TEA Model 610 Nitrogen Analyzer

Advanced Chromatography Systems

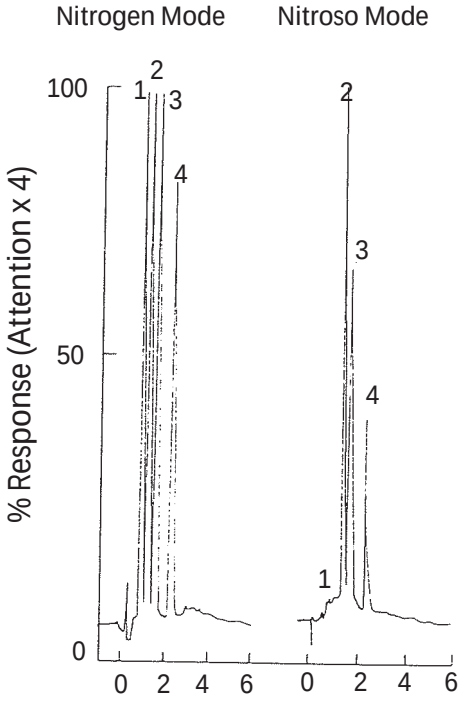
CSi

Applications

Nitrogen Versus Nitroso Modes

Gas Chromatograms of the Model 610 Nitrogen Analyzer used as a nitrogen and a nitroso analyzer. The Chromatograms were obtained using 1μl injections of 1 μg/ml solutions of pyridine, NDMA, NDEA, and NDPA. The Gc column was a glass tube 1.6m x 2mm i.d, packed with 10% carbowax 20M.

In the nitrogen mode, pyridine as well as the nitrosamines give a response. The response to the three nitrosamines is twice that for the pyridine because of the stoichiometric response to nitrogen. In the Nitrosamine mode, however, pyridine gives no response and the nitrosamine level is halved (with only 1 nitrosyl radical per molecule). This Halving of response from the nitrogen mode to the nitroso mode is a useful confirmatory test for the identification of nitrosamines.



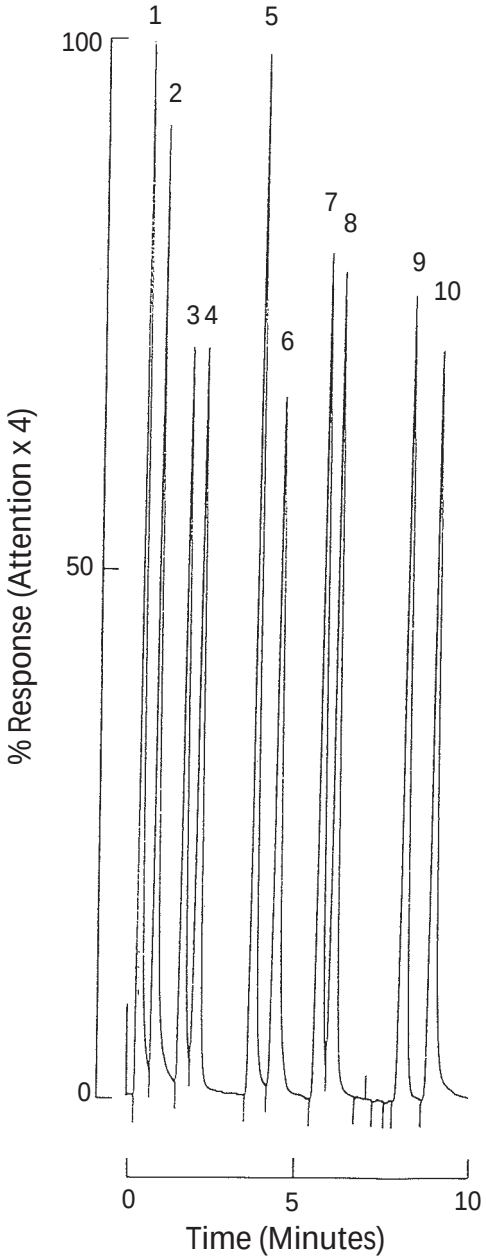
Compounds

1. Pyridine
2. NDMA
3. NDEA
4. NDPA

Detection of Aliphatic Amines

Compounds

1. Ammonia
2. Monomethylamine
3. Dimethylamine
4. Trimethylamine
5. Isopropylamine
6. N-propylamine
7. Diethylamine
8. Secondary Butylamine
9. Triethylamine
10. Morpholine



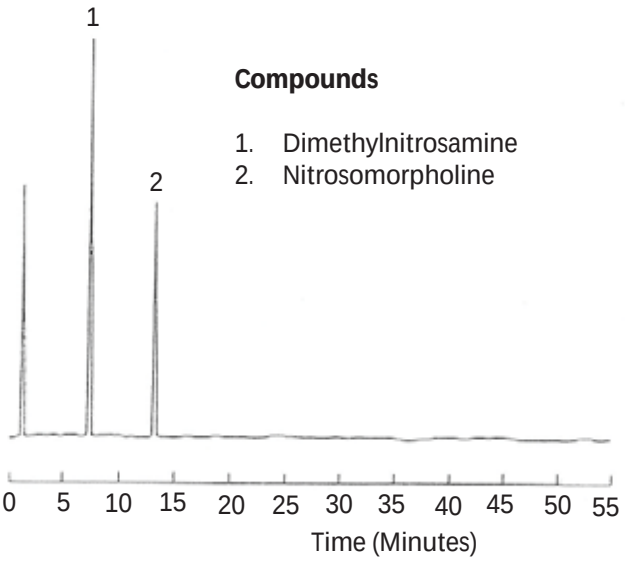
A Gas chromatogram of aliphatic amines illustrates the Model 610's selectivity for nitrogen and its compatibility with a wide variety of solvents. These capabilities enable the detector to be used routinely as an analytical method for the analysis of aliphatic amines, traditionally extremely difficult compounds to analyze because of their close structural similarities.

Model 610 Nitrogen Detection System

The TEA 610 Nitrogen Detector is the first GC detector that is a true nitrogen detector. The Selectivity for nitrogen-containing compounds is effectively infinite as the detector responds to nitrogen compounds in a ratio equal to the number of nitrogen atoms present. In addition to the retention time of the compound, these characteristics give unparalleled compound information compared to present GC detectors. The Model 610 provides a powerful analytical technique which is easy to understand and use.

The Chromatograms on this page represent three different modes of detection with the Model 610 Nitrogen Detection System. The Chromatograms were obtained on a single instrument using a 1μl injection of a diesel exhaust extract spiked with a component mixture of nitroso, nitro and nitrogen compounds. The only difference between the chromatograms is the detection mode of the Model 610.

Nitroso Mode



Compounds

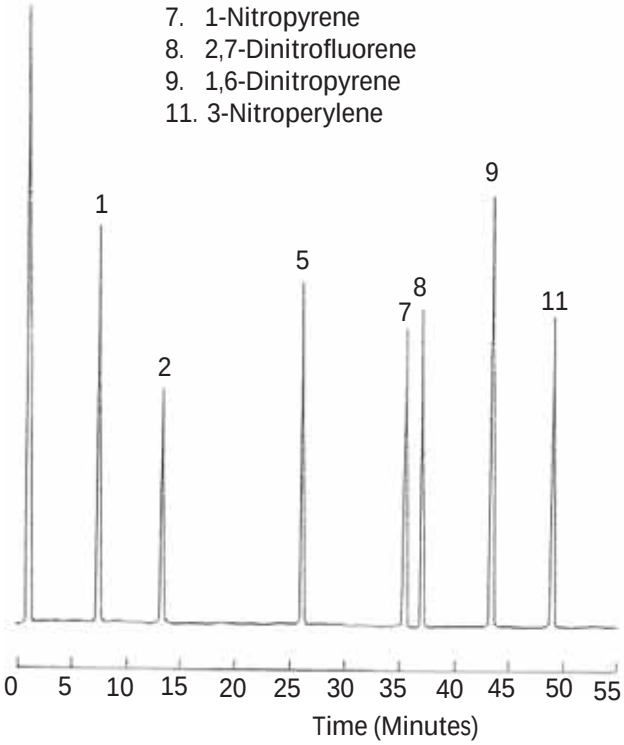
1. Dimethylnitrosamine
2. Nitrosomorpholine

In the Nitroso mode, the detector does not respond to the nitro-aromatics or nitrogen compounds present in the sample. In the chromatogram only the two nitrosamines are detected. This allows distinction between nitroso and nitro-aromatic compounds by the simple adjustment of the detector parameters.

Nitro Mode

Compounds

1. Dimethylnitrosamine
2. Nitrosomorpholine
5. 9-Nitroanthracene
7. 1-Nitropyrene
8. 2,7-Dinitrofluorene
9. 1,6-Dinitropyrene
11. 3-Nitroperylene

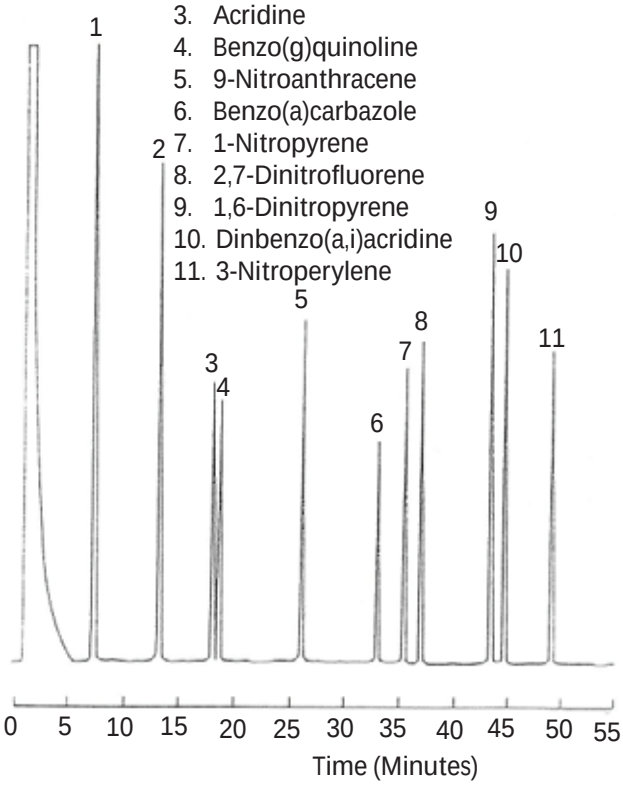


In the nitro mode, the detector responds to the nitroso and nitro compounds but does not respond to nitrogen compounds. In the chromatogram only the 2 nitroso and 5 nitro compounds are detected. This ability allows selective confirmation between nitroso and nitro compounds versus nitrogen compounds.

Nitrogen Mode

Compounds

1. Dimethylnitrosamine
2. Nitrosomorpholine
3. Acridine
4. Benzo(g)quinoline
5. 9-Nitroanthracene
6. Benzo(a)carbazole
7. 1-Nitropyrene
8. 2,7-Dinitrofluorene
9. 1,6-Dinitropyrene
10. Dinbenzo(a,i)acridine
11. 3-Nitroperylene



In the nitrogen mode, the detector responds to all 11 spiked components but gives no response for non-nitrogen compounds, including the polyaromatic hydrocarbons present in the diesel extract. The increased peak heights for the two nitrosamines is due to the response of the detector in the nitrogen mode which allows detection of both nitrogen atoms of the nitrosamine.

Refer to the Nitrogen Versus Nitroso Modes on the Applications page.

Principle of Operation

Nitrogen Mode

In the nitrogen mode of operation, the GC effluent containing nitrogen compounds is passed through a catalytic pyrolyzer at a temperature from 700 to 850˚C to produce carbon dioxide, water vapor, and nitric oxide. At temperatures from 700 to 825˚C, all nitrogen, except molecular N_2, in any nitrogen containing compound is converted to the nitrosyl radical.

Under Vacuum, the nitrosyl radical is then reacted with ozone to produce electronically excited NO_2. The NO_2 rapidly decays to its ground state, emitting light in the process. The light is detected by a sensitive photomultiplier whose signal is amplified and displayed on a chart recorder or integrator.

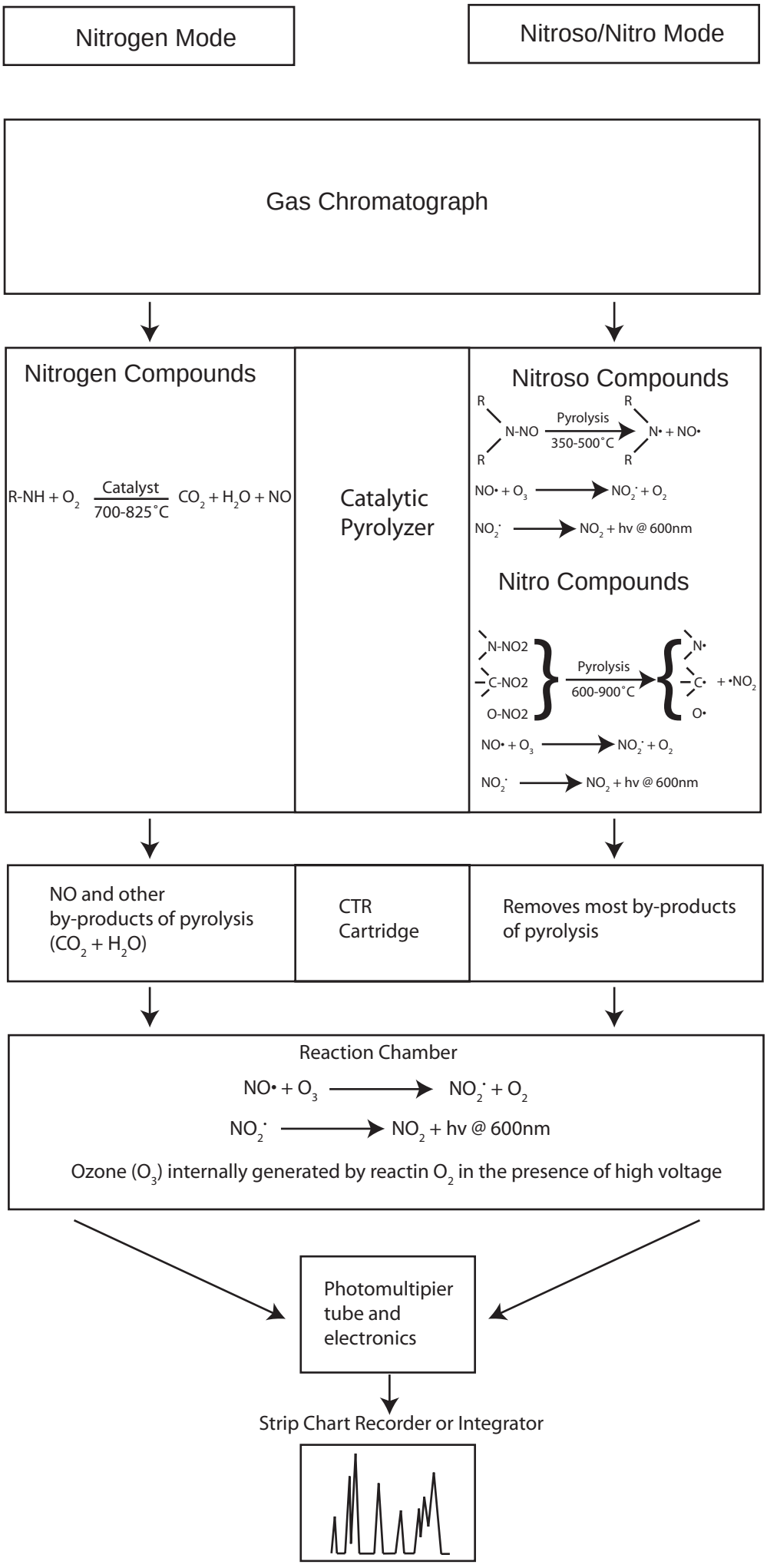
Since all organic materials (including solvents) Produce CO_2 and H_2O as pyrolysis products, the detector is uniquely selective only for those samples which contain nitrogen.

Nitroso/Nitro Mode

In Nitroso/nitro mode, the GC effluent is introduced into a reductive catalytic pyrolyzer. In the catalytic pyrolyzer under vacuum, nitroso and nitro containing compounds cleave at the -NO or -NO_2 bonds, releasing the radicals. The nitro radicals are further decomposed to nitrosyl radicals in the high temperature pyrolyzer. The pyrolyzer reaction products then pass through a gas-stream filter which allows only the nitrosyl radicals to pass through.

These nitrosyl radicals then react with ozone under vacuum to produce electronically excited NO_2. The NO_2 rapidly decays to its ground state emitting light in the near infrared region which is detected by a sensitive photomultiplier. The signal is amplified and displayed on either an integrator or strip chart recorder.

In the diagram, the yield of NO is a direct measurement of the nitro, nitroso, or nitrogen compounds present.



The Model 610 Nitrogen Detector Provides

Proven Technology

The Principle of chemiluminescence has long been known as a simple, reliable detection method. The model 610 incorporates the reliability of a steady state system with advanced pyrolysis techniques, the model 610 detector is optimized for GC analysis.

Performance

The model 610 nitrogen detector requires minimal sample preparation because of its unmatched selectivity in both the nitroso/nitro and nitrogen modes of operation. The instrument is capable of detecting picogram quantities of organic nitrogen, nitroso, or clinical matrices.

Dual-Mode Operation

The model 610 nitrogen detector is really two detectors in one. The development of a unique two-stage catalytic pyrolyzer allows specific detection of both nitroso and nitro compounds in one mode and general nitrogen detection in the second mode. By Switching a single control on the front panel of the instrument, the detector can be converted from one mode to the other. This dual-mode operation gives the instrument great flexibility for use as a means of confirmation, or for identification of unknown components.

Adaptability

The model 610 nitrogen detector is easily adaptable to any gas chromatograph. The interface between the gas chromatograph and the detector is mounted outside of the oven on the column exit with a factory supplied bracket. Installation requires only minimal plumbing and a single gas supply. The heated interface is completely controlled by the model 610 detector.

Infinite Selectivity

The most significant characteristic of the model 610 is its unique selectivity for only the nitrogen atoms present in a sample. Thus, the selectivity of the instrument for nitrogen-containing compounds is infinite.

Maximum Sensitivity without Saturation

The selectivity of the model 610 allows it to be used at maximum sensitivity without becoming saturated by compounds that do not contain nitrogen. In contrast, most other nitrogen detectors have only a 10^3 or less rejection ratio for non-nitrogen compounds.

Environmental and Clinical Screening

The non-response of the model 610 to compounds lacking nitrogen allows the instrument to be used to screen for trace nitrogen-containing compounds in environmental and clinical matrices with minimal sample cleanup.

Use with a Wide Variety of Solvents

The selectivity of the Model 610 for only nitrogen-containing compounds permits a wide variety of solvents to be used. This allows the most appropriate extraction procedure to be used for each individual analysis.

Specifications
TEA Model 610 Nitrogen Detection System

Sensitivity
Detection Limit for Nitrogen better than 1 x 10^{-11} grams N/sec (10 picograms at S/N of 3 to 1)

Selectivity
Unmatched selectivity of nitrogen versus non-nitrogen compounds

Linearity
Four orders of magnitude

Reproducibility
Typically better than 2%, limited only by the precision of the GC

Recorder Out put
0-1mv, 0-10mv

Integrator Output
0-1 Volt

Operating Temperature
10 to 32˚C (50 to 90˚

Ordering Information

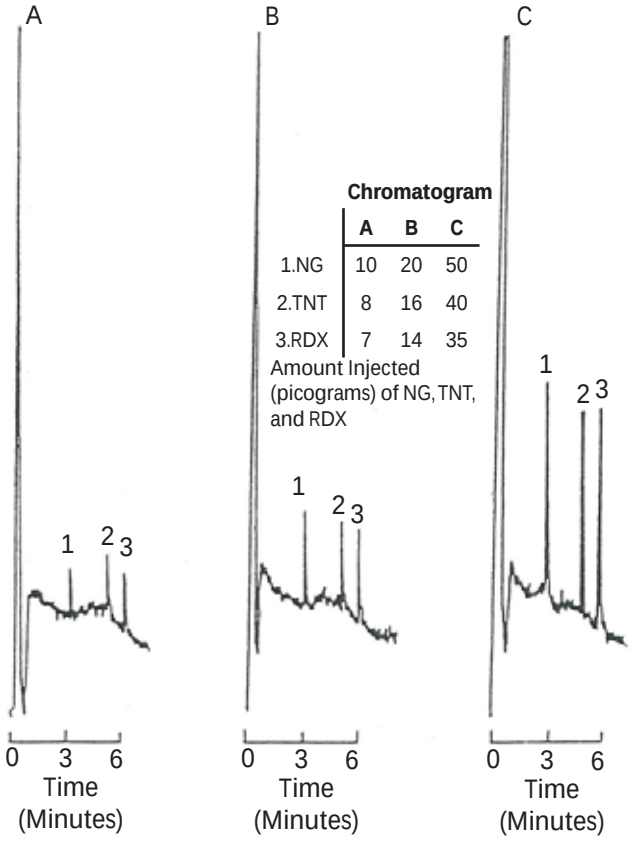
TEA Model 610 Nitrogen Detector
110V/60 Hz, Part Number 10320
220V/50Hz, Part Number 10350

Size
Height : 40.6cm (16 inches)
Width: 99.1cm (39 inches)
Depth: 63.5cm (25 inches)

Weight
Unit: 61.4Kg (135lbs)
Shipping: 77.3Kg (170lbs)

Power Requirements
100, 115, 220, or 240 VAC, 50 or 60 Hz
14 amperes instantaneous, 9 amperes continuous, 15-ampere dedicated line

High Sensitivity

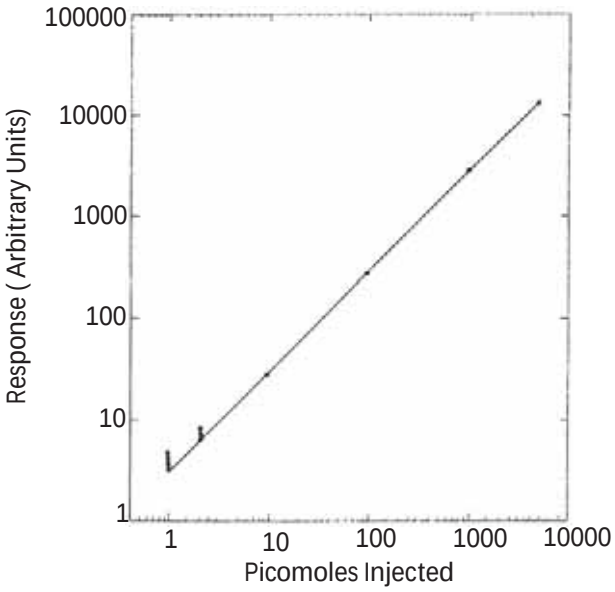


Chromatogram

	A	B	C
1.NG	10	20	50
2.TNT	8	16	40
3.RDX	7	14	35

Amount Injected (picograms) of NG, TNT, and RDX

Linear Response



This series of gas chromatograms shoes the sensitivity of the Model 610 Detector for picogram amounts of NG, TNT and RDX. The first chromatogram represents 10, 8, and 7 picograms of the materials, respectively.

A graph of the three compounds - acetonitrile, pyridine, and morpholine - shows that the model 610 Nitrogen Analyzer is linear over 4 orders of magnitude. The molar response of each of these nitrogen compounds produces an identical recorder trace.