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Far UV Absorbance Detector

Theory

Most organic and inorganic species absorb strongly in the far UV. Notable exceptions are the inert gases, helium and nitrogen which absorb very weakly in this region. Certain diatomic species such as O_2 which have low absorption in the region of the lamp energy (124 nm) will have a poor response but low ppm levels can still be detected.

The far UV detector is relatively new to gas chromatography (compared to other GC detectors) since it was introduced by HNU Systems in 1984. It is frequently compared with the thermal conductivity detector since it will respond to any compound that absorbs in the far or vacuum UV. The latter name is a misnomer since with a carrier gas flowing through the cell, a vacuum is not needed. Thus, the detector has a response that is nearly universal, a low dead volume (40 µl), and a fast electrometer time constant. The primary emission from this lamp is the 124 mn line. Although there are visible lines from this lamp, the photodiode is unresponsive to any long wavelength UV or visible emissions and only the absorption at 124 nm needs to be considered for the absorption process.

The minimum detection limits for organic compounds, oxygen, water, and inorganic compounds are in the range from 0.1 to 10 ppm. A summary of the detection limits for organic and inorganic compounds is given in Table I.

Table I
Detection Limits for the FUV Detector

Compound	Detection Limit (ng)
Sulfur dioxide	0.7
Methane	0.3
Oxygen	14
Water	3
Propane	1
Chloroform	5
Ethylene	1
Hydrogen sulfide	3

The HNU Far UV Detector (FUV) utilizes a simple, compact detector consisting of a stable UV source, absorption cavity (1 cm path), and novel UV photodiode. The detector has a universal response to all species which absorb in the 120 nm region. See Figure _ below. No response is observed for

for noble gases or nitrogen. Thus, helium or nitrogen make ideal carrier gases. The detector responds in accordance with the Lambert Beer Law:

$$I = I_o e^{-kx}$$

where **I** = Measured intensity

I_o = Incident intensity

k = absorption coefficient

x= path length

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Photons emitted from the far UV lamp (**I_o**)are absorbed by molecules passing through the cell causing a net decrease in photon flux to the photodiode (I). The changes in photon flux exhibits the Lambert Beers law relationship with concentration. The photodiode responds to the decrease in lamp flux and the change is amplified and recorded.

The linearity of this detector is better than 10^4. The sensitivity of this detector is similar to the FID for methane and 25-100 times better than a TCD for selected compounds. In addition, the FAV detector is nondestructive and can be run in series with other detectors. Applications include trace levels of 0_2, H_20 and inorganic gases which have been difficult to detect at sub-microgram levels previously.

Features

- *Universal Response-*
  Responds to organic and inorganic compounds that absorb at 120 nm with **detection limits 100 times lower than TCD**
- *Sensitivity-*
  Subnanogram for most compounds-
- Suitability for Capillary Column Analysis
  Low dead volume (<50µL) allows operation with minimum make-up
- *Non Destructive-*
  Allows series operation of detectors
- *Simplicity of Response*
  Unidirectional peaks, Beers Law Relationship
- *Adaptability-*
  Is readily adaptable to any chromatograph
- *Ease of Operation-*
  - no additional gases needed
- *Linearity-*
  - >10^4

The detection limits for a number of compounds are given below in Table:

Applications

- Trace water in helium, nitrogen, semi conductor gases, or process streams
- Detector with nearly universal response & detection limits in the low or sub ppm levels
- Responds to all hydrocarbons with equivalent or better sensitivity for CH_4 than the FID

Ideal complement to the PID

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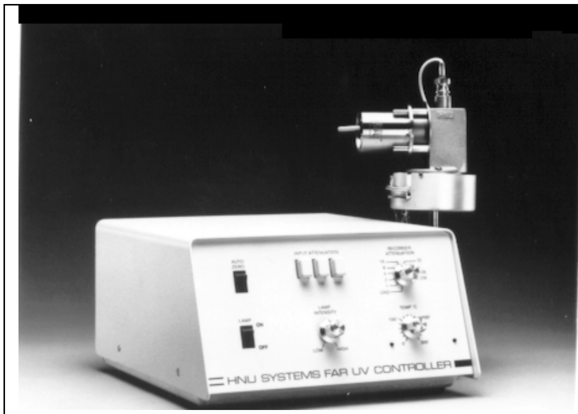
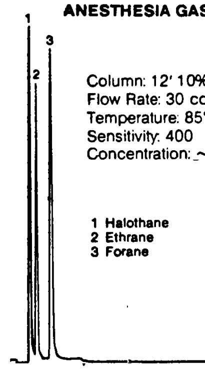
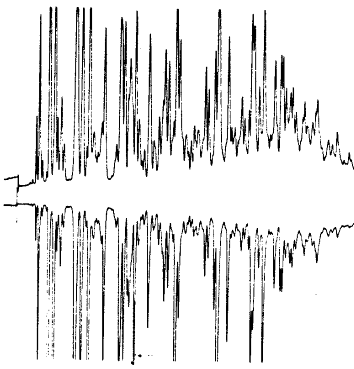


ANESTHESIA GASES



Column: 12′ 10% Apiezon L
Flow Rate: 30 cc/min. He
Temperature: 85° isothermal
Sensitivity: 400
Concentration: ~200 ng each

1 Halothane
2 Ethrane
3 Forane

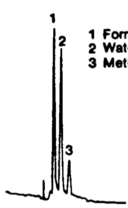


DETECTION LIMITS WITH FAR UV ABSORBANCE DETECTOR

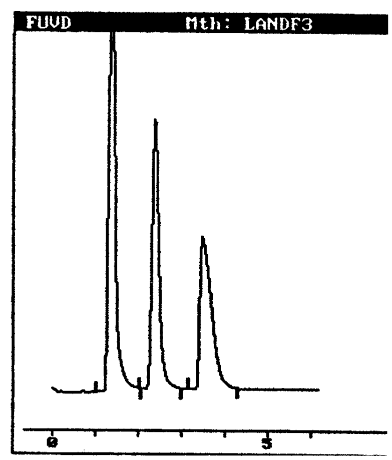
COMPOUND	LLD (ng)	COMPOUND	LLD (ng)
Sulfur Dioxide	0.7	Propane	1
Ammonia	2	Ethylene	1
Water	3	Formaldehyde	2
Hydrogen Sulfide	3	Methanol	27
Nitric Oxide	7	Freon 12	3
Carbonyl Sulfide	7	Methyl Chloride	8
Oxygen	14	Chloroform	5

FORMALDEHYDE, MEOH, WATER

Concentration: .1 μl Formalin Solution
Sensitivity: 400



1 Formaldehyde
2 Water
3 Methanol



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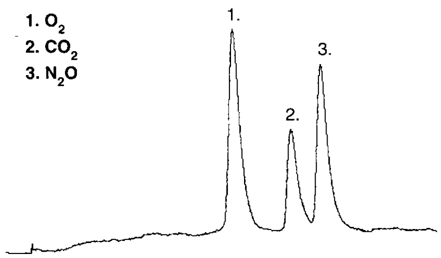
NSW-PLOT

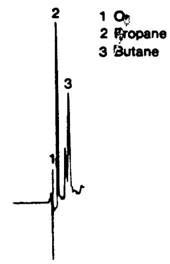
25 m x 0.53 mm

Isothermal: 40°
Direct injection
Carrier gas: He 2.8 ml/min
Detector: FarUV
Analysis time: 8 min

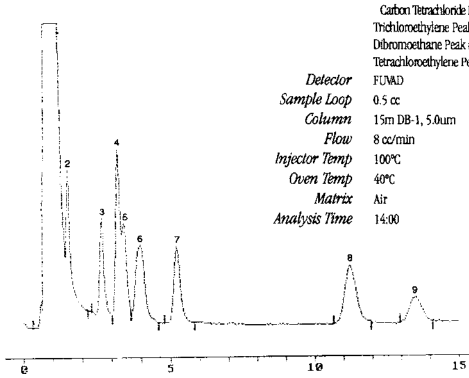


PROPANE BUTANE IN N_2

Column: 3.0′ Porapak N
Flow Rate: 22 cc/min. He
Temperature: 125°C isothermal
Sensitivity: 10
Concentration: ~100 ng each in N_2, trace O_2

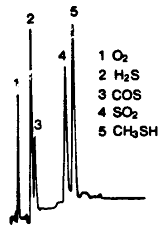


Sample	Methylene Chloride Peak #2 Chloroform Peak #3 1,2 Dichloroethane Peak #4 1,1,1 Trichloroethane Peak #5 Benzene and Carbon Tetrachloride Peak #6 Trichloroethylene Peak #7 Dibromoethane Peak #8 Tetrachloroethylene Peak #9
Detector	FUVAD
Sample Loop	0.5 cc
Column	15m DB-1, 5.0um
Flow	8 cc/min
Injector Temp	100°C
Oven Temp	40°C
Matrix	Air
Analysis Time	14:00



SULFUR GASES

Concentration: ~100 ng



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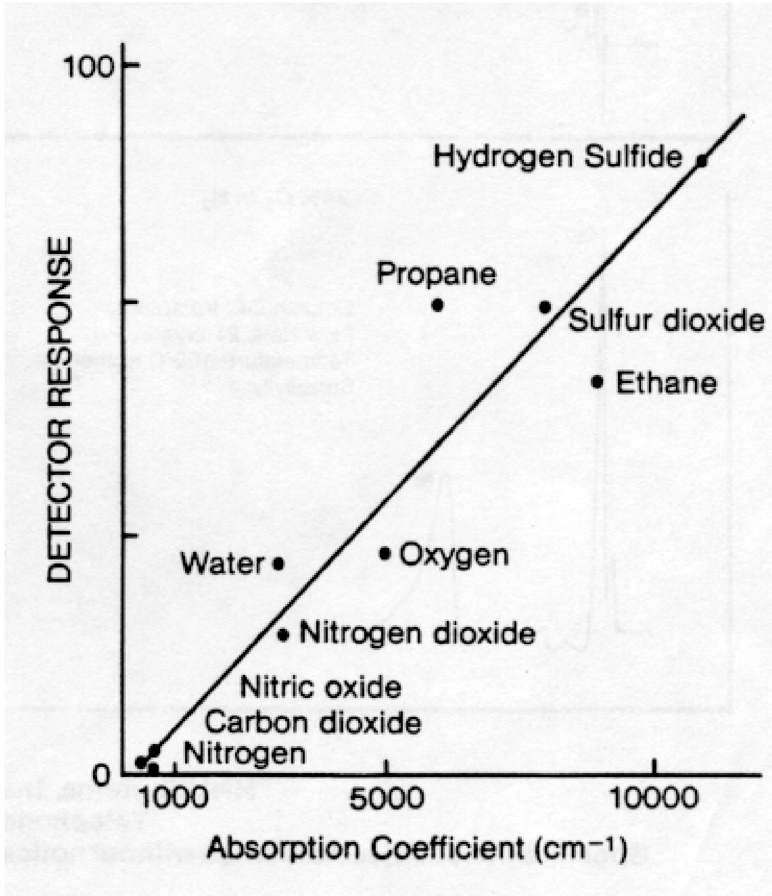

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