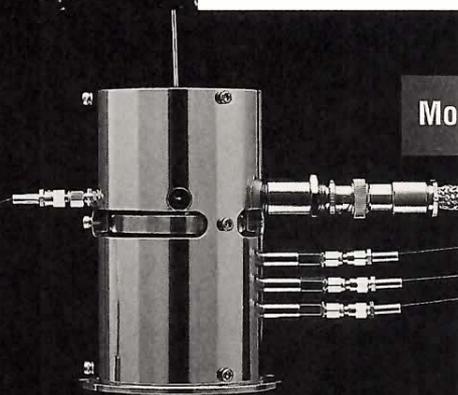


VICI

Valco Instruments Co. Inc.

Pulsed Discharge Detector

ECD
HID
PID



Model D-1

Non-radioactive

Mode-selectable

Sub-picogram sensitivity

No lamps or windows

Capillary or packed
columns

The spark within

Electron Capture

Helium Ionization

Photoionization

NEW! Non-radioactive detector

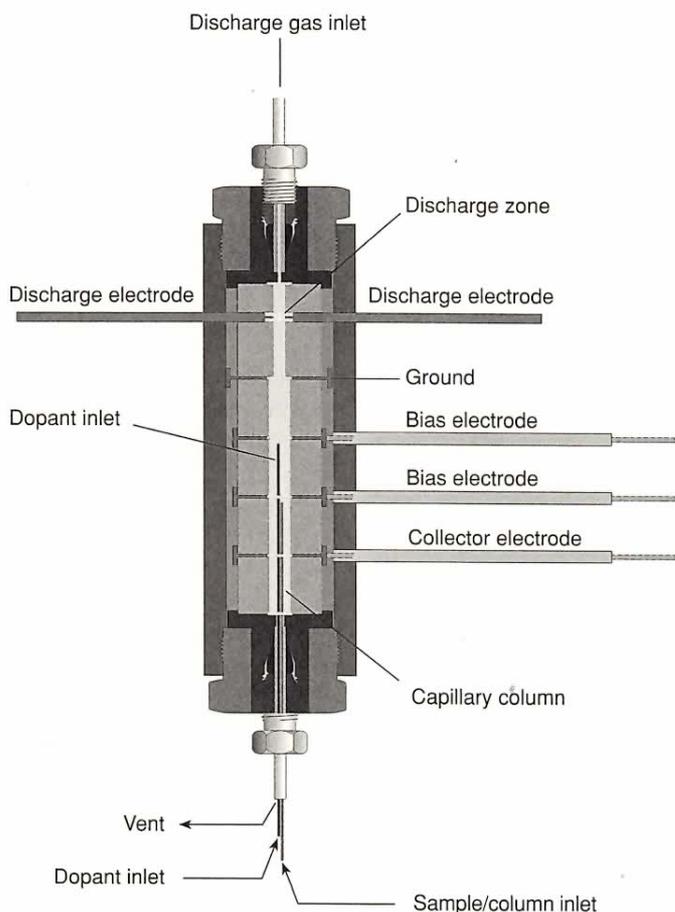
Finally, an alternative to radioactive ECDs and HIDs! Our pulsed discharge detector (PDD) utilizes a stable, low powered, pulsed DC discharge in helium as an ionization source. The resulting chromatograms are as good as or better than those obtained with conventional radioactive sources.

In the **electron capture** mode, the PDECD is a selective detector for monitoring high electron affinity compounds such as freons, chlorinated pesticides, and other halogen compounds. The minimum detectable quantity (MDQ) for this type of compound is at the femtogram (10^{-15}) or picogram (10^{-12}) level. Our PDECD is similar in sensitivity and response characteristics to a conventional radioactive ECD, and can be operated at temperatures up to 400°C . For electron capture operation, He and CH_4 are introduced between the pulsed discharge and the sample inlet.

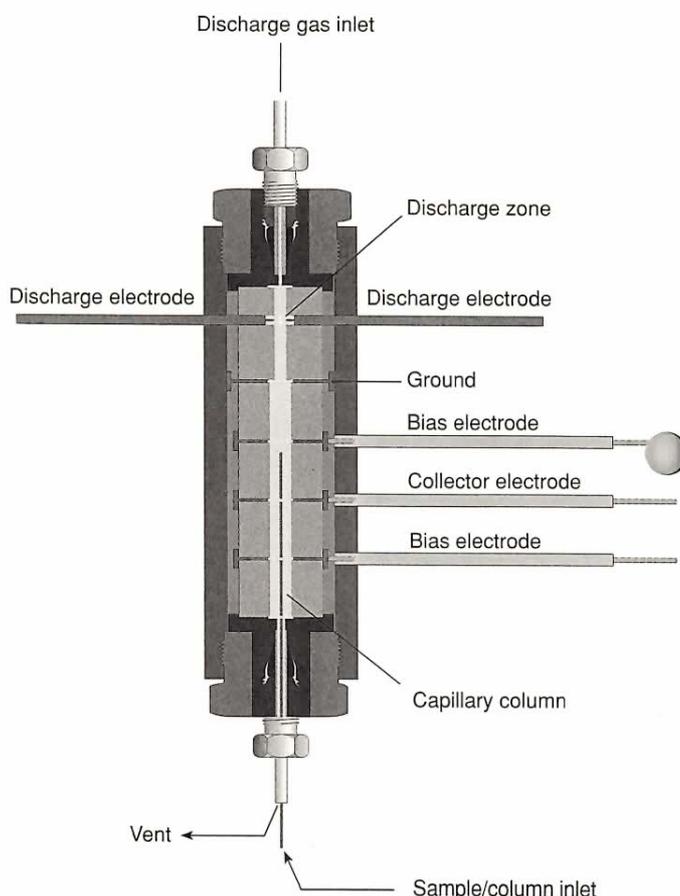
In the **helium ionization** mode, the PDHID is a universal, non-destructive, high sensitivity detector. The response to both inorganic and organic compounds is linear over a wide range. Response to fixed gases is positive (increase in standing current), with an MDQ in the low ppb range.

The PDHID is an excellent replacement for flame ionization detectors in petrochemical or refinery environments, where the flame and use of hydrogen can be problematic. In addition, when the helium discharge gas is doped with a suitable noble gas, such as argon, krypton, or xenon (depending on the desired cutoff point), the PDHID can function as a specific **photoionization** detector for selective determination of aliphatics, aromatics, and amines, as well as other species.

Patents: 5,153,519; 5,317,271; 5,394,092; 5,394,090; 5,394,091



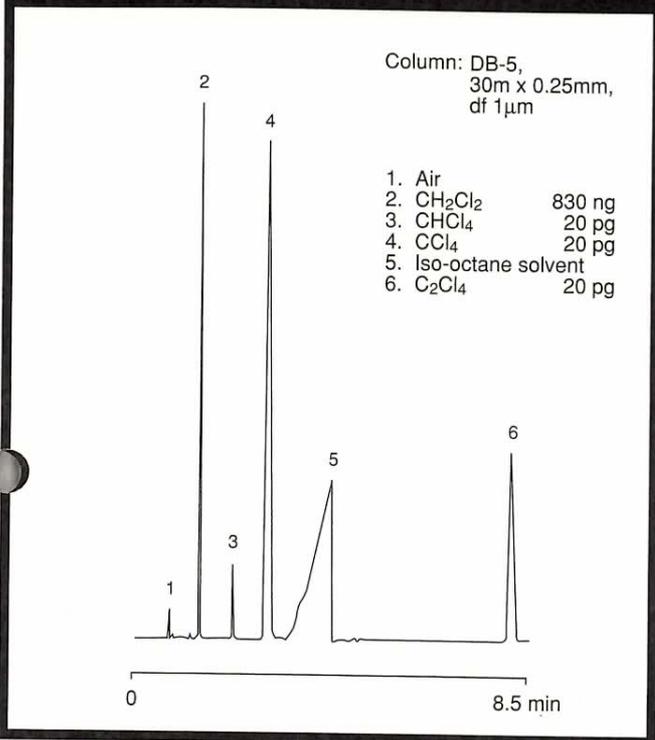
Electron capture mode
Cross section



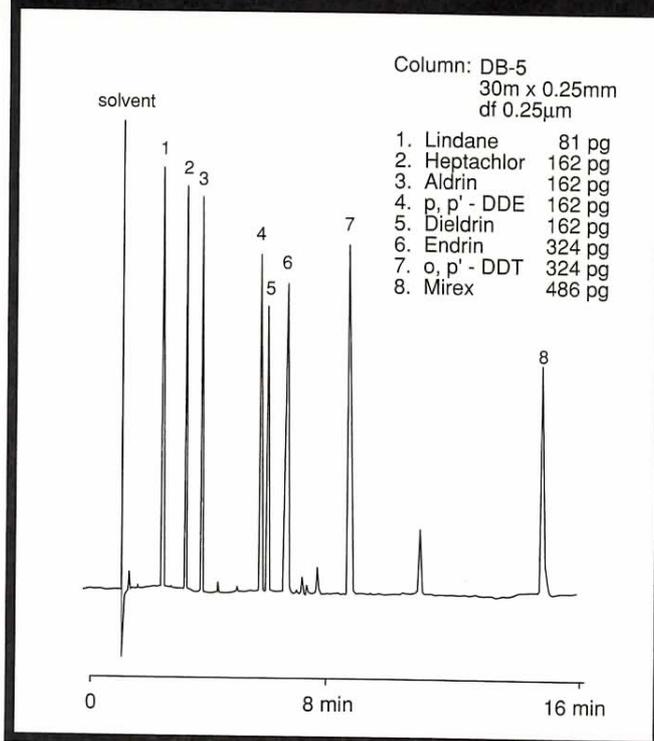
Helium ionization mode
Cross section

Electron Capture

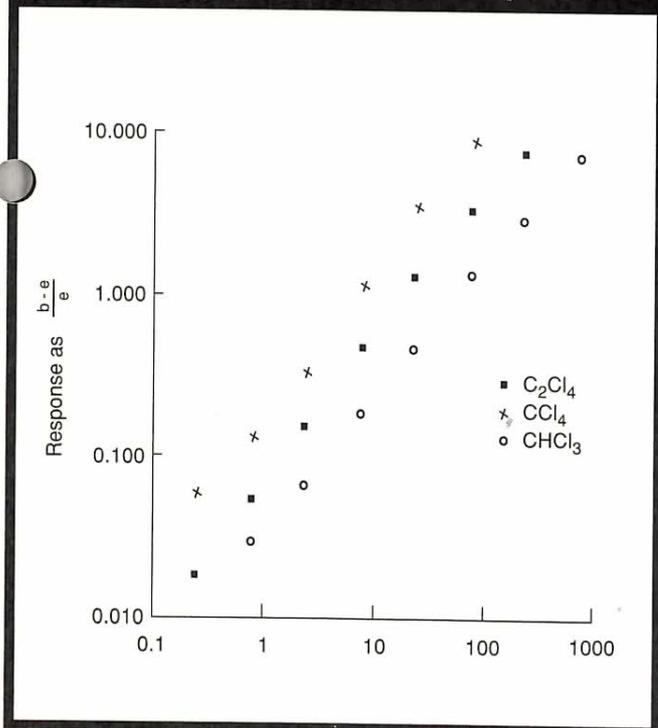
Analysis of Halocarbons



Analysis of Pesticides



Linear Range for Chloro Compounds



Minimum Detectable Quantities

Pesticides

α - BHC	0.33 pg
γ - BHC	0.32 pg
β - BHC	0.57 pg
Heptachlor	0.40 pg
δ - BHC	0.39 pg
Aldrin	0.40 pg
Heptachlor epoxide	0.40 pg
Endrin	0.53 pg
p p' - DDT	0.80 pg
Endrin Aldehyde	0.90 pg

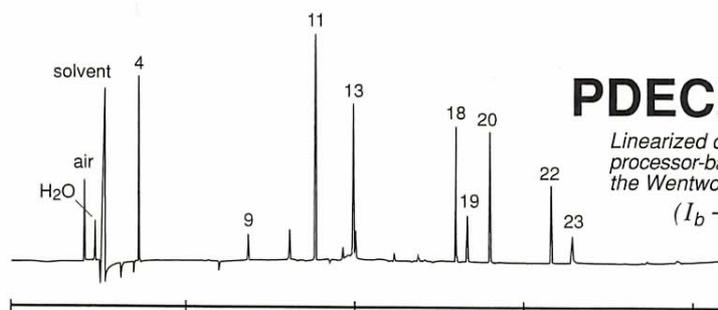
Halocarbons

CH ₂ Cl	0.7 ng
CHCl ₃	59 fg
CCl ₄	35 fg
C ₂ Cl ₄	69 fg

Electron Capture

Comparison of PDECD with Conventional ECD

The PDECD exhibits detection limits up to 10 times better than the radioactive Nickel 63 detector, with comparable selectivity.

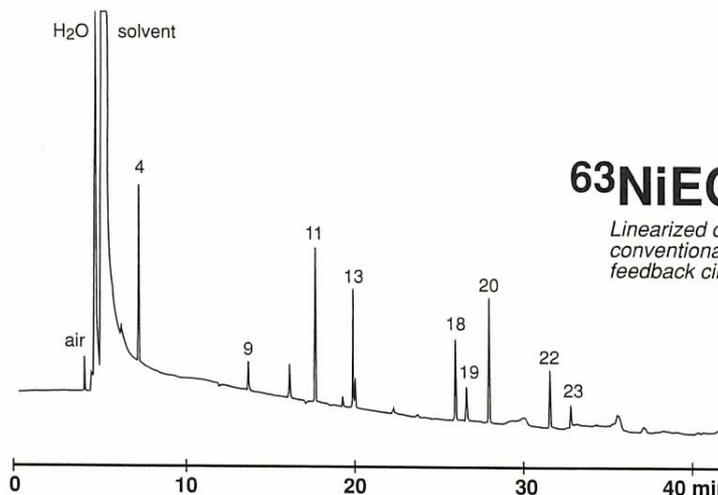


PDECD

Linearized output from micro-processor-based linearizer using the Wentworth equation:

$$(I_b - I_e) / I_e$$

The response to the solvent overload in the Nickel 63 detector interferes with the response factors and often obscures components eluting near the solvent, whereas the PDECD recovers quickly from the solvent.

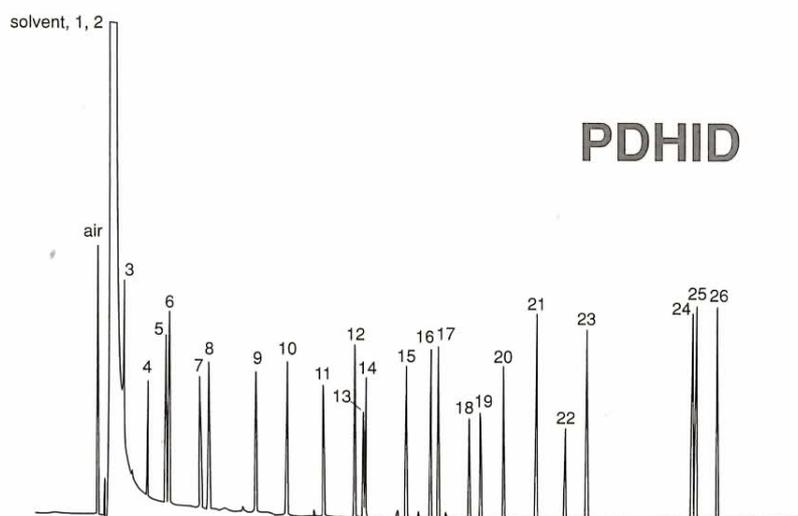


⁶³NiECD

Linearized output using conventional pulsed feedback circuitry

PDHID Analysis of Mixture used in Comparison Above

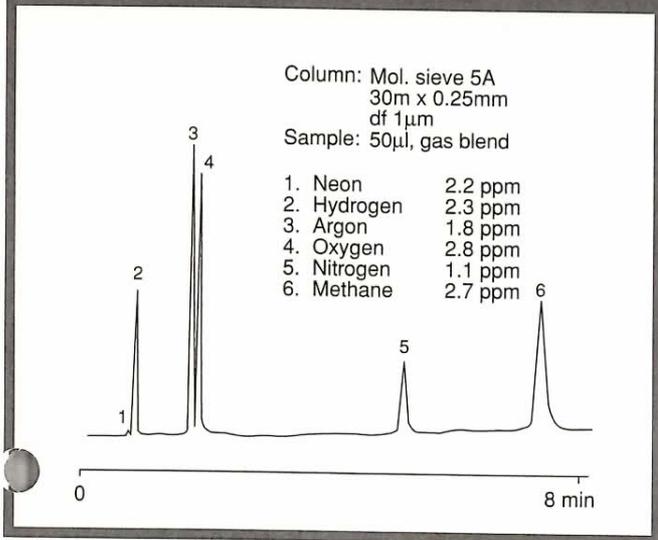
1. Chloromethane
2. Vinyl Chloride
3. Bromomethane
4. Trichlorofluoromethane
5. 1,1-Dichloroethene
6. Methylene Chloride
7. 1,1-Dichloroethane
8. trans 1,2-Dichloroethene
9. Chloroform
10. 1,2-Dichloroethane
11. Carbon Tetrachloride
12. 1,2-Dichloropropane
13. Dichlorobromomethane
14. Trichloroethene
15. cis 1,3-Dichloropropene
16. trans 1,3-Dichloropropene
17. 1,1,2-Trichloroethane
18. Dibromochloromethane
19. 1,2-Dibromoethane
20. Tetrachloroethene
21. Chlorobenzene
22. Bromoform
23. 1,1,2,2-Tetrachloroethane
24. 1,3-Dichlorobenzene
25. 1,4-Dichlorobenzene
26. 1,2-Dichlorobenzene



PDHID

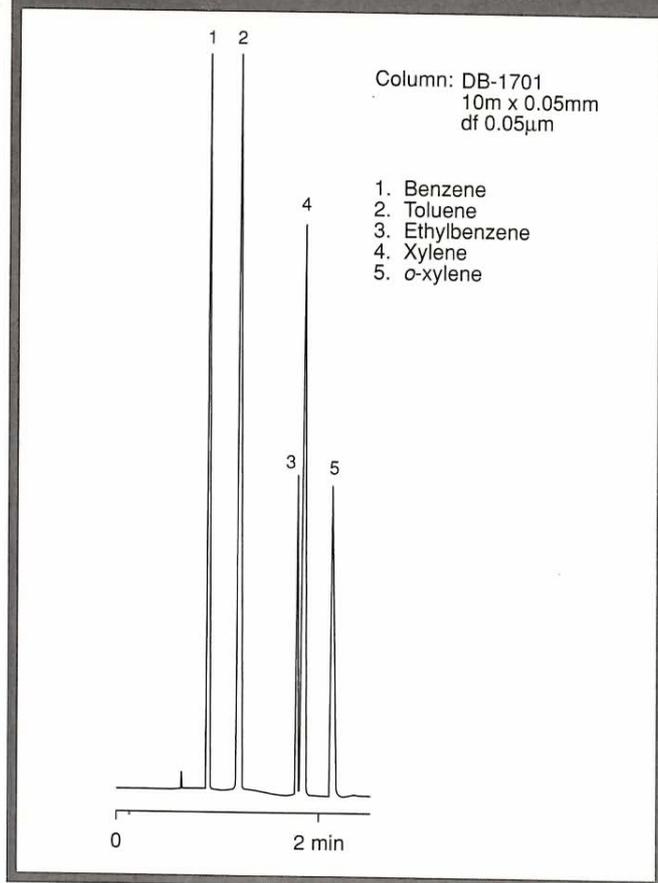
Helium Ionization

Analysis of Fixed Gases

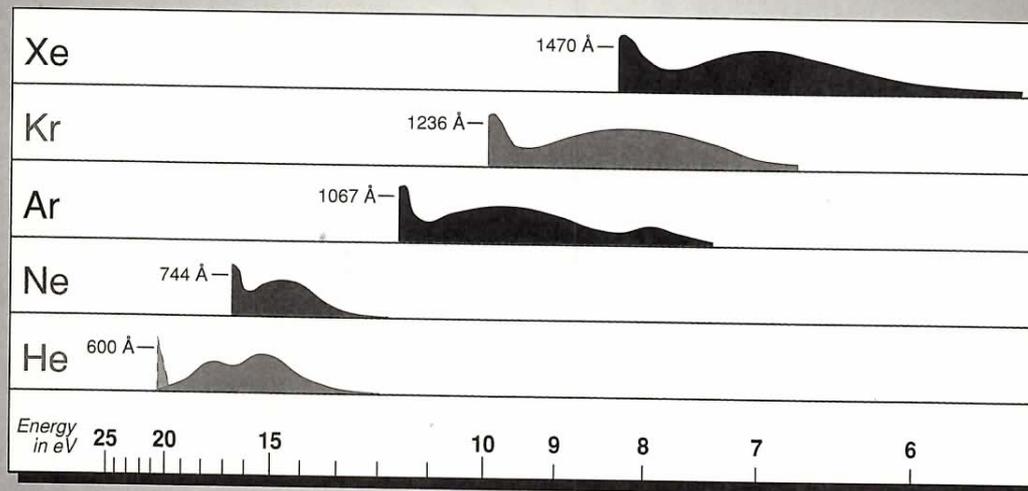


The basic detector functions as a helium ionization detector when pure helium is used as the discharge gas. The extremely high sensitivity is evidenced above. The figure to the right shows that 50 micron columns are a realistic option, due to the fast time constant of the detector. The addition of ~1% of Argon, Krypton, or Xenon to the discharge gas reduces the energy of the pulsed discharge, resulting in response selectivity combined with high sensitivity. The following pages show the detector used in these selective photo-ionization modes.

Analysis of BTEX Standard



Schematic Representation of the Rare Gas Continua

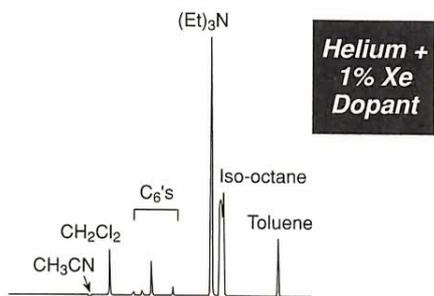
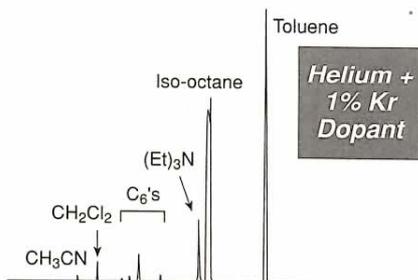
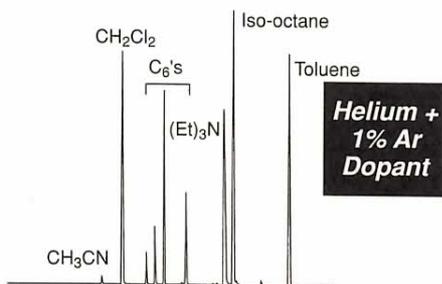
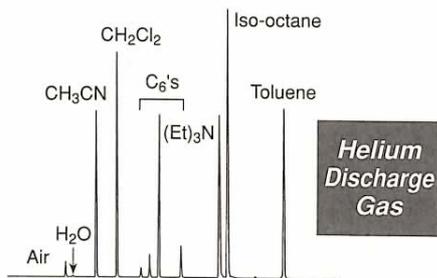


from "Continuous Emission Spectra of Rare Gases in the Vacuum Ultraviolet Region. II. Neon and Helium"
by Y. Tanaka, A. J. Jurson, and F. J. LeBlanc
Journal of the Optical Society of America, 48, Number 5, 304 (1958)

Photoionization

Analysis of Synthetic Mixes

Mix 1
Sample: 1 ng per



Ionization Potentials

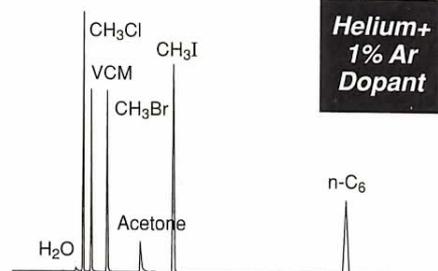
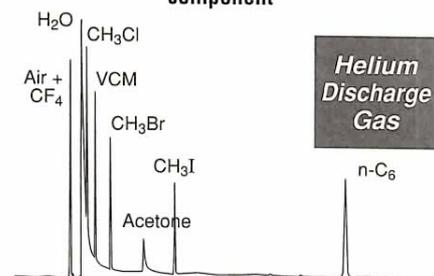
	eV
Helium	17.7*
N ₂	15.6
CF ₄	> 13.9
O ₂	12.1
H ₂ O	12.6
CH ₃ CN	12.2
Argon	11.8*
CH ₂ Cl ₂	11.3
CH ₄ Cl	11.2
Krypton	10.6*
CH ₃ Br	10.5
n-C ₆	10.1
CH ₂ =CHCl (VCM)	10.0
Acetone	9.7
Xenon	9.6*
CH ₃ I	9.5
Toluene	8.8
(C ₂ H ₅) ₃ N ((Et) ₃ N)	7.5

*Corresponds to the maximum emission

These chromatograms show the detector used in various selective ionization modes, accomplished by a simple change of the dopant gas. Many recently developed GCs can do such gas switching automatically via electronic flow controls. Since no lamp or window is used, sensitivity and selectivity *do not* change with time. The chart at left shows the relationship between the ionization potentials of dopant gases and the components in Mixes 1 and 2. When argon, krypton, or xenon is added to the helium carrier, peaks of components with higher ionization potentials are diminished.

Analysis of Synthetic Mixes

Mix 2
Sample: 10 - 15 pg per component

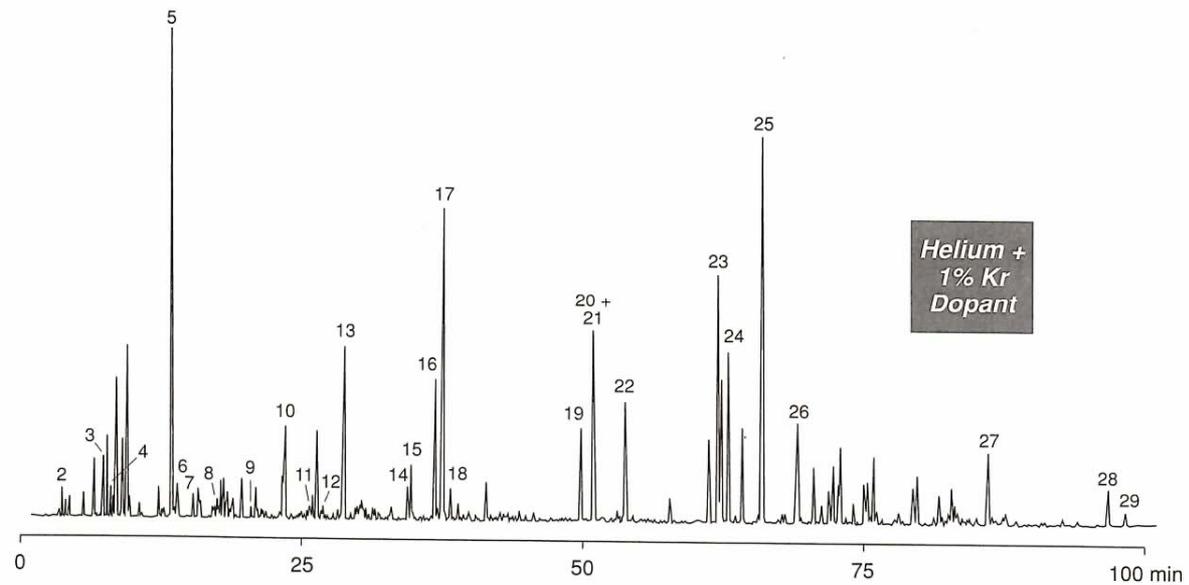
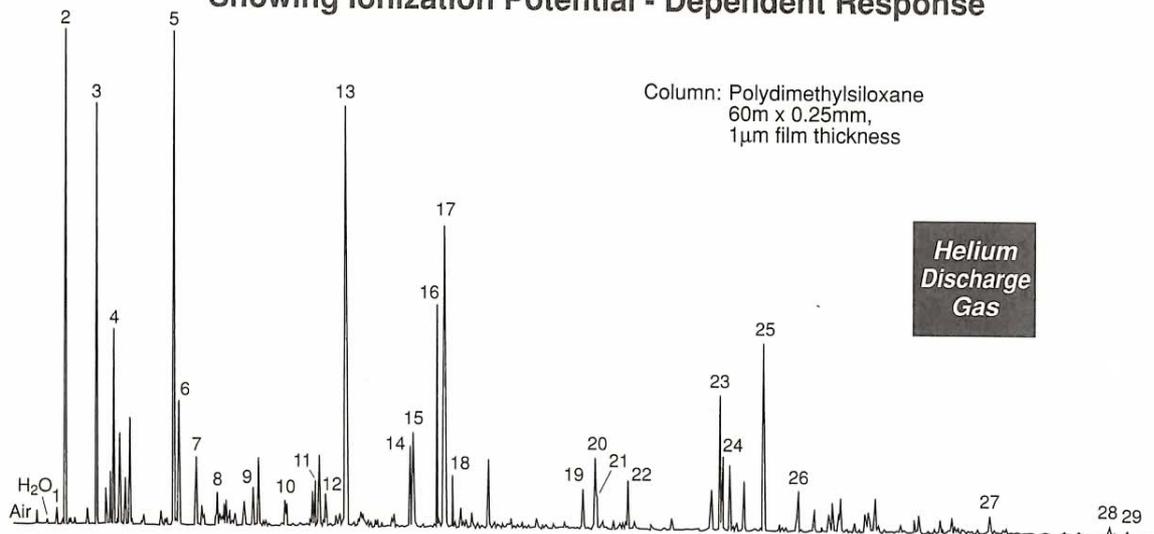


Photoionization

Analysis of Gasoline

Showing Ionization Potential - Dependent Response

Column: Polydimethylsiloxane
60m x 0.25mm,
1µm film thickness



	eV		eV
1. Isobutane		16. 2,3,4-Trimethylpentane	
2. n-Butane	10.5	17. Toluene	8.82
3. Isopentane	10.4	18. 2,3-Dimethylhexane	
4. n-Pentane	10.4	19. Ethylbenzene	8.77
5. MTBE	9.24	20. m-Xylene	8.56
6. 2-Methylpentane	10.1	21. p-Xylene	8.56
7. 3-Methylpentane	10.1	22. o-Xylene	8.44
8. n-Hexane	10.1	23. 1-Methyl-3-ethylbenzene	
9. 2,4-Dimethylpentane		24. 1,3,5-Trimethylbenzene	
10. Benzene	9.2	25. 1,2,4-Trimethylbenzene	8.27
11. 2-Methylhexane		26. 1,2,3-Trimethylbenzene	8.42
12. 3-Methylhexane		27. Naphthalene	8.14
13. 2,2,4-Trimethylpentane	9.86	28. 2-Methylnaphthalene	8.85
14. 2,5-Dimethylhexane		29. 1-Methylnaphthalene	7.85
15. 2,4-Dimethylhexane			

The practical alternative to radioactive ECDs and HIDs

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