees C)

Applications

- Detection of aromatic hydrocarbons in air, soil, water at ppb levels
- EPA Method 602, 502, SW846
- Hydrides (H_2S , PH_3 , ASH_3) at ppb levels in air, water
- Chloroalkanes in soil, water & air
 - at ppb levels (11.7 lamp)
- VOC's in soil, air & water at ppb levels

Other Add-On GC Detectors

TCD

The compact design for this universal detector enables it to be easily added to any gas chromatograph. There are two Models: one interfaces directly to a PID Analyzers data acquisition system (12 or 16 bit); the other is a standalone detector with electronics.

FUV

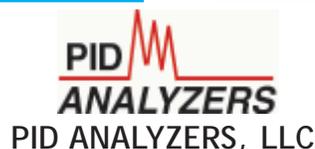
Novel photodiode and ultra stable UV lamp provides nearly universal response and low or sub ppm detection limits. the detection limit of the FUV for methane is approximately the same as the FID. At the same time, this detector will respond to oxygen and water at low or sub ppm levels.

FPD

This detector is selective for S or P compounds depending upon the filter employed. The S output is linearized to provide dynamic range $> 10^4$. A dual S/P detector is also available. Specs are below:

Table I
Brief Detector Specs

Detector	Model #	Dyn. Range	Conc. Range
FID	53	$> 2 \times 10^4$	ng-mg
FUV	54	10^5	pg-ng
FPD (S)	56S	10^4	pg-ng
FPD (P)	56P	10^4	pg-ng



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